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LO-CO-GRAF: generating maps to support command & control/crisis management using small computers

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THESIS

LO-CO-GRAF:
GENERATING MAPS TO SUPPORT
COMMAND & CONTROL/CRISIS MANAGEMENT
USING SMALL COMPUTERS

by

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March 1988

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This thesis describes and tests a system for Low Cost Graphics (LO-CO-GRAF) which enables a small computer to generate and display high quality cartographic maps from a remote mainframe computer database. A small computer must emulate a graphics terminal while interfacing with a mainframe program which processes the necessary data. This solution has been accomplished through four smaller tasks.

The tasks include communicating with the source system, emulating a graphics terminal, interfacing with a map generation program, and producing a local hardcopy of the generated map. All software and hardware required for these component tasks, in addition to the use of standard methodologies, were selected for their widespread availability at Department of Defense (DOD) agencies.

Research was conducted using the Heath/Zenith Z-120 as the small microcomputer and the Tektronix 4010 graphics terminal was chosen to model and emulate; two separate source graphics packages were used to generate maps. Concept validation involved the use of DISSPLA, the primary graphics package used on an IBM 3033 mainframe computer at the Naval Postgraduate School, and the Briefing Aid System, a map generation program maintained on the VAX mainframe computer at University of Southern California's Information Systems Institute, which was accessed and employed via Defense Data Network (DDN).

Specific "how-to" instructions were developed for application to the Heath/Zenith Z-100 series microcomputer. These instructions, which are provided as Appendices, include programs which cause the Z-100 microcomputer to emulate a Tektronix 4010 graphics terminal, provide microcomputer to mainframe computer communications using KERMIT, present interactive DISSPLA map generation programs, and explain how to access the Briefing Aid System map generation program via the DDN.

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LO-CO-GRAF:
Generating Maps to Support
Command & Control/Crisis Management
Using Small Computers

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ABSTRACT

This thesis describes and tests a system for Low Cost Graphics (LO-CO-GRAF) which enables a small computer to generate and display high quality cartographic maps from a remote mainframe computer database. A small computer must emulate a graphics terminal while interfacing with a mainframe program which processes the necessary data. This solution has been accomplished through four smaller tasks.

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THESIS DISCLAIMER

A. SOFTWARE

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

B. TRADEMARKS

The following trademarks are used throughout this thesis:

- Chromatics is a Trademark of Chromatic Computer Corporation.
- DISSPLA is a Trademark of Integrated Software Systems Corporation.
- DISSPOP is a Trademark of Integrated Software Systems Corporation.
- Epson is a Trademark of the Epson Computer Company.
- IBM is a Registered Trademark of International Business Machine Corporation.
- KERMIT is a Registered Trademark of Jim Henson's Muppets.
- MS-DOS is a Registered Trademark of Micro Soft Corporation.
- Okidata is a Trademark of the Okidata Corporation.
- Tektronix is a Registered Trademark of the Tektronics Corporation.
- VAX is a Trademark of Digital Equipment Corporation.
- VM/CMS is a Registered Trademark of International Business Machine Corporation.
- VS Fortran is a Registered Trademark of International Business Machine Corporation.
- Zenith is a Registered Trademark of Zenith Data Systems Corporation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

I. INTRODUCTION AND BACKGROUND

Effective Command and Control (C2) relies heavily on accurate maps and charts that are readily obtainable with minimum delay. While pure command post exercises of hypothetical scenarios may not be adversely affected by inaccurate, incomplete, or artificial cartographic products, any actual movement of men and/or equipment requires that the commander and his staff have timely access to comprehensive and up-to-date maps. This requirement prevails throughout each step of any exercise, planned maneuver or crisis management situation [Ref. 1: p. 3-80]. A commander who ignores his map requirements during the concept phase of operations is sure to fail. Maps and charts are essential tools for those in charge of staffing and planning. General George S. Patton, who will always rank as one of the Army's and our nation's greatest warriors, stated the importance of maps very simply in his biography.

> A study of the map will indicate where critical situations exist or are apt to develop, and so indicate where the commander should be [Ref. 2].

Perhaps the need for maps is most critical in the execution phase: the success of even the simplest operation hinges directly on the reliability and availability of accurate maps and charts. To put it simply, timely access to maps and charts is an indispensable C2 tool and must be available at all levels of command during all phases of the C2 process [Ref. 1: p. 3-82].

The usual procedure for obtaining maps in the Department of Defense (DOD) is to request them from the Defense Mapping Agency (DMA) or one of the affiliated military distributing commands. This requires intricate preplanning for anticipated future needs, as well as a long lead time of anywhere from a few weeks to several months due to the logistics involved in physically locating, obtaining, and delivering the desired maps and charts. To expedite this process, the DMA has digitized most critical world areas so that the cartographic information can be transmitted electronically. This innovation, while an important first step in providing accurate and timely map data, is somewhat limited in its present configuration because only specially dedicated computers and network systems can access the information. However, this information is available on many mainframe computers and accessible through resident graphics packages.[1] Indeed, many

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[1] For example, the Naval Postgraduate School (NPS) uses the Display Integrated Software

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of the large screen displays currently used in C2 centers for contingency planning and for the World Wide Military Command and Control System (WWMCCS) displays are of inferior cartographic resolution. Most importantly, the DISSPLA software allows anyone operating a NPS graphics workstation to generate the exact cartographic projection desired. The significance of generating detailed cartographic products by DISSPLA, is that most organizations also have a similar, unrealized capability to have this type of small scale, large area mapping program, which can provide them almost instantly with the maps and charts they require.

A. GRAPHICS IN THE MILITARY ENVIRONMENT

This thesis is specifically directed towards the creation of maps and charts, which usually represent the highest level of capability available in graphics packages. The difficulty to generate maps involves translating a three-dimensional data set generated by the curvature of the earth into two-dimensional projections that can be printed as maps. The need for accurate maps and charts has already been mentioned in general but the following specific applications serve to better illustrate this requirement.

1. Command and Control (C2)

a. Pre-planned

Maps are always needed when forces are being employed or deployed. C2 is exercised[2] via Command, Control, and Communications (C3) systems; the commander and his subordinates must be "working from the same sheet of music". The exchange of information necessary to achieve a successful mission is critical, and usually very susceptible to error. To relay his C2 decisions, the commander could prepare an interactive computer menu program[3] which could be made available to other commands, making clear the decision. The maps with overlayed or imbedded information could be either electronically transmitted or simply made accessible to others. This delicate C3 problem is resolved with a C4 (add "Computers" to C3) solution. Figure 1 illustrates the dissemination of a map presentation from the commander and his staff to other elements

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System and Plotting Language (DISSPLA) graphics software program which contains a map generation option called World Coast Utilities. Although this program is independent of the DMA database, and therefore does not reflect the continuous DMA updating of maps and charts, it can generate high resolution products that are amply sufficient for the strategic and operational/theater levels of military planning and execution.

2 C3 is sometimes referred to as "the reins of command", that is the commander's ability to maintain control of the situation.

