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COMMAND AND CONTROL RELATED COMPUTER TECHNOLOGY: PACKET RADIO.(U)

MAY 81 M BEELER, T MYER, V STRAZISAR

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Report No. 4671

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**Command and Control Related Computer Technology:
Packet Radio**

Quarterly Progress Report No. 5
1 December 1980 to 28 February 1981

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COMMAND AND CONTROL RELATED COMPUTER TECHNOLOGY:

Packet Radio

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1. INTRODUCTION

The Packet Radio station provides a variety of control, coordination and monitoring functions. BBN's role in developing this software is to specify, design, implement and deliver programs which perform these functions. BBN has additional roles in developing internet software for host machines and gateway software for interconnection of networks.

During this quarter BBN personnel participated in meetings on both Packet Radio network and Internetwork issues, as covered in section 2. Section 2 also covers publications and negotiations.

Section 3 reports important developments in several parts of station software - ELF, STACON, SPP, TCP, PRLOAD, and especially LABEL. The Labeler has undergone extensive development and testing this quarter with CAP 6.0, which is now in full overlap multistation operation.

In section 4 appear reports on the Internet Protocol and Transmission Control Protocol, and on gateways. Considerable effort has gone into bug fixes to achieve more robust and reliable software in these areas.

Finally, section 5 covers work on hardware associated with BBN's Packet Radio efforts this quarter.

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2. MEETINGS, TRIPS AND PUBLICATIONS

2.1 Meetings and Trips

BBN personnel attended the Internet Working Group Meeting at ISI on January 28 to 30. In addition to status reports on the various IP, TCP, and file transfer protocols at each site, system design objectives were outlined and discussion commenced on an extended addressing scheme. Discussions concerning source routing and multi-connected hosts were postponed until a later meeting. We announced the availability of a number of bug fixes and held discussions with ISI concerning bug reporting and fixes for the TENEX/TOPS20 internet software.

In collaboration with other project participants, we developed an agenda and subsequently attended the CAP 6 Design Review Meeting which was held at SRI January 26, 27, 1981. Among other developments, this meeting resulted in a set of recommended changes to the CAP 6 Labeler, which became the center of attention for our work on that part of the system during this reporting period (see Section 3.3).

2.2 Publications

Documentation was completed for the CAP 5.6 and CAP 6 versions of the station SPP module and for the CAP 5 and CAP 6 versions of the Packet Radio Network/ARPANET gateways. CAP 6 Labeler documentation was prepared and distributed.

Updated user documentation for the TENEX/TOPS20 internet software was made available on BBNA: Internet User Queues (IN-USER-Q.DOC) and TCP JSYS Calling Sequences (TCP-JSYS.DOC).

2.3 Negotiations and Informal Documents

We participated in discussions with Fort Bragg and SRI that focused on the congestion and load problems experienced at Fort Bragg. Our recommendation was to install CAP 5.6 software at Fort Bragg as a means for relieving their congestion problems and at the same time improving station performance under heavy load.

3. THE PACKET RADIO STATION

3.1 ELF Operating System

Throughout this project, it has been assumed that Packet Radio Stations will have ARPANET connections. Recently, there have been discussions concerning the implementation of a station which does not have an ARPANET connection. As a first step toward this goal, the ELF system was modified to allow the Packet Radio station to be booted from disk and run without a functioning ARPANET connection. The station is assembled to contain an 1822 interface to the ARPANET, and this hardware interface must be included in the station hardware configuration. However, if the connection to the ARPANET is not working (for example, if the ARPANET IMP is down), the station can be booted and run from disk. If the station is running at the time that the ARPANET connection fails, the station will continue to run.

This modification is one of several that will be needed to support a non-ARPANET station. Beyond this, stations must be reconfigured to run without the 1822 interface hardware, and the more difficult problems of delivering new station software and debugging station software must be solved.

3.2 STACON Terminal Control Module

A problem in the Station Operator Control Module (STACON) was corrected. The operator interface to the station includes a command which allows the user to flush the contents of the buffer currently being printed on the teletype attached to the STACON process. This feature is especially useful in controlling diagnostic printing of packets received and sent to the Packet

Radio Network. The packet printer produces a considerable volume of data, and the operator may wish to discard the remainder after seeing the relevant packet printout. A fault in the code which implemented this feature had caused the station to hang up at random intervals; this problem was fixed and new versions of the STACON module were delivered to all PR Network sites.

