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COMMAND CENTER NETWORK PROTOCOLS FUNCTIONAL DESCRIPTIONS.(U)

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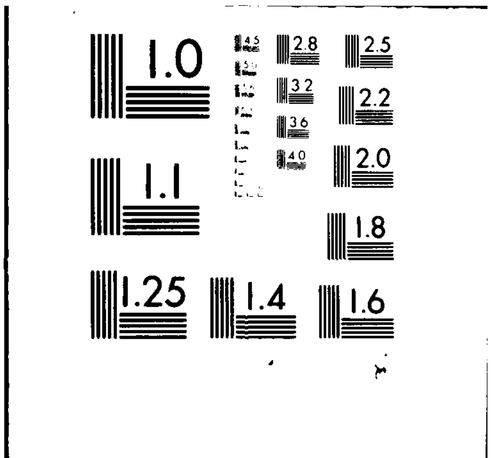

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Command Center Network Protocols
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A local network to give a commander flexible access to command and control subsystems is needed in the Navy. The Command Center Network is a proposed solution that would front-end Navy computers to a local data bus via microcomputers. The microcomputers, or Network Interface Units (NIUs), would provide software to make the network transparent to each of the Navy subsystems.

This report describes functionally each set of programs necessary to interface C^2 systems (NAVMACS, DTS, CCIS, and TSA) to the Command Center Network, through PDP 11/03 microcomputers serving as network front ends.

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OBJECTIVE

Develop protocols which would allow for the transfer of command and control data over a local computer network in a distributed fashion.

RESULTS

Protocols were developed which allow the transfer of NAVMACS, Link 11, and terminal character strings.

RECOMMENDATION

Conduct experiments with the current protocols to see whether they fulfill the role envisioned for them.

PREFACE

A local network to give a commander flexible access to command and control subsystems is needed in the Navy. The Command Center Network (CCN) is a proposed solution which would front-end Navy computers to a local data bus via microcomputers. The microcomputers, or Network Interface Units (NIUs), would provide software to make the network transparent to each of the Navy subsystems.

A glossary of CCN acronyms and abbreviations is included at the end.

CONTENTS

ILLUSTRATIONS

1 INTRODUCTION

In recent years the Navy has initiated major efforts to provide user access to diverse subsystems which contain information of interest to the afloat commander. These efforts have been frustrated by the fact that these subsystems have been developed independently for specific functions and, as a consequence, are characterized by unique interfaces and protocols, fully committed memory and cpu cycles, complex software that is costly to modify, and an interface which expects an intelligent user on the other end. To address these issues, the Navy is developing a Command Center Network (CCN) for interconnecting these subsystems in a local environment such as a ship, building, or closely grouped set of buildings. The CCN builds upon recent developments in high speed data bus technology and protocols developed for the ARPANET. Microprocessors are used to "front end" these unique subsystems and to provide new protocols which facilitate C2 functions and process-to-process interactions without the requirement for an intelligent human user.

Figure 1 illustrates the configuration to be employed for the initial CCN. This same configuration can be kept in mind while discussing the future CCN since the only change anticipated is the replacement of the PLI with some other network (ie Chaosnet). In either case, the PDP 11/03s are the NIUs which interface the C2 subsystems to the CCN. The software described in this document is software which will run in the PDP 11/03s and the KL-20/40 (since the KL-20/40 has no attached NIU).

Figure 2 demonstrates where in the configuration the various programs reside.

A functional description is presented for each set of programs necessary to interface C2 systems (NAVMACS, DTS, CCIS, and TSA) to the CCN. (All acronyms are defined in the Glossary.) The C2 subsystems, as described in reference 1, will be interfaced to the CCN by PDP 11/03 microcomputers serving as network front ends. The 11/03s are also referred to as Network Interface Units or NIUs. The NIUs consist of a DEC LSI-11 processor, 64k bytes of RAM, four asynchronous serial lines, a line time clock and an 1822 communications interface. The 1822 interface can be used to connect the LSI-11/03 to an ARPANET IMP in a direct memory access mode operating at 50 kbaud.

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1. CCN Interface Requirements, Westec Services Inc, October 1979.