3 Similar in concept to the program provided in Appendix A in that different options or bases for decision can be provided electronically.
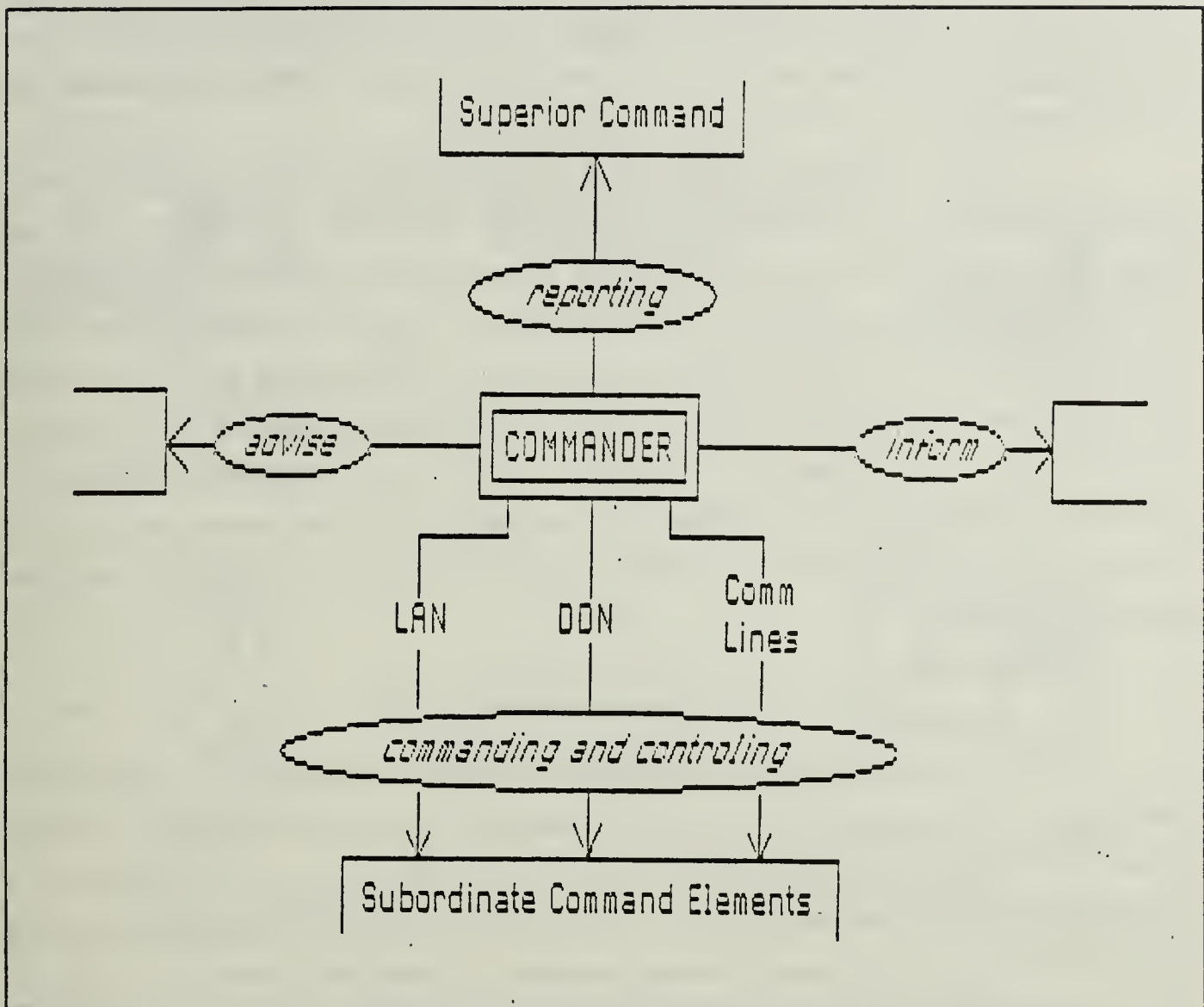
Figure 1. **Use of Digitized Maps in Normal Operations:** Distribution of commander's intentions, EOOB, admin/log information, and C3 processes of the C2 functions through Local Area Networks (LAN), Defense Data Network (DDN), or telephone quality communications lines.

in his chain of command. With this map distribution tool, the commander can provide timely progress reports to his superiors, advise and inform adjacent commanders of his intentions, and effect swift, unambiguous C2 direction to subordinate command echelons.

    b. *Emergency/contingency/crisis situations*

        Similar to the preplanned, deliberate scenarios, a commander's effectiveness in a crisis situation can also benefit from a C4 application of digitized mapping. Speed and accuracy of information transmission is possibly even more critical during an emer-

gency or crisis because decisions are being made and forces deployed with all possible speed. A precise display of forces and enemy order of battle from his superior's computer could prove invaluable to the on-scene commander. Additionally, weather and other displays could be made instantly available to him.

Most contingency operations usually are directed from a major command center. The personnel handling these emergencies are usually referred to as a Crisis Action Team (CAT) or a Crisis Management Team (CMT). Their composition is made up of operators and specialists in communications, logistics, intelligence, and other warfare and combat support occupations. Figure 2 demonstrates how the on-scene commander and the CAT or CMT can access tactical maps requiring only communications to some remote mainframe computer. Figure 2 also demonstrates another advantage of digitized maps: the graphic link between the on-scene commander and the Crisis Management Team which reciprocally would provide up to the minute decisions, results, and options.

2. War gaming

a. Laboratory

C3 is usually ignored and not normally a determinant in laboratory wargaming exercises. However, the highly specialized systems employed to generate terrain and similar cartographic displays are available only at major commands and installations, limiting their usefulness to a small, elite minority. Using digitized maps, many wargaming systems could become available at lower level commands. With the loss of dependence on highly specialized displays and systems, more inter-command or distributed wargaming could occur. This would result in more training for more forces, with obvious benefits accruing therefrom.

b. Exercises

Using wargaming in conjunction with field exercises is extremely beneficial. Instead of being limited by time and cost constraints, different options or hard to field operations can be conducted. The availability of digitized mapping programs and the increasing presence of highly accurate and current DMA data, would allow more players, more and easier access, and potentially higher quality wargames and exercises. Again, the benefits are readily apparent.

3. Other

This thesis is primarily directed towards cartographic products, but it is equally applicable towards other graphics products. Strategic analysts, as well as tactical
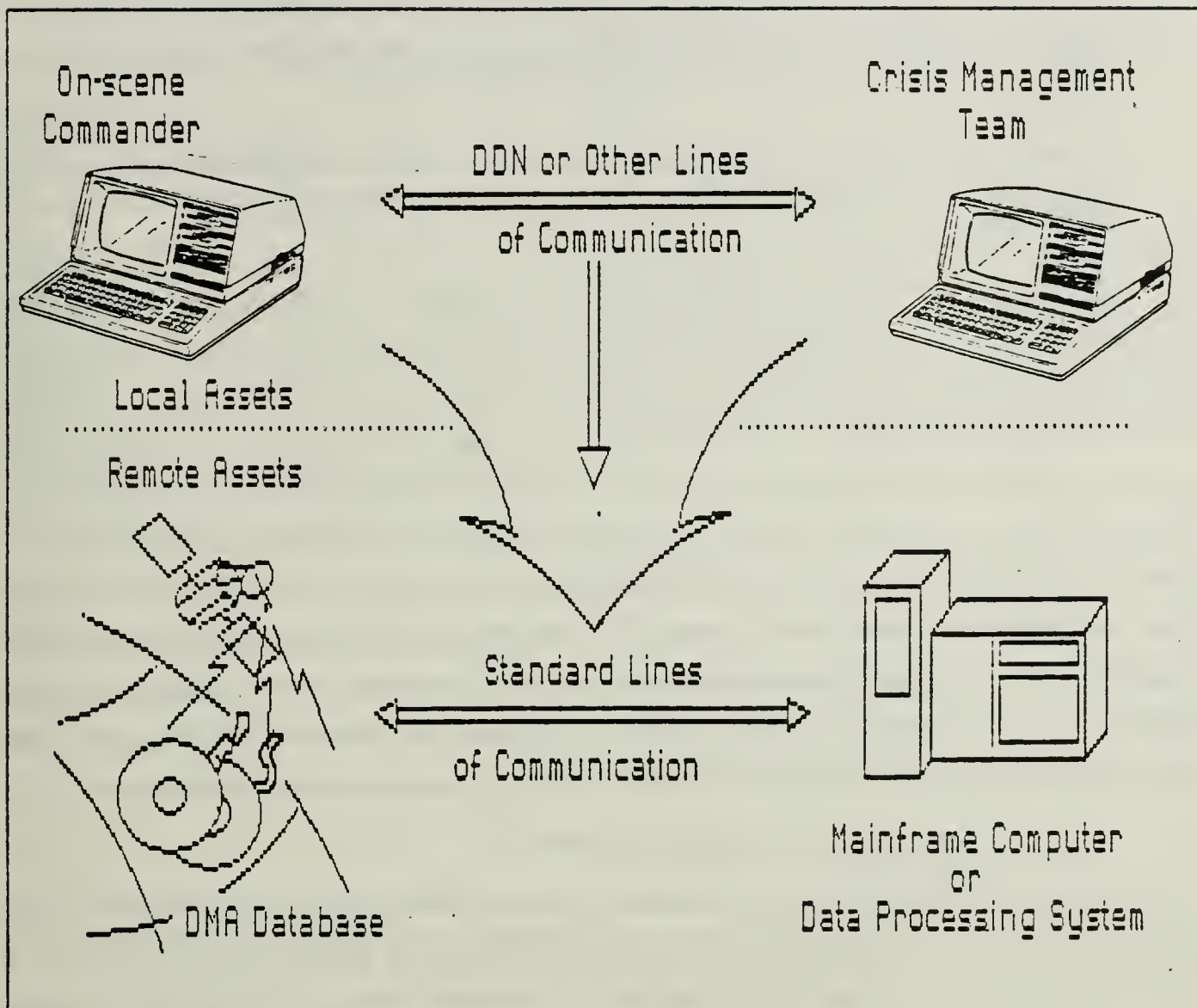
Figure 2. Use of Digitized Maps in Crisis Situations: Instant accessibility is required by the on-scene commander and the crisis management/action team.

commanders, monitor the activity levels of numerous indicators [Ref. 3: p. 86] such as enemy order of battle, troop strength, logistic support, levels of supplies, casualty rate, weather, etcetera. These indicators are often not quantifiable and depend on some other previous analysis. When only men were in this loop, knowledge of the general situation and of the other analyst's psyche was sufficient to judge the quality of a decision. The current trend in technology and sensors is to place a greater reliance on the use of Artificial Intelligence (AI), specifically Expert Systems. Versions of these AI systems process raw sensor data, perform primary estimations, and then effect dissemination [Ref. 3: p. 35]. This is the best solution when dealing with:

1. High threat or short reaction time weapons response.

2. Sensor systems which deliver massive amounts of raw data from which usable information must be derived through algorithmic processes.

