Texas Packet Radio Society Projects : An Update

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Abstract

The last paper published in the ARRL Networking Conference concerning TexNet was in 1987 (I) and we felt it was about time to publish an update. This paper will discuss the current status of the Texas Packet Radio Society's TexNet development, TexNet TexLnk software for the TNC, and the TexNet CARDINAL project. We hope this paper will serve as a method to further distribute information regarding TPRS projects and be able to generate correspondence from interested parties about our activities.

Introduction

Figure 1 shows the current status of the Texas/Oklahoma/Arkansas network. The Texas and Oklahoma networks were joined in May 1990, adding an additional 400 miles of RF network. The future looks bright for further development and expansion of the network using both RF and landline links. Handling day to day problems on the network has now turned into a part-time job. Ever since the eighth network node, the network is in an ever changing state — nodes will break, get struck by lightening, fall off buildings, and about everything else you can think of will happen! The fun part of the TexNet network was in the designing, implementation, and deployment. Now an enormous amount of work is done in supporting node owners, keeping hardware working, and making the networkoperational. Building a network is fun, maintaining it becomes an effort of love. Many of the projects described in this paper are the results of now having a network large enough to finally test how TexNet works and operates.

Further expansion of the network outside of Texas will be possible by an agreement recently made with Southwest Network Services (SNS) for circuits to cities in Texas and other states. TPRS is the sole contact and coordination will occur through TPRS. Please do not contact SNS about this service. These are 9600 bps, point to point circuits, and TPRS intends to extend coverage of the TexNet networkto such cities having individuals wanting to support and join in the eff ort. A few cities available outside of Texas are Oklahoma City Tulsa, Baton Rouge, New Orleans, Birmingham, Atlanta, and Nashville. These circuits are available now. Future cities include Denver, Los Angles, San Francisco, Phoenix, and others. Those interested in SNS coordinated TexNet service should write TPRS. The possibility of extending the network coverage and allowing this service to act as a bridge to other TexNet-like networks is exciting (3). Also, the development of GLNET (2) in Michigan has been astonishing, occurring at a rate of about twice the Texas network expansion. Since Dayton '90, 11 nodes are now operational. GLNET is currently the third working TexNet network outside of the state of Texas.

Software Update

TPRS has continued refining and improving the TexNet software, with the final version of 1.5 being released this last June. TPRS has been utilizing version 1.4 of the TexNet code for 2 years, and predecessor versions from 1 .O over four years Versions 1 .0 and later provided automatic network routing, with automaticalternate routing. The routing function automatically builds the complete network map in a distributed fashion, as has been reported