3.3 Labeler

This quarter's work on the Labeler process focused on the CAP 6 version of the software. The design review meeting at SRI suggested a number of changes to the labeler. These include:

- o Route patch packets to establish modifications of a route without the need for complete redefinition.
- o Periodic station labeling.
- o Modifications to the labeler's behavior in response to a request for a zero-hop route.
- o Revisions to conform with the new packet formats which were agreed to at the design review meeting.

The revised packet formats made possible an additional labeler improvement, namely an increase in the maximum route length from seven to eight hops. This modification was relatively easy to accomplish since our matrix squaring algorithm can provide eight hop routes with our normal three squarings (two - four - eight hops).

During the quarter, each of these modifications was implemented and tested. In addition, we performed general testing and debugging activities. We carried out testing at Collins, which focused on revised packet formats and route loops. We also tested the CAP 6 software at SRI with emphasis on a

downloading problem (described below), mobile testing, and performance bench marking. The SRI tests also included the case of seven PR units simultaneously requesting labels (a case which exceeds station resources). Tests at BBN focused on the issue of two stations simultaneously serving one network.

During the various tests we located and corrected a number of software faults, as described in the following paragraphs.

Spurious repetition of route requests from the gateway PR were causing the Labeler to generate unnecessary repeated route set-up packets back to the PR. The route requested was to the gateway - a device attached to the gateway PR. Consequently, the problem was diagnosed as arising from the absence of TOPs from the gateway unit. The problem was eliminated by modifying the gateway software to emit TOPs in response to assertion of its ready line.

Under certain conditions the Labeler caused system failures with the error message "Packet Allocation Bug." This failure mode was caused by faulty handling of an unusual case of simultaneous conditions:

1. a label packet completing its round trip after three transmissions, and
2. a new label packet dispatched to the same PR before time out of the previous connection slot.

Problems were experienced by SRI under conditions of simultaneous downloading and labeling of a "new" PR unit. The difficulty was traced to a spurious discard of the PR in question from Labeler tables before loading was complete.

We located and corrected what is believed to be the cause of an intermittent and rarely occurring Labeler bug (occurrences at

most once or twice per month). Continued experience with the Labeler will hopefully establish the success of this modification.

The SRI station tests uncovered two additional Labeler problems when the route computation was increased from seven to eight hops maximum. The first of these proved to be a minor code fault whose effect was to consistently crash the station IPR.

One effect of this first problem was to destabilize the network to an extent sufficient to uncover a second and more serious problem. In particular, with IPR failure, the apparent network connectivity fluctuated repeatedly with PR units appearing to be added and discarded in rapid succession. Under these conditions a software fault was activated which wrote over random locations in memory.

Finally, testing at BBN's two station network revealed an ancient Labeler bug which has existed since early CAP 5. This was analyzed and corrected, resulting in new versions of both the CAP 5 and CAP 6 Labeler releases.

As of the end of this reporting period, we have delivered the CAP 6.0 Labeler software to SRI, and we are preparing to release the updated CAP 5 version to Fort Bragg pending final tests at SRI.

3.4 SPP (connection) Process

We released new versions of the SPP2 (station to packet radio protocol) module for CAP 5.6 and CAP 6. Several problems were discovered while testing the TCP module, which calls on the SPP2 module to communicate with the Packet Radio Network. These

problems were corrected early in the quarter, and the SPP2 module was tested extensively at SRI. Later an additional SPP2 fault was found in the code for retransmitting packets to the network. This code was revised appropriately and a new version of the SPP2 module delivered to all stations. The retransmission fault was encountered at both Collins and Ft. Bragg, but to the best of our knowledge was never seen in the station at SRI.

3.5 TCP Process

A TCP for the CAP 5.6 station was delivered. This was the first version that interfaced to the SPP2 process; earlier versions had interfaced to the station connection process which implemented the original SPP protocol. When the conversion to SPP2 began last spring, the TCP module was modified to interface to the new SPP2 module. The delivery of the new TCP software was delayed until this quarter due to the lack of hardware and software needed to test the TCP at BBN. The TCP was eventually debugged in the SRI Packet Radio Network.

A version of TCP for a CAP 6 station was also released this quarter. Minor modifications were made to accommodate changes in the packet header format and changes in the interface to the station SPP2 module.

3.6 PRLOAD process

Early in the quarter a new PR down line loader (PRLOAD) was delivered to Fort Bragg. After delivery, it became clear that, contrary to previous assurances, the Fort Bragg station was lacking the TCU-100 time of day clock which is specified as part of the standard station hardware ensemble. Consequently,

references to the clock hardware register locations caused a bus timeout trap, halting the station. A new version of PRLOAD was delivered, with all TCU-100 references temporarily commented out. This permitted the station to run, and all PRLOAD features to be available, except that all time of day printouts (station up time, print time, enable and disable loading watch, load start and load finish) printed meaningless time values.