3. Repetitive, and very subtle, information sources where changes in state may not be detected by casual or distractable observation. Also as a guard against misleading information or disinformation where the target observation system has known limitations.

The application of Expert Systems in C3 is ongoing; however, the analyst and commander no longer know the man who is feeding them the information on which they are basing decisions (and possibly lives). These AI/Expert Systems are generally decision tree or probabilistic based. For a human to enter into this system in the middle of the cycle, a graphical representation of the AI system's knowledge could be available. In Decision Support Systems (DSS), a common presentation vehicle is the Probable Futures Map [Ref. 3: p. 121]. With this information, a commander could better understand the conclusions and recommended options from his intelligence and decision support systems. These graphic representations are easily transmitted; a graphics capable microcomputer is needed to display them. This thesis turns one of DOD's most common microcomputers, the Zenith Z-100 series, into an available graphics terminal.

B. WHY THIS PROJECT IS IMPORTANT

This C2 problem needs to be addressed with a C4 solution. In a time when rapid transfer of data is common-place, a commander should no longer have to depend on a hard copy of a map or chart being carried to his subordinates and superiors. Neither should the tactical commander be tied excessively to his chart bag or map case.

1. Current system

a. Requests

The current system requires that requests for cartographic products be submitted to DMA or one of its military distribution centers for issue. The tactical commander usually needs one or two copies of each map in each of the areas he is expected to operate. This relies heavily on forethought to ensure all necessary maps are ordered and kept on hand. The burden is also on DMA to generate, print, store, and then distribute maps to users. Allowing users to access digitized mapping files, develop their own projections (usually of a tactical scale), and electronically receive the product would significantly reduce man-hours, printing costs, and warehousing requirements. DMA would need to develop some user friendly programs in order to allow access and to maintain high standards for their cartographic products, but this could be easily ac-

complished within the scope of current assets. The recurring theme of the problem this thesis addresses is that maps and charts can and should be received in a more timely manner.

b. Contingency

The commander and his staff routinely have literally hundreds of charts and maps which are carried around for contingency purposes. These maps of these require continuous updating and are regularly superceded and replaced. The requirement to maintain large quantities of maps adds associated logistic and manpower burdens. There is a need for an alternate means of obtaining up to date maps and charts in the fulfillment of a contingency requirement.[4]

2. Suggested Approach

Commanders should be able to transmit their situation and intentions on maps both up and down the chain of command. This thesis investigates that objective using no cost or government proprietary software and a microcomputer (the Heath/Zenith 100) that is widely available and well-suited to the job. The ability to pass maps and charts electronically has several significant benefits to the users, the mapping agencies, and DOD as a whole. Some of these possible benefits are listed below:

1. Immediate availability of high quality, updated maps and charts to lower echelon commanders. Though not being able to replace typeset printed maps, an electronically transmitted version with the necessary information overlayed or imbedded would be an improvement over lesser quality products.

2. Independence from some of the logistics tail of most commands and all staffs, that is chart bags, map cases, and their associated files. Maps and charts for locations not in a commands area of responsibility (AOR) could be called electronically, rather than keeping a hard copy on-hand.

3. Decreased requirement for DMA printed maps and more time available to order correct maps and charts before the detailed planning and execution phases.

4. Decrease in manpower requirements to keep chart and map allowances updated. The emphasis on maps and charts for a command's AOR being always up to date and other areas being available on-call electronically.

5. Better utilization of common, general purpose military microcomputers for more missions.

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4 The needs of a tactical commander cannot be fulfilled by this type of system at this time. The transfer of tactical quality maps electronically is currently an option using specialized graphics terminals only, however this capability has been extended to some major Air Force C2 commands as of this writing (see Chapter I.B.3.a below).

a. Electronic distribution

DOD agencies have started using the Defense Mapping Agencies (DMA) database of digitized maps. This is usually accomplished with a dedicated mainframe and a graphics workstation. Accessing the DMA World Data Bank II, one can build maps of any location in the world. To build the map, enter the center of the desired map and then the directional distances from the center to be displayed. The system automatically retrieves, draws, and then scales the map. Features include coastlines, waterways, political boundaries, roads and railroads; additionally, latitude and longitude, UTM, or GEOREF grid systems can be overlayed[Ref. 4: p. 44].

b. Generation

In addition to accessing DMA maps, mainframe computers can also be used to maintain their own databases of graphics software. Cartographic products generated by these programs could be sent and received throughout the chain of command. The ability to send and receive graphics products up and down the chain of command would result in consistent quality of information and less confusion due to interpretation of the written word[5]. A side benefit could also be realized with the distribution of other graphics products for visual affect and emphasis.

c. Existing systems

There currently exist several digitized mapping programs for microcomputers. Many are available through user's groups and via computer bulletin boards, but all of them have limitations which will not fulfill the requirements of this thesis. A brief review of some of these products follows.

(1) Map Maker. The program Map Maker produces two forms of quantitative maps: choropleth (area coloring) and graduated circles. Any set of statistical values may be displayed for its corresponding geographic area. Map areas are limited to states, counties, census tracts, or areas defined by the user.[Ref. 5: p. 67] This program is typical of those developed for the social sciences and demographics. Its resolution and accuracy would probably be inadequate for military purposes.

(2) World Map. This software allows users to generate a world map on the screen and even to zoom into various areas. Only boundary lines are drawn on the map and there are no details. The map is very good for allowing the user to set a latitude and longitude and then zoom in on the area in question. A number of cities and capitals are given and can be located and zoomed in on from the world map. [Ref. 5: p. 83] This

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5 A picture is worth a thousand words.

program could be useful to the strategic level planner who is only concerned with low cartographic resolution maps. Lack of data points would seriously hinder lower level planners who require greater accuracy and detail.

(3) *World Digitizer.* Another new map generation program is *World Digitizer* which has a similar capability to World Map, described above. It is written in the language C and performs all of its functions very quickly. The data it uses to generate maps is composed of one million connected latitude and longitude points. This is the first program reviewed which specifically warns the user of its inaccuracies. Its application to strategic and operational planners uses is possible.

(4) *MicroDEM, formerly Terrain Analysis.* This program provides digital topographical support. The program uses Digital Terrain Elevation Data (DTED) Level I produced by DMA, but the characteristics of the data limit its capability and require careful analysis of its results. The program can dump to a printer line of sight profiles, weapons or sensor masking plots, color tinted elevation maps, slope maps, and three dimensional oblique views. Data sets used by the computer cover 15 minutes of longitude, which corresponds to a standard tactical map. Programs are available for the Fulda Gap (16 disks), the Korean DMZ (5 disks), and Fort Irwin/West Point (11 disks). [Ref. 5: p. 18] This program is highly accurate and is updated regularly. However, the logistics trail to provide replacement and corrected disks would represent no major improvement over the existing system with regards to logistics, manpower burden, nor timeliness. Exploration of this system resulted in this thesis advocating the use of mainframe computers to generate the maps required, whether organically produced or drawn from DMA data. Regardless of the microcomputer advocates' claims that their machines can do it all, some jobs remain too large. The microcomputer is better used to display a map the mainframe has stored for it, and then to print it.