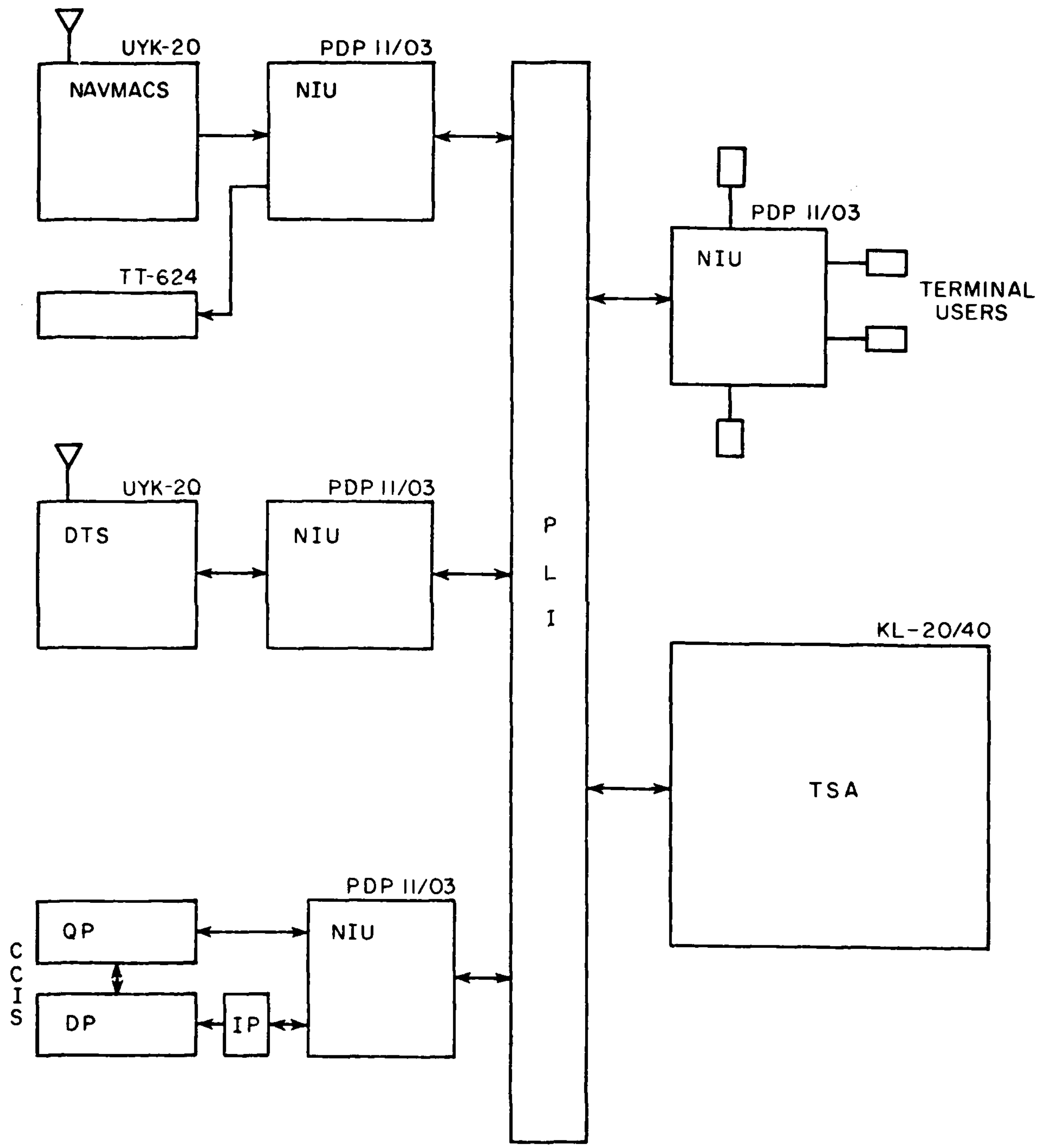

Figure 1. CCN configuration.