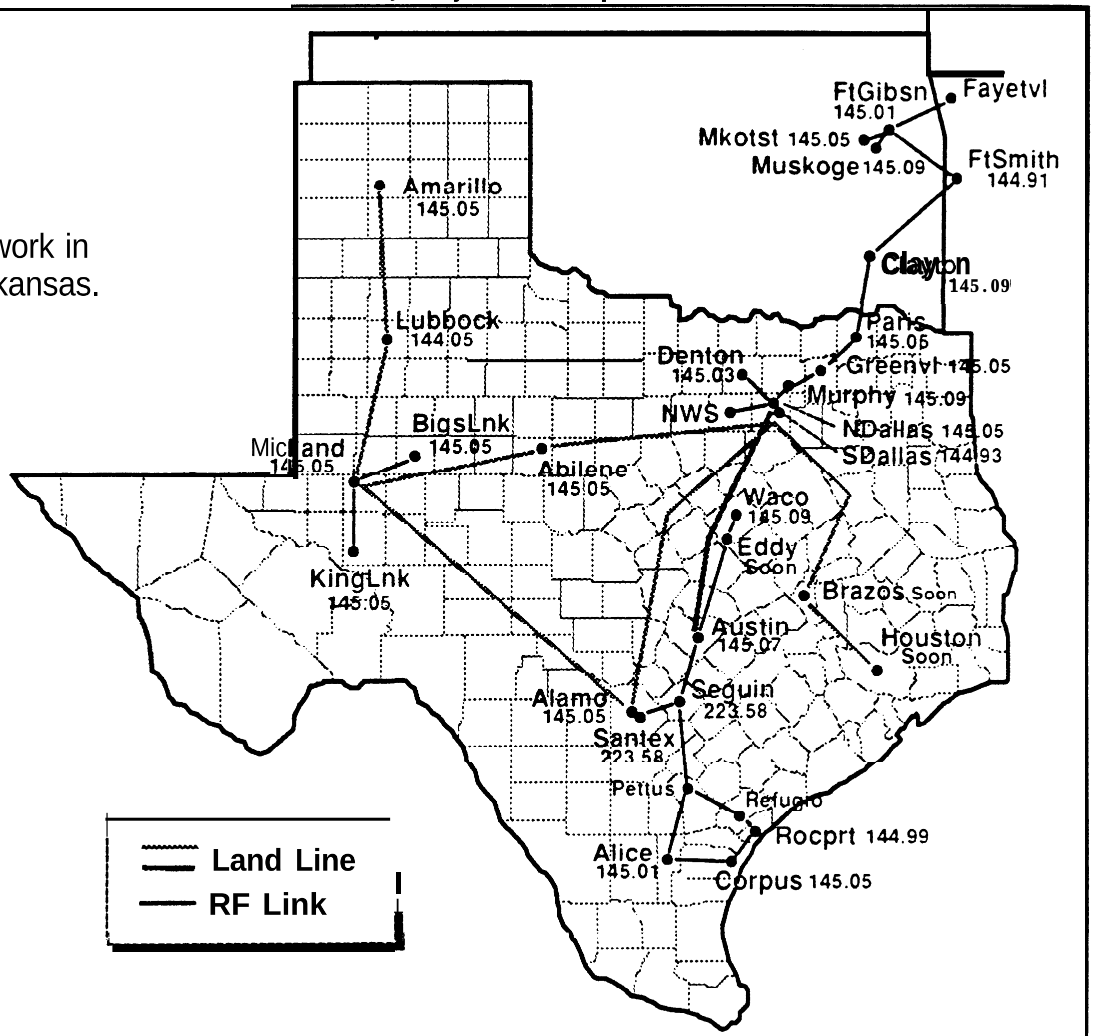

Figure 1:
Current **TexNet** network in Texas/Oklahoma/Arkansas.

previously (I). Over the last five years, the network has grown to **40** nodes, utilizing 9600 baud 440 trunks, with over 1000 miles of radio paths at 9600 baud and over **1500** miles total networking including landline connections. RF links in the entire system are on the same frequency (+/-2 PPM). Several links are 70 miles long without the benefit of mountains. During the last few years, we have observed a number of 440 MHz propagation openings. The original design of the network software allowed programming of marginal-trunk lock-outs in each node image, to prevent slightly over-the-horizon conditions from causing routing events to bypass adjacent hops. Approximately ten 600+ mile propagation openings have occurred each year where the network routing has assumed adjacency between pairs of nodes 600+ miles apart. When ıe band opening ceased, the routes would then be stale' and the time it took for the new routes to be corrected was unacceptable. Another affect of band openings and node failures was the creation of asymmetrical routing in the network, which is seen by having a good 'to' route but the 'return' route has failed, causing packets to be lost in the either.

In late 1988 the TexNet Network Management System (NMS) was placed on the air to take care of wide-area network anomalies and manage day to day operations of the network. Creating this system both supported the short term problems in wide-area network support and allowed the long term development of an intelligent network supervisor. The NMS 'polls' each node in the system every 10 minutes, and calculates network statistics. Each night at midnight, it uploads three network performance reportsto one of the network message servers. These reports show the retry rate, transmitted frame count, received frame count, buffer utilization, and number of user log-ons on every link on every node in the network for the day. Additionally, the outage-table shows each ten-minute slot during the day for each node, showing information on which particular nodes did not respond to a poll (within 59 seconds). This information has been used to show time-of-day dependencies on network performance. Additionally, the NMS takes automatic corrective action at nodes that appear to be dead (don't respond within 59 seconds of a query). It is capable of sending a node-specific 'fire-code' sequence to fail-safe hardware in each node by broadcast-flooding this sequence throughout the network in order to remotely reboot any node. No operator intervention is required for any of these events, thus making the network more reliable.

On February 17th, 1990, the TexNet Support Group met to discuss the future of TexNet software and to discuss the anomalies seen in the network. This meeting has led to the current 1.6 software now underdevelopment and testing. Version 1.6 is aimed strictly at correcting wide-area network operation anomalies which have only now been discovered with the network of this size.