3. Direction of Computer Mapping

There exist two distinct categories in which the military commander or his staff would need to generate maps. The first is the strategic and operational[6] levels of command. The requirement would be for large area, small scale maps on which a commander could place symbology, icons, or text for broad direction and situational reporting. Accuracy and resolution quality would be secondary to convenience and speed of use. Ideally, situation reports and concept of operation maps could be prepared, easily stored

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6 Operational level of command can be roughly equated to the theater level or the area in which a corps commander would operate.

and instantly accessible to subordinates and superiors. The maps could readily be played back by remote units requiring only a small graphics capable computer and a modem (Ref. 6). The second situation occurs when lower level users employ maps and charts for tactical purposes. The programs mentioned in the previous section either lack sufficient resolution or require dozens of computer data disks to present a specific area. The resolution problem is unacceptable, when resolution needs to be 10 meters or less. The multiple disk problem offers no logistical or timeliness improvement over the current system of carrying bundles of charts or maps. This situation would require that the maps be created from a highly accurate and continuously updated cartographic database. Access to DMA online digitized maps would be a necessity. Some attempts at integrating the DMA data bases into a real-time enviroment are being attempted. A sampling of these programs follow.

a. TRACE

The U.S. Air Force is currently purchasing an automated decision support tool for C3I called Tactical Resource Allocation for Combat Effectiveness (TRACE). This system is available from Lockheed Missiles and Space Company or through Chromatics, Inc. The object is to develop a flexible and transportable system which can allow a command center to reduce time in resource planning and allocation. TRACE runs on a Digital Electronics Corporation (DEC) VAX computer with the Chromatics CX1536 High Resolution Graphics display. The programming is in Fortran and Graphical Kernel System (GKS). This combination of hardware and software allows real-time generation of maps using DMA digitized data.[Ref. 4: p. 44, 46] Though this system works at the command level, it is too hardware dependent ever to become available at the tactical level. Soon, this system will allow the strategic and operational planners to generate high quality maps and, hopefully, to disseminate them to lower echelon commanders.

b. National Marine Fisheries Services

The National Marine Fisheries Services (NMFS), which operates under the National Oceanagraphic and Atmospheric Agency (NOAA), has been developing the capability of a small graphics capable computer to display DMA or NOAA maps and charts. The computer emulates a Tektronix 4010 Graphics Display (similar to the emulator used in this thesis) and the reports indicate that the concept is feasible. Operational evaluation was conducted at Galveston, Texas. [Ref. 7]

c. Future DMA products

DMA is in the process of developing a film digitization capability which would be used in the future for a digital point positioning data base product.[Ref. 8] Access to this type of information would be available via the same means as cartographic data and could be similarly displayed. This is another tactical tool which can be utilized and should be explored in the future.

II. METHODOLOGY

A. APPROACH

This thesis will identify all components of a Low Cost Graphics (LO-CO-GRAF) system to address the problem of generating maps, transferring the maps between users, and producing a hard copy of that map from a command, control, communication and computer (C4) perspective. Computing and communicating between computers and data networks will be the central focus of the approach, with an additional restriction that this be a no/low cost solution to the problem. With the appropriate set of equipment and software attributes, commanders can enlist the aide of computers to ease some of the burdens of command and control. The combined use of mainframe computing power and the ability to communicate or translate that power to smaller more accessible computers will provide a valuable tool to the commander and the command and control function. The set of remote "source" systems that generate the graphics, local microcomputers, communications software, the graphics terminal emulator software program and the software required to print out graphics products will comprise the LO-CO-GRAF system. As seen in Figure 3, which provides an overview of the system architecture and components, communications software will enable each remote terminal to transfer data from the mainframe computer (or other graphics source system) to other user terminals. The programs required to send the electronic maps are available for most microcomputers and are an essential component of the system. The program required to playback or display the maps can be transferred within the system's terminals, as well as the printing programs.

1. Advantages

The LO-CO-GRAF system will take advantage of the high quality graphics programs and large storage potential characteristically available on mainframe computers, while using them to perform the calculating and plotting functions required to produce maps and other high quality graphics. Taking this approach will overcome some of the problems encountered by other map generation programs which tried to perform all of the functions on the microcomputer. Utilizing a mainframe also takes advantage of the fact that the database is constantly being updated by the Defense
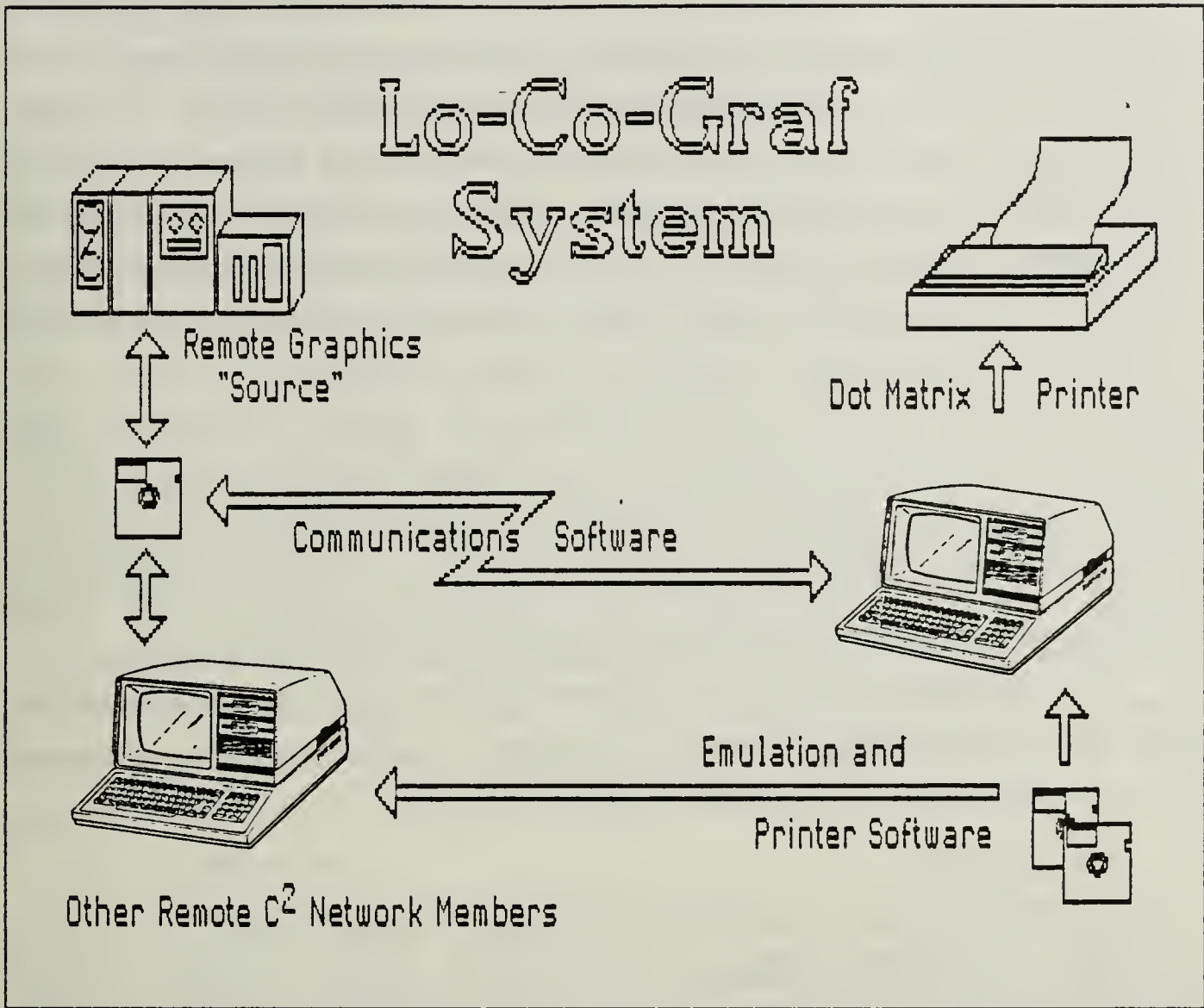
Figure 3. The LO-CO-GRAF System architecture.

Mapping Agency, providing up-to-date information.[7] The C2 community must be able to access this information from remotely located terminals in order to obtain the greatest benefits. With the aid of a communications software package and terminal emulator this can be accomplished at little or no cost by utilizing equipment assets already available to most organizations.

2. Distributed

Doing the work remotely is a major point where LO-CO-GRAF departs

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[7] Being able to access and process the DMA databases, that is the digitized cartographic products, as they become available circumvents the delay associated with the logistics lag time involved with ordering maps.

from similar graphics programs.[8] By accessing a remote source which will actually generate the derived graphics and by keeping that function separate, the microcomputer is free from the major task of maintaining the sizable database required to generate the maps and avoids the problem of trying to manipulate and process all that data. After downloading the high quality graphics products from mainframe computers and other sources, it can be translated to a form that can be understood, displayed, stored, redisplayed, and transmitted to other users. There are commercial and military hardware and software packages available that provide the capability to process DMA data or generate maps and other higher level graphics. Unfortunately these systems are very costly and require too much memory storage capability or too many hardware enhancements to be widely employed without incurring large costs to implement. The objective of this thesis is to demonstrate that a system could be made widely available at no cost to the users, by taking advantage of existing assets.