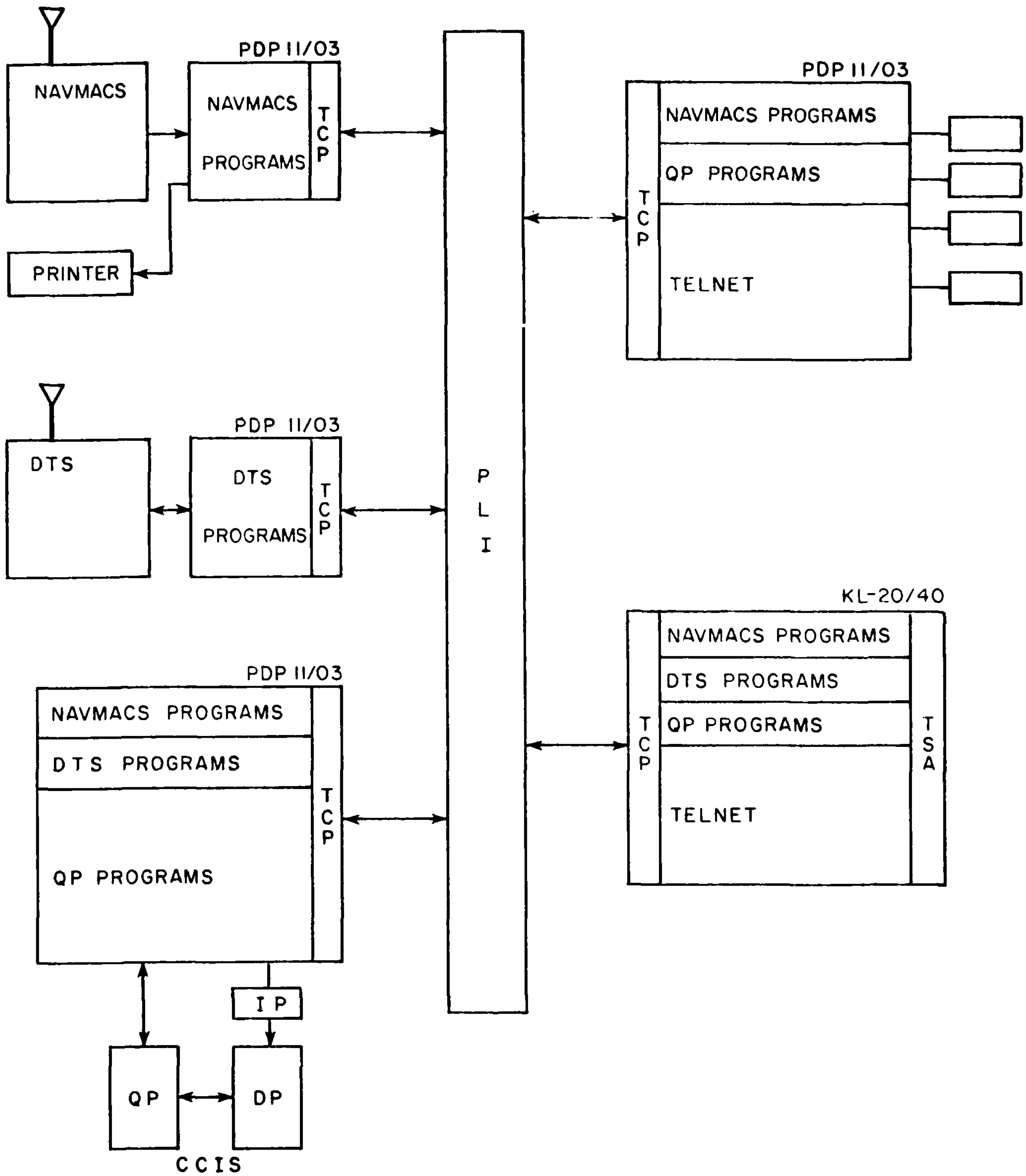

Figure 2. CCN program location.

Existing software will be used as much as possible, especially for the initial CCN. THE NIUs will employ SRI's MOS and the network protocols Telnet and TCP. SRI's software is described in reference 2. Telnet and TCP exist on the KL-20/40 for TSA's use, so no NIU is necessary there. The remaining software that needs to be developed consists of those programs which perform the specific tasks associated with each C2 subsystem. These are the programs which are described in this document. A list of functions of each set of programs is given, along with a list of characteristics unique to each system and a discussion of what will and won't be available in the initial CCN. In the following discussion, the descriptions are divided according to the systems being interfaced, in the following order: NAVMACS, DTS, CCIS, TSA, and terminal users. Both the long-term and initial CCN are considered, in the following order of discussion: long-term functions, characteristics of interest (which characterize the uniqueness of each application), and initial CCN capability. In the latter are listed first those functions which will be implemented, then all functions which although not implemented for the initial CCN, will be implemented later as time permits. Implementation will be avoided for some functions because of the lack of mass storage devices on the NIUs and for others because of the need to simplify the initial CCN.

2 NAVMACS

2.1 NAVMACS MESSAGE RECEIVING PROGRAMS

2.1.1 Functional Requirements

Deliver NAVMACS messages to terminal users on the CCN as well as processes like TSA and IP.

Allow a parameter indicating what kinds of messages the user is interested in receiving. (The user, throughout this discussion, could be a process, a terminal, or a printer.)

