

Bolt Beranek and Newman Inc.



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Extensions to DEC TOPS-20 Operating System
Final Report

January 1979

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Extensions to DEC TOPS-20 Operating System

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes modifications made to the TOPS-20 operating system in order to enable ARPA research programs previously supported by the TENEX operating system to be supported by TOPS-20. In addition, it describes modifications to the ARPANET network control programs (NCPs) for both TENEX and TOPS-20 to enable those hosts to use the "new style" extended host/IMP leaders. The changes to TOPS-20 have been delivered to DEC and merged with the standard DEC version of the system, and will be		

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maintained by DEC along with the rest of the system.



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1. Summary

The objective of this project was to augment the TOPS-20 operating system for the DEC System-20 computer system to enable it to support ARPA information processing technology programs. All of the tasks in the project have been completed, and the software has been delivered to DEC and the ARPANET community along with the supporting documentation. This report describes the various tasks.

For a number of years the DEC KA10 processor operating under the TENEX operating system developed by BBN has been central to many ARPA information processing research projects. Recently DEC has developed a new line of processors, including the KL10 and KL20 processors, which are significantly faster than, but functionally compatible with, the older KA10. The operating system for this new line of processors is a descendant of an early version of TENEX (circa 1972) and is called TOPS-20. The new DEC processor together with the TOPS-20 operating system is called the DEC System-20.

Because the DEC System-20 offers similar capabilities to the older KA10-based TENEX system and is considerably more cost effective, many ARPA sponsored installations are upgrading their equipment to these newer systems. This switchover has the additional benefit of acquiring an operating system that is supported by a computer manufacturer (DEC).

Until this project was completed, however, the benefits of upgrading to the DEC System-20 have been limited due to a number of software incompatibilities between TENEX and TOPS-20. The source of the problem was that many of the improvements and increased capabilities that have been added to TENEX since 1972 had not been integrated into the TOPS-20 system. As a result, the computational requirements of many ARPA projects, such as the National Software Works (NSW) and the Advanced Command Control Architectural Testbed (ACCAT), of other government projects such as the Military Message systems, and of many users could not be supported by TOPS-20. The purpose of the work described in this report was to correct that situation by making the additions to the TOPS-20 system required to allow these projects to move from TENEX to TOPS-20.

In addition to the changes described above, as part of this project we modified the Network Control Programs (NCPs) of the TOPS-20 and TENEX operating systems to make use of the "new style" Host/IMP leaders. These modifications make it possible for TOPS-20 and TENEX hosts to address (and therefore communicate with) the full range of ARPANET hosts.

The specific tasks in the contract statement of work were:

- "Implement the modifications to the DEC TOPS-20 operating system that are specified in Section II of the contractor's proposal (BBN Proposal P77-ISD-47).
- Provide documentation to the best commercial standards for the TOPS-20 modifications specified in Section II of the contractor's proposal.

- Modify the Network Control Programs for the TOPS-20 and TENEX operating systems to use "new style" Host/IMP leaders in order to allow TOPS-20 and TENEX hosts to address the full range of ARPANET hosts."

The following sections of this report describe each of these tasks.

2. TOPS-20 Modifications

Considerable care was taken to ensure that the TOPS-20 modifications undertaken were adequate to support the requirements of ARPA's users and were acceptable to DEC who would assume responsibility for maintaining them.

At the outset of the project, the entire community of ARPA contractors was polled to identify any TENEX features not included in the TOPS-20 system that were required to support the contractor's computational needs. After a set of requirements had been identified and a set of proposed modifications to TOPS-20 specified, we met with DEC to determine how best to satisfy the requirements. In some cases it was agreed that the proposed modifications could be integrated directly into TOPS-20 as specified; in others, due to conflicts with other DEC plans for TOPS-20 development, compromises as to how to best support given requirements were reached. The result of these negotiations with DEC was a new specification for additions to TOPS-20. The resulting specification was then circulated to the ARPA community for approval. A number of minor changes to the specification were recommended by the community and agreed to by DEC. The specification was then implemented.

The rest of this section lists the modifications made to TOPS-20 and briefly describes each. The reader interested in more detail is referred either to the proposal for this project (BBN Proposal P77-ISD-47) or to DEC documentation for release 3 of TOPS-20.

- Addition of JSYS traps.

The JSYS trap mechanism provides a means for one process (fork) in a job to intercept (selected) operating system calls (JSYS's) executed by other processes in the job before the calls are acted upon by the operating system. (This feature is described in "JSYS traps, A TENEX mechanism for encapsulation of user processes", by R. Thomas, proceedings of 1975 National Computer Conference.) JSYS traps were implemented initially for the TENEX operating system. The mechanism was added to TOPS-20 as part of this project.

- Extensions to the ATACH JSYS.

The TOPS-20 ATACH JSYS is the means by which a job controlling terminal is associated with a user time sharing job. For example, the EXEC "ATTACH" command which permits a user to connect his terminal to an existing job is supported by this JSYS. The ATACH JSYS was enhanced to allow a user process to "attach" any terminal currently assigned to it to some specified job. Prior to this modification ATACH could be used only to attach the process' own controlling terminal to another job.

- Extensions to the CRJOB JSYS.

The CRJOB JSYS is the means by which a user process in an existing job may create a new job. The modification to CRJOB increased the ways in which the job to be created could be specified and initialized.

- Extensions to the TIMER JSYS.