To accomplish this goal, it is necessary to make a few starting assumptions. First, what is the working environment? And then, what equipment can be expected to be available in the C2 community?

B. ASSUMPTIONS

The first assumption is that the LO-CO-GRAF system should be capable of transmission over telephone networks. This type of operation will allow the headquarters or the central C2 controlling node to bring in other new members and share the graphics among a set of operational units or commands. The only requirement is that that unit have a similar set of hardware and software available.

Some hardware is universally available to support the C2 components wishing to use, produce and transmit graphics products. The software required will be introduced or provided as a by-product of this thesis. The real contribution of the LO-CO-GRAF system is the ability not only to obtain the graphics, but also to transmit any maps generated along with the software necessary to use it. Some assumptions follow about the working environment and the assets available.

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8 Microdem and Terranal, for example, use data which has been processed and prepared to enable a small computer to then generate maps locally. One problem with this process is that you need to keep all the data on hand locally and then reprocess it as needed. The data disks required are very cumbersome and are just as difficult to keep current logistically as paper maps.

1. Sources

High quality graphics products are available on many mainframe computers which are capable of processing raw data and generating maps. Most, if not all, mainframe computers have resident programs to perform high quality graphics functions. The graphics programs are either capable of generating their own maps, as in the case of Display Integrated Software System and Plotting Language (DISSPLA) program, or are capable of processing DMA data to plot maps from raw data.

In the case of a remotely located C2 terminal, the mainframe will not be accessible by a direct connection to the microcomputer. Connecting will require access through some communications system in order to make the graphics program available. "Available" means obtaining access to the mainframe through a modem and communications software package or communicating to some other graphics generating facility, such as those available on the Defense Digital Network (DDN). In either case, the operative word is available. An additional requirement for this thesis is to implement LO-CO-GRAF at no additional cost. Next, the problem of establishing communications between the remote mainframe (or other map source) and the local microcomputer must be addressed and resolved.

2. Communications

Communications software is readily available at no cost as freeware or Government proprietary software and in most cases is already available on a mainframe computer available to the potential users. If no communication software package is available, one must be obtained, again at no cost, in order to stay within the low cost (no cost) objective. This thesis assumes there is a communications software package available which will enable communications between the remote map generating system and the local microcomputer.

For the case where no communications system is available to provide access to the mainframe, instructions for obtaining the software will be provided within this thesis. The software must be adaptable to as many different mainframe computers as possible to allow access to all the many types of graphics source machines available. The communications software must also provide for communications between the graphics sources and to the microcomputer.

3. Microcomputer

The microcomputer must be capable of translating and processing the graphics data. The Zenith Data System Z-100 microcomputer is both capable and

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available. There are many Z-100 computers in the military inventory which are not utilized to their full capability.9 The Z-100 was chosen because it has very good built-in graphics capabilities, which will be discussed later in greater detail in Chapter III.

To take full advantage of the resident graphics capability of the Z-100, a software program will be developed and documented as part of this thesis to make it emulate a standard high quality graphics terminal. Through emulation, the Z-100 will gain the ability to process, display, and store (map) graphics. After storing the data, the last step is to be able to recall or redraw those saved images as well as print them out on paper.

4. Printers

The last assumption is that there will be a requirement to print any maps or other images which are generated by LO-CO-GRAF.10 Choosing a graphics screen dump program which applies to several of the more common military printers will provide a way to print any map images saved by the terminal emulator program.

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9 The major reason for not fully utilizing the Z-100 capabilities is that they are neither software nor hardware compatible with the more recent and popular International Business Machine (IBM) personal computer (PC) machines. The differences are examined in detail in Chapter III.C.

10 There are many dot matrix printers throughout the DOD in both militarized and commercial versions. The Epson MX, Okidata Microline, and Zenith MPI-99/150 series dot matrix printers are examples of standard DOD printers.

III. TECHNICAL EXPLANATION

A. MAP GENERATION

The ability to generate maps for strategic or theater level operations is commonly available in mainframe graphics programs. The mapping characteristics may include a variety of coastlines, political boundaries, and waterways, as well as selection between the different types of projections. The major limitation is that only a limited number of data points have been saved for the maps to be drawn from. Two unique resolution problems are encountered while creating maps. First, the aforementioned lack of data points can only generate maps with resolution measured in kilometers (possibly fractions of kilometers). An example of this type of resolution problem can be seen in Figure 4. Secondly, display resolution is limited by the type of computer monitor being used and also by printer resolution characteristics.

1. Resolution Problems

The standard definition of resolution is the smallest distance between two different points that is distinguishable. In printer terms, the expression used is "dots per inch" or dpi (a typical laser printer can perform 300 dpi or resolution to 1/300 of an inch). For computer monitors, resolution is stated in the number of pixels, that is, the number of points on a screen displayed vertically and horizontally. The number of dots per inch is not fixed by the computer screen, though. Just as a television picture looks less grainy on a small screen, a computer monitor with a 13-inch screen will look better than a 19-inch screen. This is because the picture is really made up of a fixed number of pixels, the larger the screen then the further apart the dots will be [Ref. 9: p. 34]. Resolution can be changed by the user in both the horizontal and vertical by adding hardware upgrades to the graphics circuitry, therefore manufacturers refer to the total number of pixels displayed. A common example would be the Color Graphics Adapter (CGA), which has a color resolution of 320 by 200.

Table 1 presents a sampling of devices, their actual resolution, and their presentation characteristics. These numbers must naturally be compared to the visual acuity of the human eye. Typically, a person can distinguish objects one degree apart at six feet. Human vision remains highly dependent on distance, contrast, color and shading, shapes, brightness and darkness, and the viewer's age (Ref. 10).
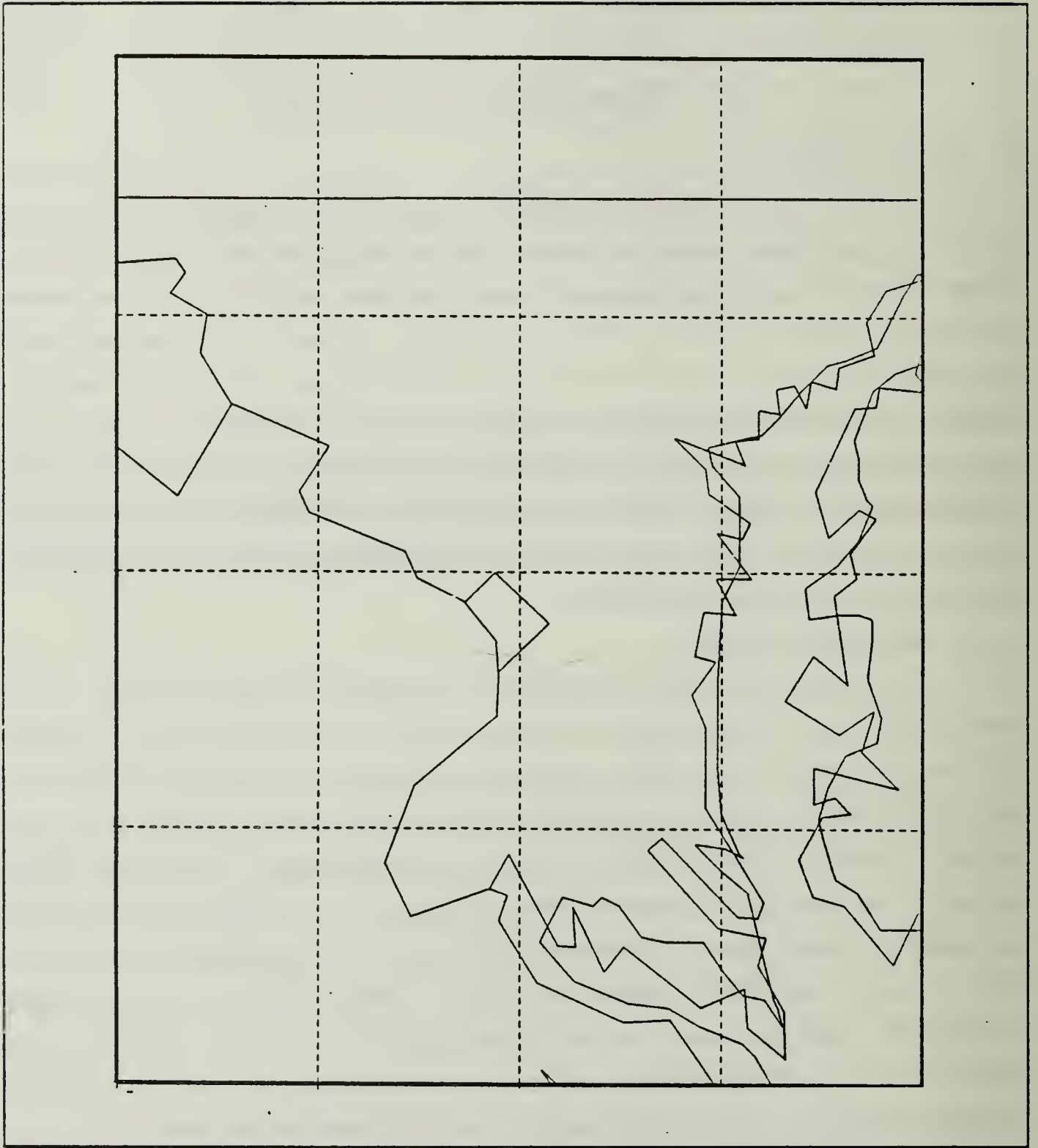
Figure 4. Example of resolution problems: Map of Washington, DC area.