Require a user to login or a process to authenticate itself.

Signal a user when NAVMACS messages arrive.

Allow a user to file messages for later retrieval.

Allow a user to stop the process at any time.

Inform the user of net errors which result in loss of messages.

Convert baudot to ASCII.

Employ a multiaddressing scheme to deliver the same NAVMACS message to several users.

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2. Terminal Interface Unit Notebook, by JE Mathis et al, Defense Advanced Research Projects Agency, May 1979.

Send each NAVMACS message to the NAVMACS TT-624 line printer. (The line printer is being shared with other processes on the CCN.)

Allow the NSM to have NAVMACS messages sent to third parties. (The NSM can arbitrarily decide that a process or terminal on the CCN should receive certain NAVMACS messages.)

Filter messages based on subject or headers.

Print only the headers of messages for the user.

Inform the user when the NAVMACS processor is being held off. (The processor is held off whenever buffer space is a problem or hardware is malfunctioning.)

Allow a terminal user to direct NAVMACS messages to a third party.

Convert RAINFORM formatted messages to CCN format.

2.1.2 Characteristics of Interest

The NAVMACS processor and the attached NIU are shown in Figure 3.

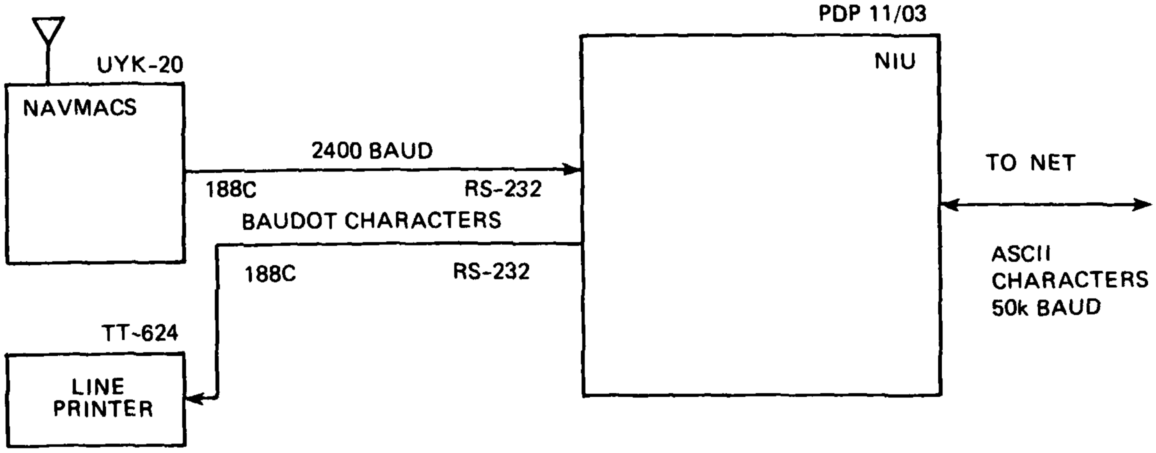

Figure 3. NAVMACS processor and NIU.

NAVMACS messages consist of baudot characters and are on the average 2100 characters long. The messages are delimited by SOM (start of message) and EOM (end of message). Since the NAVMACS processor is normally sending the messages to a printer (ie the line going to the NIU is normally attached to a TT-624 line printer), the only way of controlling flow is to set the printer's ready line to a low voltage, causing the NAVMACS processor to stop sending the current message. When the ready line is set to a high voltage again, the processor will send the message again in its entirety. Messages arrive at the NAVMACS processor over a communications link operating at 75 baud. The NAVMACS processor sends the characters serially to the printer at 2400 baud. The NAVMACS processor has 32k bytes of storage space available for incoming messages, and if this space becomes full it is programmed to drop any new messages since there is no mass storage device available.

2.1.3 Initial CCN Capability

2.1.3.1 Functions which will be implemented

Deliver NAVMACS messages.

Allow a parameter indicating the type of messages the user is interested in but limited to: all messages, or only RAINFORM formatted messages.

Signal user when NAVMACS messages arrive.

Allow the user to stop the process at any time.

Convert baudot/ASCII.

Employ a multiaddressing scheme to deliver the same NAVMACS message to several users. (But the scheme used will be to send the message once for each interested user since the TCP currently does not support multi-addressing; alternatively, TCP could be modified to support multi-addressing.)

2.1.3.2 Functions which will not be implemented

Require a user to login or a process to authenticate itself.