The new version 1.6 code fixes affected network trunk conditioning under extremely marginal signal conditions, but more importantly, allows remote manipulation of the network routing tables. This new network code allows the NMS to read and reprogram the network routing tables from a central location without any operator intervention. The new version of the NMS that supports this will allow for NMS to realign the network routing automatically to compensate for propagation anomalies, orcertain types of equipment failures. The network is still capable of automatically setting up its routes in a completely distributed fashion, but we can now offerover-riding 'help'forthetables when necessary.

TexNet TexLnk TNC Project

The original TexNet code was developed on the TNC II, until the first TexNet NCP (4) was built and the code moved to the NCP. After a year of working on the 1.4 and 1.5 code and examining the originally developed code, Jim Brooks, W5ERO, was able to get a single port version of TexNet code again operational on a TNC II. The project is now called TexLnk, since the purpose of TPRS getting this software working again was to create inexpensive high-speed links between network nodes and provide thin-route networking in West Texas where the population of packet users does not demand full-blown TexNet nodes yet. The project was not done to create another, poo operating, single frequency network. TexLnk and CARDINAL, described below, are both intended as supplemental technology to allow more robust networking options.

During the beta-test period, two high-speed linking nodes were deployed and have worked as expected, providing 9600 baud networking between sites with NCPs. This is accomplished by adding a TPRS 9600 baud modem as the external modem. One drawback to the current TNC version is that it does not support the hardware 'firecode' feature available on TexNet NCPs. Firecode allows the node to be hard-reset remotely by command. One of the nodes was equipped with a tone decoder reset and the other was not. The one without required a 35 mile drive to reset it, which has only been required once, since most problems can be corrected by a soft-reset which will still work without the hardware 'firecode' circuitry.

TPRS has been hesitant in releasing this software to the public, since TPRS feels that people will try to make it work as a single-frequency network, which will work, but not give the same performance as TexNet. TexNet works well because: 1) the network trunks, which are on a separate frequency to avoid congestion problems, operate eight times faster than user access to the network, 2) the network software works very well, and 3) the quality network services provided to the user. TPRS is releasing this software as a 'SHAREWARE' (5) product. Contact TPRS about getting a copy of the software and utilities. A manual, image editor, and paper on how 'not to use it'should be available by the networking conference from TPRS.

TexLnk provides the same software functionality as a full-blown TexNet node, except that it is a single port node. The features provided are : Digipeating, Conference Bridge, Networ' Interface, and Local Console. For more informatio. on TexNet services refer to the TPRS TexNet User's Manual (6) or the 73 article on TexNet published in October 1989. (7)

Two dual port projects are being worked on. Hopefully an inexpensive dual-port solution will be available in the coming months to allow this software to be used as a low-cost dual-port TexNet node running on a TNC II, providing 1200 baud local access and 9600 baud networking.

CARDINAL Project

The CARDINAL card is a communications coprocessor card for an IBM-PC XT/AT compatible computer. The design has been tested and is operational with boards in layout. CARDINAL allows vastly simplified development of AX.25 based applications, network applications, and additional services or features for the TexNet network. The original intent of the CARDINAL project was to replace the first and only software development platform for TexNet (8). By having a plug-in card, we can now use the power of the PC for development and provide multiple cards to TexNet developers for faster code development. From the initial design, the current project has been worked on to allow the card to do much more.

CARDINAL contains almost identical components to the TPRS Node Control Processor (NCP) board that is used as the standard TexNet node. It contains 2 SIO/0 serial chips, a Z80 processor, Z80-CTC, 64K of RAM, a dual-port connection between the Z80 and the PC-XT bus for use of the RAM, and optional hardware breakpoint logic. The dual-port is actually just a standard single-port static RAM, but special logic on the board 'steals' the Z80 refresh cycles, and sequences the PC access during this time. This is a very cost-effective way to implement the dual-port hardware. The current TexNet code image runs, unaltered, on the PC-plug-in card. For the Z80, layer-2 drivers for versions 1 and 2 of AX.25 are available (for those who don't really care about TexNet) and a native TexNet layer-3 driver is developed and being debugged. All three have been proven operational at 9600 baud.