Returning to the television example, a typical television monitor only produces 200 lines of resolution, much less than that possible with a graphics adapter. Yet to the eye it is more than sufficient to portray an image. The reason for this is the large number of colors or shadings being used. This multi-color, low resolution technique is excellent

Table 1. SAMPLE RESOLUTIONS

Screen Resolution	Actual Resolution	Lines/char @ 12 pt
320 X 200 on 13"	36 ppi (horizontal) 30 ppi (vertical)	5
640 X 480 on 13" (Z120)	72 ppi	12
1024 X 768 on 16"	90 ppi	15
1536 X 1152 Chromatic CX1536 (TRACE)		24
Dot matrix printer (standard 9-pin)	up to 240 dpi	40
24-pin dot matrix printer	up to 360 dpi	60
Laser printer	300 dpi (typical)	50
Typesetter	1200 dpi	200

Taken in part from [Ref. 9: p. 36] and manufacturer's specifications.

when displaying real-life images, but inadequate for text images [Ref. 9 : p. 35]. The problem is heightened by the intense resolution/accuracy requirements needed for mapmaking. The anti-aliasing schemes used to improve the appearance of text on a monitor would only introduce error into cartographic representations.

2. DISSPLA

The graphics package available on the IBM 3033 mainframe computer at NPS is the DISSPLA program. This system was developed by Integrated Software Systems Corporation (ISSCO) of San Diego and is widely used throughout the Navy, DOD, industry, and other academic institutions [Ref. 11]. According to DISSPLA, any desired graphics product can be achieved within one to two hours, using the interactive system. Some of the products include specialized business, cartographic projections (of interest to this thesis), and a dynamics program. All of which are detailed for practical applications in the DISSPLA User Guide [Ref. 12].

Automated graphics is a powerful and useful computer application of significant importance to distributive computing and wargaming in the military. The capability to plot computer generated maps on demand is an essential tool for opera-

tional commanders, as well. There are many software packages which provide programs of commands and subroutines to produce very powerful graphics outputs. The geographic data required to plot the maps is stored in mass storage in several resolutions[Ref. 12: Part D], which can be called to generate maps of various projections.

a. Programming

DISSPLA was developed using Fortran IV constructs. Current Fortran compilers use Fortran 77 or, if an IBM system, VS Fortran. Both are fully backwards compatible and have the greater variety of options for entering data which aids in cartographic design and engineering.

The DISSPLA package is actually a library of FORTRAN subroutines which can be called and arranged with other FORTRAN source code to generate the desired map. It required a great deal of time to learn how to organize these subroutines to generate maps and plotting a few maps of different theaters of operation to show the power of this DISSPLA option.

The process of calling subroutines at various levels within the DISSPLA package is perhaps the most difficult concept, but not the first that can cause trouble. To use DISSPLA means one will interface through a set of more than 300 user- callable subroutines. The subroutines access a network of usually invisible (except when an error condition occurs), internal sub-subroutines which communicate with each other using blocks of more than 200 variables. As can be seen, calling a subroutine is no simple matter. The logic flow in DISSPLA is unidirectional through more than twenty levels of subroutines.

By levels, it is meant that a call on one subroutine may do nothing more than set a parameter or flag a variable for use by another subroutine, or a subroutine occurring later on in the program. Calling a subroutine that depends on another subroutine which has not already been called will cause you to go into computer "Never-Never" land. Fortunately, to generate maps one will only have to specifically address four kinds of routines to change to proper levels.

The program listings in Appendixes A and B, emphasize comments which show the transitions between programming levels. Using the programs listed in Appendix A, one will not need to know a great deal about the levels to generate maps, but should understand that they exist and can cause great difficulty when generating complicated plots if they are not accessed in the correct order.[Ref. 11]

b. *Running DISSPLA*

To use DISSPLA under VM/CMS, one must link to the support disks which contain the data files. This involves establishing appropriate input and output files, file definition statements, and text library programs, which is a tedious and time consuming process. There is an exec[11], DISSPLA EXEC, that must be used to actually run a program and link to all the appropriate files and create the correct environment to work in DISSPLA.

An on-line help file is available by typing "disspla ?". Although this file is helpful, it does not make it easier to create three dimensional plots (maps are two dimensional projections of three dimensional data points) nor does it address how to generate a map specifically. The most valuable source of information for plotting maps is contained in the DISSPLA Pocket Guide [Ref. 12: Part D]. It contains several example programs with more information about the calling of map plotting subroutines.

c. *DISSPOP* option

When the DISSPOP option of DISSPLA is called, the output is a device independent plot file, rather than an actual plot. This file is called a metafile and is highly compressed. It can be interpreted by one of a selection of post-processor programs for output to a particular device. [Ref. 12: p. F-1] Exercising the DISSPOP option, or a similar capability under a different graphics program, a commander could generate the map or chart with any necessary information attached and then store it. Any subordinate or superior with a graphics device listed in the DISSPOP post-processor device menu could then instantly retrieve, display, and print (if they also have that capability) these maps and charts. The use of a device independent plot file will have to be a capability included in a command center's map generation program.

B. COMMUNICATION

The second part of the solution involves establishing a way to communicate between the mainframe and a remote microcomputer. Computer to computer communications requires a working knowledge of the technical characteristics of both machines, a modem, and a basic understanding of communications software. First, a discussion of the functions of the modem and how it provides the connection between the remote graphics generating system and the microcomputer.

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11 An exec is an executable file, which when called will initiate programs and configure your operating system or virtual machine for a specific task.

1. Modems

There are two basic modem configurations, internal and external. Electrically there is no difference and the procedures that follow, as well as the software to be provided/introduced, will work with either variety. All modems are rated in terms of their transmission speed. The ratings are in baud[12] (e.g. 300, 1200, 2400,...etc.), which refers to the number of bits per second the modem is capable of transmitting or receiving. A 1200 baud modem will transmit and receive data four times faster than a 300 baud modem, and half as fast as one rated at 2400 baud. Most communications software systems today allow connection at any speed, but the faster the better.

2. Communication Software

A communications software program is used to access a communications network or remote system. This allows the microcomputer to dial the necessary telephone numbers, establish an electrical connection, and then communicate with the remote system. The remote system may be a mainframe computer, another microcomputer or a data communications network, like the Defense Data Network (DDN). The main function of this software is to make the remote system recognize your microcomputer as an input/output terminal.

By electrically looking like an input/output terminal, the microcomputer can talk to the remote system over telephone lines as if it were connected (hardwired) to the other computer system directly. Most communications software programs will also allow transfer of files and programs from the microcomputer to the remote system and vice versa. The file transfer feature will play an important part in the LO-CO-GRAF network so it is important to select a program which utilizes a standard communications protocol. The communications software package selected for this thesis has been developed for over 200 different computers and microcomputers.

3. KERMIT

KERMIT actually stands for Kl10 Error-free Reciprocal Microcomputer Interconnection over Teletype (TTY) lines. This computer communications protocol designation was established when CP/M was the preferred microcomputer operating system and it was not changed as the system was later developed for use with other disk operating systems (DOS).

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12 Baud rate is a measurement of the capacity of a communications channel to pass information.

KERMIT was developed and written at the Columbia University Center for Computing Activities as a packet switched file transfer and communications program. KERMIT is not necessarily better than other programs but it is free and it has been adapted for use on many micro, mini, and mainframe computers. The partial list in Figure 5 shows a few of the more popular versions.