Allow a user to file a message for later retrieval.

Inform the user of net errors which result in loss of messages.

Allow the NSM to have messages sent to third parties.

Filter messages based on subject or headers.

Print only header of message for user.

Inform the user when the NAVMACS processor is held off.

Allow a terminal user to have NAVMACS messages sent to third parties.

Convert RAINFORM formatted messages to CCN format.

2.2 NAVMACS PRINTER PROGRAMS

2.2.1 Functional Requirements

Print NAVMACS messages on the TT-624.

Direct user output on the CCN to the TT-624.

Store user text for printing later if the printer is busy.

Keep user text separate from other users.

Convert ASCII characters to baudot for the printer.

Prevent users from tying up the printer.

Employ a priority scheme in granting access to the printer.

Inform the users of success/failure of printed text.

Require users to login.

Advise users when the printer is not available.

Inform users when the printer buffer space is exhausted.

2.2.2 Characteristics of Interest

Figure 3 applies here as well. Characters must go to the printer in baudot format on a serial asynchronous line. The attached NIU is an LSI-11/03 with no mass storage device, so buffering is limited. (The actual limit can be determined only at software development time.) The printer does accept a "new page" or "formfeed" character. The line to the TT-624 has a ready indicator to control the flow to the printer.

2.2.3 Initial CCN Capability

2.2.3.1 Functions which will be implemented

Print NAVMACS messages on the TT-624.

Direct user output on the CCN to the TT-624.

Separate user's text from other users.

Convert ASCII characters to baudot for the printer.

Prevent users from tying up the printer.

2.2.3.2 Functions which will not be implemented

Store user text for later printing.

Employ a priority scheme for granting access to the printer.

Inform users of success/failure of their printed text.

Require users to login.

Advise a user when the printer is not available.

Inform users when the printer buffer space is exhausted.

3 DTS PROGRAMS

3.1 FUNCTIONAL REQUIREMENTS

Deliver track data from the DTS computer to interested users.

Deliver track data from users to the DTS computer.

Require users to login or processes to identify themselves.

Prevent transmission over CCN of track reports containing no change in data field.

Deliver tracks based on content (air tracks to some users, surface tracks to others, etc).

Signal the user when tracks arrive from the DTS computer.

Employ a multiaddressing scheme for delivering the same tracks to several users.

Inform users of success/failure of tracks sent to the DTS computer.

Convert track data from binary to ASCII.

Store track data for later retrieval.

Allow NSM to have tracks sent to a third party and filter on subject or content; ie the NSM can change the addressee list (for the purpose of insuring that certain processes on the CCN get all air track information or surface track information etc).

Convert ASCII/binary.

Convert to/from CCN format.

Allow an option to disable the default of receiving all tracks and receive only certain tracks based on some filter.

3.2 CHARACTERISTICS OF INTEREST

Figure 4 shows the DTS computer and its attached NIU.

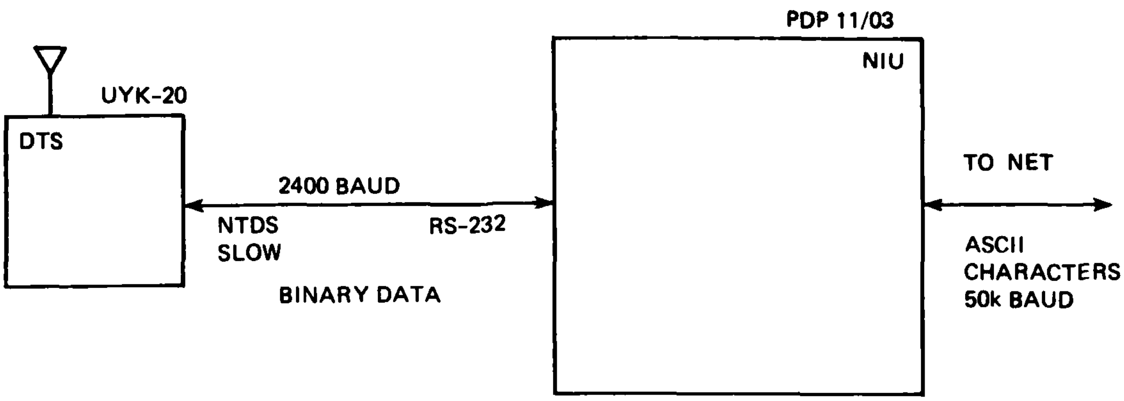

Figure 4. DTS processor and NIU.