The PC drivers allow the passing of data frames, and control requests from the PC to the Z80 processor and vice versa. The Z80 acts as a coprocessor, and in fact, operates continuously even as the PC is rebooted with a CTRL-ALT-DEL, since the CARDINAL card ignores the PC-reset line. These drivers are supplemented by a TSR in the PC that periodically queries the 280 for completed send and receive packet activity. The TSR runs in the background, and will support shared ring-buffers for both transmit and receive in the PC RAM so that the application on the PC can ignore any real time aspects of the communication task. An application has been written in Borland's Turbo-C that merely queues up transmit requests or examines received queues for incoming data. In this way, the PC application task needs to know almost nothing of the AX.25 or TexNet protocols, and have no timing constraints whatsoever. A simple network-capable multi-user read-only BBS with directory functions took less than 3 pages of 'C' code to implement using these drivers. Since the function calls and buffer passage resolve all data and control possibilities via function codes, it is not necessary to parse ASCII strings to manage connection setup and teardown.

Extensive debug utilities are written, that allow download of coprocessor software, single-step, breakpoint, register alteration, programmable trap, memory dumps, and disassembly of the current image. The debugger is written in 'C' and runs foreground on the PC, but can leave hardware traps and breakpoints armed before exiting. These armed traps allow debugging both the coprocessor and simultaneous applications on the PC.

The low-level device drivers on the PC are based on 'handles' so that the actual I/O addresses and the number of CARDINAL cards plugged into the PC can be easily selected by function calls. The device driver returns a 'handle' to the selected CARDINAL card. This facilitates changing the actual PC I/O address of the card, and allows multiple cards to be plugged into a single PC. The current card has up to 4 synchronous channels and straps on the CARDINAL card allow 4 different addressing ranges, resulting in the ability to construct a 16-port (synchronous AX.25) PC configuration. The TSR level drivers have programmable transmit and receive buffer ring sizes, allowing optimization for different applications. The PC drivers and TSR are written in 8086 assembly language.

The native layer-3 interface to TexNet makes it fairly easy to add new and diverse network capabilities to TexNet. Applications being planned include support for other network types, database applications, DX Cluster support, a new weather server, and others. Having the application in the PC and not in the node, will allow us to get away from the current space constraints and having to write Z80 assembly for the TexNet NCP.

An example usage of CARDINAL might be : a user at any node types the string: 'Message @ CARDNAL' and is automatically connected to and assigned a unique network-layer port number at the CARDINAL card. The network knows how to route the request (due to it's automatic routing function) and the recipient node knows the entire layer-2 and layer-3 address from the network datagramstructure. Up to this point, the PC software hasn't done anything yet! The PC software is passed a buffer with the user connect call string, and the unique port and layer assignments by the 280. This simple scheme facilitates adding new applications that appear to be part of the network, but without new users needing to know anything about callsigns, locations, or networktopology, etc. This maintains the transparent appearance to the user which is part of the TexNet network design. The 'C' application on the PC responds with either a log-on function, or an application selection query message to the user, depending on what the user has asked for. Plans are being discussed to add a services broadcast to version 1.6 which would allow users to know which services are available at which nodes on the network.

Conclusion

What comes after these projects for TPRS? Only time will tell, but some guesses are: providing more diverse services across the network, increasing networkthroughput either by increasing speed or by using data compression — allowing users to access the network faster, integrated voice and data networks, TexNet ported to other platforms, and probably a whole bunch of other brain storms we haven't even had yet. If you would like to know more about any of the above projects or want to find out more about TPRS, please feel free to write.

NOTES:

1. McDermott, Tom, N5EG. "Overview of the TexNet Datagram Protocol". Proceedingsof the ARRL 6th Computer Network Conference. Redondo Beach, California. 1987.

2. Great Lakes Network. Contact Jay Nugent, WB8TKL, 3081 Braebum Circle, Ann Arbor, MI, 48108.

3. "Southwest Network Services". TexNet Support Group, TPRS Quarterly Report. Volume 7, Issue 1, July 15th, 1990. p 18.

4. Node Control Processor. The computer section of a TexNet node.

5. SHAREWARE - If you use it, then please send in the registration per-node to TPRS so that we can keep working on new things.

6. TexNet User's Manual available from the TPRS for $1.00.

7. Jones, Greg, WD5IVD. "TexNet Packet-Switching Network" 73 Amateur Radio. Issue 349 October 1989.

8. The TESTBED node was the only memory resident TexNet node built. Built by Tom Aschenbrenner, WB5PUC it was used to write all of the original version 1 .O code. TESTBED was an elaborate multiboard homebrew CPM system which emulated a TexNet node.