The TIMER JSYS was modified to allow a process to request a software generated interrupt (PSI) at a specified time in the future. The time for the interrupt could be specified either as an elapsed time or as a specific time in the future.

- Addition of the SCTTY JSYS.

The SCTTY JSYS allows a process to specify the terminal that is to be used as the controlling terminal (i.e., the source of terminal PSI's) for a particular portion of the job process hierarchy. Prior to the implementation of this JSYS all processes in a job shared the same controlling terminal.

- Addition of the GFRKH JSYS.

This JSYS enables one process to acquire a "handle" for another process in its job. The absence of GFRKH from TOPS-20 apparently was accidental. This project corrected that oversight.

These features are currently supported in release 3A of the TOPS-20 operating system which is the current DEC release of the system for the ARPANET.

3. Documentation of TOPS-20 Modifications

Documentation for the modifications to TOPS-20 described above were submitted to DEC. The documentation was prepared as modifications to two existing DEC manuals; one a user's manual, and the other a reference manual. In particular, the documentation submitted was keyed to DEC documents DEC-20-OMUGA-A-D (Monitor Calls User's Guide, first printing May 1976) and DEC-20-OMRMA-A-D (Monitor Calls Reference Manual, first printing February 1976).

4. New Style Leaders for TENEX and TOPS-20

Until relatively recently, the number of hosts that could be addressed within the ARPANET was limited to a relatively small number by the protocols used between IMPs and between IMPs and hosts. In particular, only 64 IMPs and 4 hosts per IMP could be addressed. The number of addressable hosts has been significantly increased by changing the addressing conventions used in the leaders of messages exchanged between IMPs and between IMPs and hosts. The network currently supports the use by hosts of both "old style" leaders which can address a limited number of hosts, and "new style" or extended leaders which can address the full range of ARPANET hosts.

Until this project was completed, all TOPS-20 and TENEX hosts used old style leaders and could therefore address only hosts on 64 different IMPs. This had not been a problem until recently. However, with the installation of more IMPs, TENEX and TOPS-20 hosts would have been no longer able to address the full range of hosts.

This posed two potentially serious problems. The first is that the ARPANET Network Control Center (NCC) software which executes on a TENEX host would have been unable to interact with all ARPANET IMPs. The NCC software makes use of the so-called "raw network message" facility of the TENEX network software. To correct this first problem, we converted the TENEX raw network message facility to use the new style leaders.

The second problem was that standard TENEX and TOPS-20 user programs, including such important programs as TELNET, FTP and the network mail systems, would not be able to communicate with all ARPANET hosts. These programs interact with the network through the Network Control Program (NCP). Since the TENEX raw network message facility operates in parallel with the standard TENEX NCP, changes to it alone would not allow user programs to make use the extended addressing supported by new style leaders. This second problem was corrected by integrating use of the new style Host/IMP leaders throughout the entire NCP for both the TOPS-20 and TENEX systems.

The NCP modifications required presented two problems, both related to the expanded size of host addresses. First, certain network tables maintained internally by the operating system had to be redesigned. In particular, host number fields in the tables had to be enlarged, and "lookup" functions for finding hosts entries given host numbers had to be modified.

The second problem concerned the manner of portraying the extended host addresses to user programs. The difficulty here derives from the fact that many existing programs assumed host addresses to be only 8 bits and behaved accordingly. For example, such a program might allocate only 8 bits for the storage of host addresses, and would therefore operate incorrectly if it tried to store and subsequently later use a 24 bit host address supplied to it by the operating system.

The solution to this problem was to make the changes "transparent" to old user programs. This was accomplished as follows. Two new JSYS's were implemented: GTHST (get host) which transforms host numbers into the ASCIZ strings for the corresponding host names and vice versa; and GTNCP (get NCP) which obtains status information for specified network connections. In addition, all of the existing NCP-related JSYS's are continued to be supported in an upward compatible manner. For example, all such JSYS's that return host numbers return 8 bit versions (the corresponding old style addresses) of the full 24 bit host addresses.

This approach makes it possible for old programs to continue to operate correctly since they make use of the "unmodified" old system calls, and at the same time it allows new programs to make use of the extended host addressing by means of the new JSYS's.

Certain important "utility programs" were modified to make use of extended addressing. These include the FTP server (FTSCTL and FTPSRV), the standard system ICP responder (NETSER, used for remote terminal access (TELNET) and other network services), and a frequently used network status program (NETSER).

To summarize, the changes made to the ARPANET software for TENEX and TOPS-20 to support extended leaders were:

- The IMP driver was rewritten to use extended leaders. The IMP driver is the module that supports the raw network message facility as well as the standard NCP.

- The higher level network software (NCP) was rewritten to use the extended addressing.
- the internal network and NCP tables were restructured to support extended host addresses.
- The user interface to the NCP was modified to provide an upward compatible interface to the lower level modifications.
- Two new JSYS's (GTHST and GTNCP) were added to provide user access to extended host addressing.
- Certain important utilities were modified to make use of the extended addressing.

The modifications described above were made to both TENEX and TOPS-20. The TENEX modifications were released to the ARPANET TENEX community as updates to the last "official" release of TENEX (version 1.34). These modifications are currently running on all three BBN TENEX hosts. The TOPS-20 modifications were delivered to DEC and are scheduled for release by DEC as part of release 4 of TOPS-20. One of the two BBN TOPS-20 hosts is currently operating with the NCP modifications, and the second will be shortly.