Data from the DTS computer come in binary form over a 30-bit-wide NTDS slow line to the NTDS computer. In the CCN, an RS-232 conversion box will sit between the DTS and the NIU since the LSI-11/03 cannot be interfaced with NTDS slow. Therefore, to the CCN the line to the DTS will look like an RS-232 synchronous data line. The LSI-11/03 here is as described in the introduction except for the addition of the synchronous line interface. The data from/to the DTS are binary, with a start/stop data word and a track number for historical purposes. The NTDS control lines will appear to the LSI-11/03 as RS-232 control lines so that the existing protocol (as described in NELC TM-119, Interface Design Specification) can be employed in the LSI-11/03.

3.3 INITIAL CCN CAPABILITY

3.3.1 Functions which will be implemented

Deliver track data from the DTS computer to interested users.

Prevent transmission over CCN of track reports containing no change in data fields.

Signal the user when tracks arrive from the DTS computer.

Employ a multiaddressing scheme to deliver the same tracks to several users.

Convert track format from binary to ASCII.

Convert to CCN format.

3.3.2 Functions which will not be implemented

Deliver track data from users to the DTS computer.

Require users to login.

Inform users of success/failure of tracks sent to the DTS computer.

Store track data for later retrieval.

Deliver tracks based on content.

Allow the NSM to have tracks sent to a third party.

Convert ASCII to binary.

Convert from CCN format.

Option to pass all tracks or certain ones based on some filter.

4 CCIS PROGRAMS

4.1 FUNCTIONAL REQUIREMENTS

Serve as the IP by delivering NAVMACS RAINFORM messages and DTS tracks to the DP.

Format the RAINFORM messages and DTS tracks appropriately for the DP.

Allow users to query the QP and return responses to them.

Allow users to send responses to the TT-624 printer.

Establish a priority scheme for query users.

Require users to login.

Store queries/responses if printer is busy.

Queue queries if QP is busy.

Queue messages in IP for DP.

Send queries/responses to both the printer and the user.

4.2 CHARACTERISTICS OF INTEREST

Figure 5 shows the CCIS processor and its attached NIU.

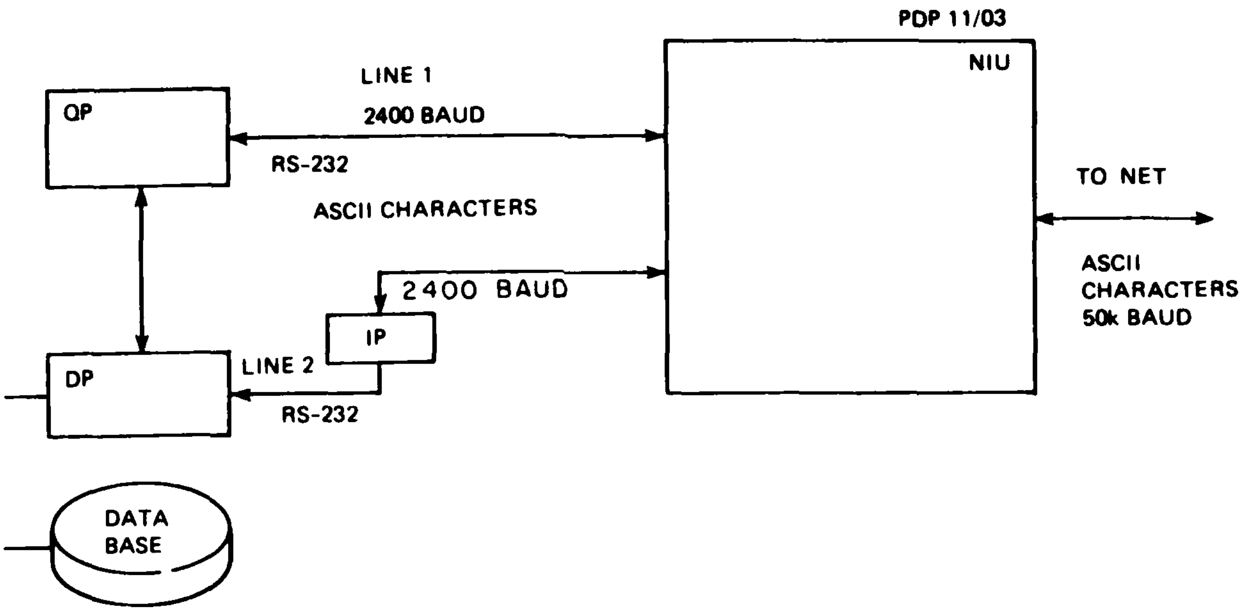

Figure 5. CCIS and attached NIU.