Subsequently, SRI expedited installation of a TCU-100 in the Fort Bragg station, and we delivered a normal version of PRLOAD with clock routines reactivated. This version is now running at Fort Bragg.

Also during this quarter, we began testing PRLOAD in the multistation environment at SRI. SRI reported difficulties in simultaneous attempts by both stations to load a single PR. The design allows for such load attempts, which should not cause significant overhead or problem with the load operation. To diagnose the situation further details were needed on the functioning of the load procedure. Consequently, we modified PRLOAD to print additional data describing each load operation (when the load watch feature is enabled). Beyond the timestamp and loadee PR ID which were already contained in the printout, we added the loader PR ID, the packet number at which the load begins (to distinguish new loads from continuations), and the file name requested by the loadee.

At this writing we have found two suspicious occurrences above and beyond SRI's observation that many load attempts begin and end before the PR is satisfactorily loaded. First, we found that an abnormally high fraction of the load attempts - often well above half - are terminated for lack of any acknowledgement received by the station from the loader PR. Second, the load

attempts almost always start with packet zero, the first packet of a load, instead of a later packet, as would be expected in continuation of a failed load.

At the close of the quarter, we are pursuing this matter and expect to isolate some problem in the station, the PRs, or the down load protocol between station and PRs.

3.7 Support

Software was delivered to various sites this quarter as follows:

SOFTWARE	COLLINS	SRI	BBN
IPR CAP 6.0.6		X	
IPR CAP 6.0.7	X	X	X

In addition, both station and EPR CAP 5.5 software were recorded on each of two disks at Fort Bragg. In April, new versions of three station software modules were placed on one disk at Fort Bragg. The plan is to test this software and if it is acceptable, place it on the Fort Bragg backup disk as well. These three modules are an ELF which no longer needs an ARPANET connection, a STACON with a problem in the control-O feature fixed, and a PRLOAD which fully uses the time of day clock. These modules are discussed above in Sections 3.1, 3.2 and 3.5 respectively.

4. INTERNETWORKING

4.1 Internet Protocol and Transmission Control Protocol

We made progress on several fronts in the IP/TCP area, much of it guided by users' questions and problems. Except for bug reports, our interaction with the users suggested that the IP/TCP installation procedures and user-level documentation were not sufficiently detailed.

The April 1980 Installation Guide referenced a structure which is not normally accessible from the ARPANET. The files of interest had been moved to BBNC in the fall of 1980 to rectify this problem but, due to departure of the staff member responsible, the documentation had not been updated to reflect the change. Difficulties were also experienced with the operating system changes required for installing the Internet and Transmission Control Protocols in a TENEX or TOPS20 host. The trouble lay in differences between the corresponding modules of the two operating systems: TENEX has been evolving both at BBN and other sites since ARPA stopped supporting it, and the TOPS20 changes were keyed to DEC's pre-release Version 4 sources rather than the official release. In neither case did the source comparison files give enough context to pinpoint the required modifications. Two bug reports were traced to a site having missed one of the required operating system changes. It was also discovered that many of the files on BBNC were automatically archived as a consequence of not having been read for three months. Insufficient resources on BBNC for ANONYMOUS users lead to hung FTP jobs and frustration to many of those trying to access the files.

Major progress has been made in resolving these problems. All of the files which were accessible only on BBNC have been moved to BBNA and the related documentation has been updated to indicate the location of modules related to TENEX, TOPS20, IP, and TCP. Correction files based on TENEX 1.34, the last version supported by ARPA, and DEC's official TOPS20 Version 4 release either have been or are being prepared. These files are augmented with comments and several lines of context so that, for those sites which are starting from their own modified sources, the areas where changes are required may be easily located. A scheme has been worked out to help automate updating of these correction files as either DEC or BBN makes future changes.

The primary user documentation for internet user queues and the TCP JSYSes has been revised to remove some of the ambiguities and errors and to expand the explanations. These documents, IN-USER-Q.DOC and TCP-JSYS.DOC, are accessible via the ARPANET. Additions and changes will be made in response to further comments and suggestions.

Several bugs and anomalies were reported during the quarter. While many of the bug reports, particularly those from ISI, included patches that pinpointed and corrected the problem, a few were too vague to be of much use (e.g., "internet user queues don't work"). Many of the recently reported bugs have arisen due to the increased use of the IP/TCP facilities.