Every version that has been implemented is available from the Columbia University KERMIT Distribution Center.[13] The program can be downloaded by any file transfer system with a modem connection or by accessing the distribution center through an electronic data system like the Defense Data Network (DDN). A complete set of instructions are available (Appendix D) which provide all the instructions necessary to access the KERMIT archives. Once you have obtained a copy of KERMIT it must be set-up with the correct parameters to use it in the LO-CO-GRAPH system.[14]

4. Utilization .

There is a very exhaustive manual available in disk format which explains all the parameters and options for using KERMIT. It is beyond the scope of this thesis to explore all the abilities of the program itself. An instruction guide which explains all the steps necessary to operate KERMIT, as required for the LO-CO-GRAPH system, appears as Appendix E.

The KERMIT instruction guide is written specifically to allow connection of the Zenith Z-100 to the International Business Machines (IBM) 370 mainframe. It is not necessary to know anything more about KERMIT to use it as the communications software in this system. Minor modifications to the set-up procedure will allow connection to the Defense Data Network.

Connection to the DDN and or mainframe will allow access to a graphics program designed to generate high quality graphics and maps. These programs require a graphics terminal or workstation quality monitor in order to display the graphics. This leads into the next area of the project. It is necessary now to make the remote graphics source system think the microcomputer is a graphics processing terminal.

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13 The center maintains a file (Appendix C) on their computer which contains a much more comprehensive list of KERMIT applications and provides all the information needed to find the correct version for your computer.

14 This will be discussed at length in Chapter IV.

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MACHINES(S)              OPERATING SYSTEM      LANGUAGE

Micros and Workstations - - - - - - - - - - - - - - - - - - - - - -

Apollo                   Aegis                 Pascal
Apple II                 DOS 3.3 or ProDos     6502 Assembler
Atari ST Series          GEM                   C
Commodore 64             DOS                   CROSS (or FORTH*)
DEC Professional-350     P/OS                  Bliss
Honeywell L6/10          MS-DOS                MASM
IBM PC family            PC DOS                Lattice C
OS9/68000 Portable       various               Assembler
Sirius 1/Victor 9000     MS-DOS                C
TRS-80 Model 4           TRSDOS                ASM
Tandy 2000               MS DOS                MASM
TRS-80 I and III         TRSDOS                Z80 Ass.


Minis and Mainframes - - - - - - - - - - - - - - - - - - - - - - -

Cray-1, Cray-XMP         CTSS                  Fortran-77
Data General             AOS/VS with MV/UX     C
DECSYSTEM-20             TOPS-20               MACRO-20
Honeywell 6000           DTSS                  Virtual PL/I
Hewlett-Packard 3000     MPE                   SPL
IBM 370 Series           VM/CMS                Pascal/VS
IBM 370 Series           MTS                   Asm, Pascal
Sperry/Univac-1100       EXEC                  Assembler

VAX                      VMS                   C
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Figure 5.   Partial list of available KERMIT applications

C. TERMINAL EMULATOR

There are many types and makes of microcomputer available within the DOD community. Creating a way to transport graphic images among all of them would involve many problems. For this reason the selection of a microcomputer on which to base the emulation program is a critical decision point in this thesis research. This choice is dictated by the availability and cost of the microcomputer as well as its resident graphics handling capabilities. Why select the Heath/ Zenith Z-100 over the IBM-PC? One of the greatest assets of the Z-100 computer is its high-resolution graphics capability which is made easy to use by the availability of powerful graphics statements in the Heath/Zenith (Z-BASIC) implementation of Microsoft BASIC [Ref. 13: p. 77]. The following sections provide a short history and detailed analysis of this decision.

1. Z-100 versus IBM PC

The IBM Personal Computer (PC) was introduced in late 1981. Because of IBM's success in the mainframe market place and the fact that their name was nearly synonymous with 'computer', it took the microcomputer world by storm and quickly became the industry standard. To become the 'standard' was an important development in the then new marketplace. The biggest change it introduced was the idea of third party software development. Until then almost all software was developed or sponsored for development by each computer manufacturer for exclusive use with their computer.

The fact that other parties could now write and produce software for use on a set of new standard computers was both a blessing, for all the new microcomputers that were to come, and a disaster for all that had already arrived. IBM had done something different in their computer architecture that made it vastly different [Ref. 14: p. 47] from nearly all previously designed computers including the Z-100 .

2. Differences

The biggest differences appear in the physical hardware buss structure, the operating system and read only memory (ROM). The hardware buss that IBM selected on which to base thier PC's equipment architecture was not compatible with the S-100 buss, the industry standard. This means that the physical connections are different from previous hardware implementations. These buss differences account for most of the hardware incompatibility while the ROM is to blame [Ref. 14: p. 48] for the rest. The ROM is called in order to access many of the hardware features required to accomplish interfacing between the software, the operating system and the microcomputer.

Even a relatively simple application like word processing requires cursor movements and delete functions which must be accessed by the ROM. If a program goes to a memory location expecting to find an instruction and finds nothing or, even worse, a piece of data, it will not be able to execute the correct instruction. This will cause the program to stop. Even more complicated kinds of interface problems arise when performing graphics functions because so much interaction is required between screen instructions, memory storage and system functions to produce screen images.

The actual image displayed is a product of the series of mapped or drawn lines of dots. Each dot is drawn (turned on or off) on the screen. The number of dots

available to turn on or off per inch are the picture elements (referred to as a 'pixels') and the higher the number of pixels, the higher the resolution of the graphics. The number of screen pixels addressable are characteristically between 640 X 200 and 640 X 400, horizontally and vertically, respectively. All the different pixel combinations and sizes require different aspect ratio (height to width) calculations in order to correctly represent graphic images. Beyond these complications, within each system there are graphics modes (e.g. low, medium high, etc.) which correspond to different resolutions. Different microcomputer systems store the data and information required to describe the picture in different memory locations, which adds yet one more level of confusion. From this brief description of some of the variables, it can be seen that trying to write one software program, especially a graphics intensive one, which would apply to all microcomputers is an impossible task.

3. Z-100 Screen

In the normal text mode, the Z-100 will display 25 lines of text at 80 characters per line. Each character is comprised of a matrix of 8 X 9 pixels. A quick and simple calculation leads to the screen resolution of 640 (horizontal) X 225 (vertical) dots which can be turned on or off to draw a picture. Although too complicated to address in great detail in this thesis, there is a process by which the display circuitry in the Z-100 can address the pixels to provide a picture 400 lines across, instead of 225. This process is called interlacing because every other line is displayed in an alternating fashion. The price payed for this extra resolution is a flicker apparent to the human eye in this mode. Normally the screen is refreshed, or drawn over, 60 times every second.[15] In the interlace mode, the alternating portions of the screen are refreshed only 30 times a second, which can be seen by the naked eye. This gives the appearance of "flickering".

4. Tektronix Screen

The interlace mode would provide a much better quality (higher resolution) representation of the actual graphics quality if using that mode when emulating a Tektronix graphics terminal. The Tektronix screen format is a 1024 X 1024 pixel instruction set, but the rectangular shape of the cathode ray tube (CRT) reduces the visual area to a 1024 X 780 pixel size. There are other differences between the location scheme for pixels on the Tektronix and the Z-100. Figure 6 below shows

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15 The 60 times a second is a result of the supply power of 60 Hz (60 cycles per second).

there is also a difference in the orientation of the screen's home or (zero,zero) starting point.

The CRT graphics can be routed (saved) to a disk file or sent directly to a dot matrix printer [Ref. 14: p. 73] and printed with nearly the same resolution as the original picture.16 The real advantage of this will become apparent in the next section about the printer programs .

5. Emulation Program

There are a number of factors which must be discussed in order to attack the problem of creating a program which would display graphic information on microcomputers. The major factors to be considered are the language to use in program development, the type of data used to describe/create the drawings, the format and contents of the picture data file, and the actual drawing program itself. Each of these areas is further examined below.

a. Language Selection

The advantage of using a high level and more structured programming language than BASIC is that it would perhaps provide an easier avenue to approach the actual program coding. But built-in graphics statements are only available in the PC-DOS version of PASCAL, and there are only a few libraries of graphics subroutines available for C which are only for the IBM [Ref. 15: p. 71]. BASIC, on the other hand, is an old and reliable, if not omnipresent, language that is available on almost all government- owned machines. Using BASIC's built-in graphics statements will ensure the program will run on all of the target microcomputers and can be easily changed as required by nearly anyone with a minimum set of programming skills.

b. Tektronix Graphics Protocol

One of the many standard graphics formats used widely is the Tektronix graphics terminal protocol. The high performance Tektronix 4010 series terminals will interface with many host graphics processing programs such as SAS/GRAPH, TELL-A-GRAF, GKS, VANGO, DI-3000, PLOT-10, DISSPLA and many more. There are commercial emulation software packages available for the IBM PC which emulate all the capabilities of the 4010 terminal except those that depend on the storage

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16 A common standard dot matrix printer like the OKIDATA has a 60 X 66 dot per inch printing pattern. When printed sideways at 9.5″ x 6.5″, this produces an area print of 627 X 390 dots. Recall the dot per inch resolution of the CRT was 640 X 400 in the interleaving mode.