The QP and DP are microprocessors and the DP has mass storage for its data base. Lines 1 and 2 are RS-232 asynchronous serial lines with data traversing in both directions on line 1 and in one direction only on line 2. The DP accepts data over line 2 every 4 seconds (adjustable). There is no acknowledgment from the DP over this line. Data can arrive asynchronously over line 1 because the QP provides a buffer for a one-line query (80 characters). Responses are sent back over line 1 in the same manner and are of variable length. An EOM is contained in the data for message delimiting.

4.3 INITIAL CCN CAPABILITY

4.3.1 Functions which will be implemented

Serve as IP by delivering RAINFORM and DTS messages to DP.

Format RAINFORM and DTS messages appropriately for DP.

Allow users to query QP and return responses to them.

Allow users to send responses to printer.

Allow users to send queries/responses to printer and to receive them.

4.3.2 Functions which will not be implemented

Establish a priority scheme for query users.

Require users to login.

Store queries/responses if printer is busy.

Queue queries if the QP is busy.

Queue messages in IP for DP.

5 TSA PROGRAMS

5.1 FUNCTIONAL REQUIREMENTS

Deliver NAVMACS messages to the KL-20/40 for TSA.

Allow a parameter indicating what kind of NAVMACS messages TSA is interested in.

Require TSA to authenticate itself as a NAVMACS user, NAVMACS printer user, DTS user, and QP user.

Signal TSA when NAVMACS messages arrive.

Allow TSA to file the NAVMACS messages for later retrieval.

Allow TSA to stop the process at any time.

Inform TSA of net errors which result in the loss of NAVMACS messages.

Inform TSA when the NAVMACS processor is being held off.

Allow TSA to send text to the NAVMACS TT-624 line printer.

Allow TSA to file text for later printing if the line printer is busy.

Keep TSA's text separate from other users' text.

Prevent TSA from tying up the line printer.

Inform TSA of success/failure of printed text.

Deliver DTS track data to TSA.

Send track data from TSA to DTS.

Signal TSA when track data arrive.

Allow TSA to store tracks for later retrieval.

Inform TSA of success/failure of sent tracks.

Allow TSA to query the QP.

Allow TSA to direct the query/response from the QP to the line printer.

Allow TSA to both receive the responses from the QP and print them on the TT-624.

Filter on subject or header in NAVMACS messages.

Store the queries/responses sent to the QP for later retrievel if the printer is busy.

Send tracks from TSA to the DP.

5.2 CHARACTERISTICS OF INTEREST

TSA is a process which runs on the KL-20/40 operating under the TOPS20 operating system. The KL-20/40 is interfaced to the PLI and uses the network protocols TCP4 and Telnet. The KL-20/40 has 256k words of memory and 370M bytes of mass storage. The KL-20/40 also has an attached line printer and 16 asynchronous communication lines for interactive terminal users.

5.3 INITIAL CCN CAPABILITY

5.3.1 Functions which will be implemented

Deliver NAVMACS messages to the KL-20/40 for TSA.

Allow a parameter indicating what kind of NAVMACS messages TSA is interested in but restricted to: all messages, or RAINFORM formatted messages. (TSA will have the ability itself to sort NAVMACS messages.)

Signal TSA when NAVMACS messages arrive.

Allow TSA to file the NAVMACS messages for later retrieval.

Allow TSA to stop the process at any time.

Allow TSA to send text to the NAVMACS printer.

Keep TSA's text separate from other users' text.

Prevent TSA from tying up the printer.

Deliver DTS track data to TSA.

Signal TSA when track data arrive.

Allow TSA to store track data for later retrieval.

Allow TSA to query the QP.

Allow TSA to direct the query/response from the QP to the NAVMACS printer.

Allow TSA to both receive the response from the QP and have it printed on the TT-624.

5.3.2 Functions which will not be implemented

Require TSA to authenticate itself as a user of any of the C2 subsystems.

Inform TSA of net errors which result in the loss of NAVMACS messages.

Inform TSA when the NAVMACS processor is being held off.

Allow TSA to file text for later printing on the NAVMACS TT-624.

Filter NAVMACS messages based on subject or header.

Send tracks from TSA to DP.

Inform TSA of success/failure of printed text.

Send tracks from TSA to DTS.

Inform TSA of success/failure of sent tracks.

Store the queries/responses sent to the QP for later retrieval if the printer is busy.