Several system crashes were traced to errors in the internet free storage module, in particular, in cases where free storage was exhausted. Correction of these problems was straightforward. However, the user load did not seem heavy enough for the observed memory consumption. Further investigation revealed yet another problem: memory was being filled with gateway echo reply

packets. This, in turn, lead to the discovery that the gateway module was not being being run often enough (one bug and a design decision).

Another bug report indicated that logouts were hanging forever. The reason was not hard to discover: the logout procedure waits for a connection abort counter to count down to zero; the counter was at -1. As a preliminary cure we patched the code to keep the counter from over/underflowing; in the meantime, progress is being made in pursuit of the bug which caused the counter to be decremented an extra time.

In an attempt to separate the site-dependent bugs from the IP/TCP bugs, a login account has been created so that a user whose program doesn't work at the local site may try the program on one of the BBN systems. If it works at BBN then the bug is probably due to modifications made at the local site. This effort has been hindered by problems with the stand alone test system. Disk packs, including the public structure, were corrupted. The disk drive/controller was suspect, but DEC's diagnostics failed to reveal any problem. An operating system incompatibility was also possible, since the test system alternated between a DEC monitor and a BBN monitor. Other problems intervened until one of the disk drives was moved to another BBN system which had a disk failure; it then failed the diagnostics and was repaired.

4.2 Gateways

Several modifications were made to the gateway software. Those listed below were made to both the ARPANET/Packet Radio Net gateways and the ARPANET/SATNET gateways:

1. Forwarding of internet packets that are not internet version 4 packets was eliminated.
2. The fragmentation code was corrected to allow the gateways to accept the maximum size packets allowed by each network to which they are connected and to fragment these packets into as many packets as are needed to forward the packet to its destination. Earlier versions of the gateway could produce no more than two fragments from each packet received; this restricted the maximum size packets that each gateway could accept.
3. A bug in the retransmission of routing update packets was fixed.

In addition, the gateways for the Packet Radio Network were modified to support both CAP 5 and CAP 6. Currently, software to support either CAP 5 or CAP 6 is conditionally assembled into the gateway.

The ARPANET/SATNET gateways were also modified to implement a new version of the Host/SIMP protocol. This protocol was modified slightly to correct a problem in the Host/SIMP reset mechanism that occasionally caused the interface to remain in the reset state until the Host was restarted.

4.3 File Transfer Protocol

Development of file transfer protocol server and user modules occupied about a third of the quarter. It was decided to base the new modules on the older NCP FTP; the change to TCP as the data transfer mechanism and to the modified protocol of IEN-149/RFC-765 is being carried out at the same time to eliminate an intermediate version. A single source for the NCP and TCP versions cuts in half the number of modules which will have to be maintained. The server's mail system interface was

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parameterized to simplify installation at different sites. A test program was developed which allows the server to be tested as a "user program."

5. HARDWARE

Two hardware activities were undertaken this quarter, both centering on 1822 interfaces. In the first we experienced a failure of the SRI 1822 board from the TIU "Alta-Coma", used in TCP testing. SRI offered to repair the board, so it was sent to Menlo Park, and a replacement picked up at the time of the CAP 6 Design Review Meeting.

The new board has been installed, but Alta-Coma now exhibits a different problem. We suspect difficulty with the BBN Pluribus TIP (RCC network) or possibly the interconnecting cable between TIP and Alta-Coma.

The second activity involved ACC 1822 boards for the ministration which needed upgrade to fix a "last character short" problem and a "last bit on gather" problem. We sent the boards to ACC, as arranged in the previous quarter. SRI offered to test the first upgrade in their lab, and also to look for a "host ready relay" problem observed on some similarly upgraded boards. The boards passed the tests at SRI, and have now been installed in the LSI-11/23 ministration, permitting further testing of ministration software.

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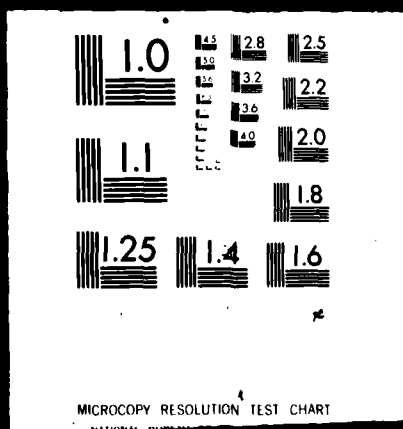
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SUPPLEMENTARY

INFORMATION

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The reporting period covered by this report has been extended to January 15, to align the reporting periods with the contract date. The period reported in QPR No. 5, distributed recently, is January 15, 1981 through April 15, 1981. Due to a clerical error, the copies of that report were dated as covering December 1, 1980 through February 28, 1981. This was in error; please correct your copy accordingly.

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