6 TERMINAL USERS

6.1 FUNCTIONAL REQUIREMENTS

Deliver NAVMACS messages to terminal users.

Accept a parameter defining the type of NAVMACS messages the user is interested in.

Require the user to login.

Signal the user when NAVMACS messages arrive.

Allow the user to file the NAVMACS messages for later retrieval.

Allow the user to stop the process at any time.

Inform the user of net errors which result in the loss of NAVMACS messages.

Print only the headers of NAVMACS messages.

Inform the user when the NAVMACS processor is being held off.

Allow the user to query the QP.

Allow the user to direct queries/responses from the QP to the NAVMACS line printer.

Store queries/responses for later printing if the TT-624 is busy.

Allow the user to run TSA.

Allow a user to have NAVMACS messages sent to a third party.

Allow users to both receive NAVMACS messages and send them to the printer.

6.2 CHARACTERISTICS OF INTEREST

Terminal users will have Telnet available so access will exist to all CCN resources from a terminal on the CCN. A user can telnet to the KL-20/40 where he will be required to login. The user can then run TSA or any other process available on the KL-20/40.

6.3 INITIAL CCN CAPABILITY

6.3.1 Functions which will be implemented

Deliver NAVMACS messages.

Accept a parameter defining the type of NAVMACS message the user is interested in but limited to: all messages, or RAINFORM formatted messages.

Signal the user when NAVMACS messages arrive.

Allow the user to stop the process at any time.

Allow the user to query the QP.

Allow the user to direct queries/responses from the QP to the NAVMACS printer.

Allow the user to run TSA.

6.3.2 Functions which will not be implemented

Require the user to login.

Allow the user to file NAVMACS messages for later retrieval.

Inform the user of net errors which result in the loss of NAVMACS messages.

Print only the headers of NAVMACS messages.

Inform the user when the NAVMACS processor is being held off.

Store queries/responses from QP for later retrieval if the line printer is busy.

Allow a user to send a NAVMACS message to a third party.

Allow the user to both receive NAVMACS messages and send them to the printer.

7 NSM

7.1 FUNCTIONAL REQUIREMENTS

Have NAVMACS and DTS data sent to third parties.

Have NAVMACS and DTS data filtered on content.

7.2 CHARACTERISTICS OF INTEREST

The Network Services Manager (NSM) is as of yet unspecified. It is expected to perform many systemwide functions in the future and, in general, to monitor the network. It may provide services such as code conversion and name-server functions.

7.3 INITIAL CCN CAPABILITY

The NSM will not be available for the initial CCN.

GLOSSARY OF COMMAND CENTER NETWORK ACRONYMS AND ABBREVIATIONS

ARPANET	Advanced Research Projects Agency Network
ASCII	American Standard Code for Information Interchange - a seven-bit code used to represent 128 symbols
Baudot	Seven-level International Telegraph Code 2 using one start bit, one stop bit, and five bits representing one of 62 symbols
Bit	Binary digit
Byte	Eight-bit word
C2	Command control
CCIS	Command Center Information Subsystem
CCN	Command Center Network
cpu	Central processing unit
DEC	Digital Equipment Corporation
DP	Data Processor (one of three processors used in the CCIS)
DTS	Data Terminal Set
EOM	End of message
IMP	Interface Message Processor
IP	Interface Processor (one of three processors used in the CCIS)
kbaud	One thousand bits per second
LSI-11	Digital Equipment Corporation processor model
LSI-11/03	Digital Equipment Corporation processor model
MOS	Micro Operating System
NAVMACS	Naval Modular Automated Communications System
NIU	Network Interface Unit
NSM	Network Service Manager

NTDS	Navy Tactical Data System
NTDS slow	Interface requirements specified in MIL-STD-1397
PDP-11/03	Digital Equipment Corporation computer model built on an LSI-11/03
PLI	Private Line Interface
QP	Query Processor (one of three processors used in the CCIS)
RAM	Random access memory
RS-232	EIA standard electrical interface defining control lines, voltage levels, and signals for exchange of binary data
SOM	Start of message
SRI	Stanford Research Institute
TCP	Transport Control Protocol
TCP4	Transmission Control Protocol version 4
Telnet	ARPANET protocol which allows a user at a remote site to login to a time-sharing system as if he were at a directly connected terminal
TENEX	Operating system for PDP-10 computers manufactured by Digital Equipment Corporation
TSA	Tactical Situation Assessment
TT-624	Data General Corporation line printer

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