Screen Resolution and Orientation

```
0, 780              1024, 780          0, 0                      639, 0

     ↑ Y                                    Y
     |                                      |
     |                                      |
  ───────────────────▷              ───────────────────────▷
         X                                  X
     |                                      |
     |                                      ↓
0, 0                1024, 0            0, 224                 639, 224
```
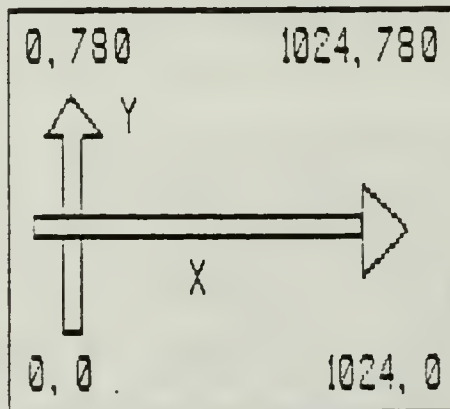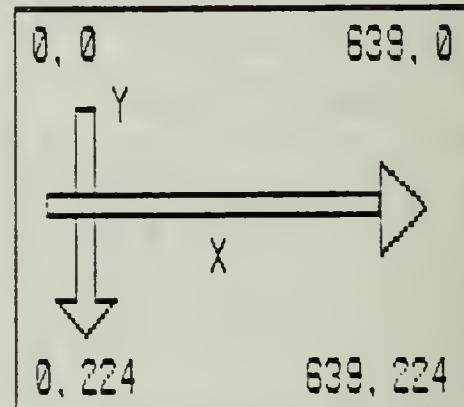
Tektronix 4010 Screen   Zenith 100 Screen

$$Z\text{-}100_{(X)} = \frac{5}{8}\ Tek_{(X)}$$

$$Z\text{-}100_{(Y)} = \frac{7}{24}\ Tek_{(Y)} - 224$$

Figure 6. Differences between the Tektronix and Z-100 CRT.

tube technology.[17] These emulator programs are relatively inexpensive, but require a specific hardware upgrade[18] to enhance the normal IBM graphics capability to a higher resolution range, which brings it closer to the normal resolution capabilities of the Z-100.

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[17] The storage tube technology referred to are the write thru and defocus attributes which are activated by escape sequence instructions.

[18] The hardware upgrades required are the Color Graphics Adapter (CGA), Enhanced Graphics Adapter (EGA) or other graphics enhancing computer hardware upgrade.

c. Drawing Program

Utilizing the built-in graphics capabilities of the Z-100, the graphing protocol of the Tektronix terminal can be emulated using the drawing instruction statements in Z-BASIC. The approach is outlined in these five steps:

1. Read the drawing instruction from the mainframe or other other graphics source.

2. Calculate the equivalent proportional movement on the Z-100 screen.

3. Draw (turn on or off) each vector of dot(s).

4. See if there are more drawing instructions from the source system.

5. Go to step (1) and continue until finish or end of data file.

d. Implementation

The emulator program, listed in Appendix F [Ref. 13: p. 80] was adapted easily for use with the DDN. The playback program, also listed in Appendix F and suggested in the same article, allows any picture to be saved to a disk file from the main emulator program and to be redrawn to the CRT. The program code itself is very well documented and a very detailed discussion of the program can be obtained from the original article if further information is required. The emulator can be adapted to nearly any system easily with only slight variation.

e. Capabilities

The emulation program was selected because it includes only the minimum set of capabilities required to complete the task of emulating a tektronix graphics terminal. There are no extras to cloud the major emulation issues required to prove the LO-CO-GRAF system concept. The basic program includes a communications module which allows dialing from the keyboard if using an auto dial modem. The graphics data from a mainframe processing program can be captured (saved) on a disk on the microcomputer to be replayed/displayed onto the Z- 100 CRT.

f. Picture Data File

After the graphics source program is accessed, any picture screen can be saved[19] to a disk in about 50 kilobytes of disk storage space, which leaves enough room for the emulator program, the playback program and six picture files on a disk formatted with 360 K of storage. The advantage of this method of storage is that playing back the picture takes a very short time because it fills the video memory with the

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19 This process is actually reading each screen memory address and copying each byte from memory to a file named by the operator, thus creating a picture data file.

data and does not have to redraw the picture vector by vector. With the picture (e.g. map, graph, etc.) redrawn and presented on the CRT, the next and last task of the LO-CO-GRAF process is producing a paper copy for use.

D. SCREEN PRINTING

Paper copies of maps, charts, and other graphics may never be replaced by other media. With all the computing and storage power available today there is still a reluctance to do away with the "file" or "working" copy. The LO-CO-GRAF system would not be complete without a means to print a paper copy of the graphics it produces.

Saving the frame[20] by capturing the video memory of the CRT to a disk file is the heart of the playback and screen printing function. Recall (para III.C.5.c.) the decision to write the map information to the screen and then save it as a pixel by pixel memory dump. This process maintains the best possible resolution from the original vector drawings and now realizes the payoff for that decision. The last, and now easiest, task for the system is to simply dump the screen pixels to a printer.

There are many screen dump programs available to accomplish this but the one chosen is licensed by the U. S. Government and applicable to many standard DOD printers.

1. SCDMP

SCDMP is a printing utility that allows reproduction of a complete video screen on a dot matrix printer, including both text and graphics, without having to exit the current program. The SCDMP program may be loaded manually (by entering SCDMP<cr>) or automatically, via 'autoexec.bat', into memory at the beginning of a session where it remains resident until needed. To print a desired stationary screen or frame, simply press <SHIFT-F12>, which generates an interrupt-5 and activates the screen dump.

2. Options

The SCDMP program allows a choice of which color bank of video RAM is dumped (if the Z-100 has all banks of color RAM installed). The number of video RAM (VRAM) banks installed in the computer is determined automatically by SCDMP upon initial load. For the color version, entering a <B> for blue, <R> for red, <G> for green, or <A> for all banks immediately after the <SHIFT-F12> will select the VRAM bank to be printed. If no character is entered,

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20 "Frame" is used here to describe the graphic and/or alphanumeric contents of the CRT screen.

<A>ll banks is the default. If only one bank of color RAM is installed, only the green bank can be dumped. For use with LO-CO-GRAF, there is no need to change from the default since only the green bank is loaded with data from any saved map. SCDMP also allows multiple density printing for some printers. Entering an <H> immediately after the <SHIFT-F12> or color selection would cause the printer to use a higher density mode for printing. The default density is normal or standard density. The higher density switch will make the printout much darker. There are several other useful switch options which are explained in more detail in the SCDMP documentation.[21]

3. Printer Support

The printers currently supported for U. S. Government use are the Epson MX/RX/FX Series with Graftrax, the Okidata Microline 83A, and Zenith/MPI 99/150 Series. A dot matrix printer which is compatible with any of these may also be used. Only the printer control instructions need be the same. The control sequence information can be determined from the printer operating manual [Ref. 16]. Printing a paper copy is the last piece of the LO-CO-GRAF system. The next step is to put it all together and actually create, capture, save, playback, and print a map. The total system will be evaluated in the next chapter with attention given to any problems encountered.

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[21] See Appendix G for specific information.

IV. ANALYSIS OF DATA

This chapter investigates the actual steps required to obtain maps in a typical session using the Defense Data Network and provides an analysis of the graphics products produced and the emulator performance. The session begins with accessing the DDN to obtain the KERMIT files necessary to establish a viable communications network and ends with a final session showing how to use that network to transmit a map file.

A. OBTAIN KERMIT

The best way to show how the system works is to use it to promulgate itself. Assuming only a knowledge of the system components and some basic skills operating microcomputers and any DDN terminal it is possible to see the power of LO-CO-GRAF in action.

1. The DDN Session

The following session on the DDN is a demonstration of how to obtain the KERMIT files necessary to establish a working communications network to handle file transfers between command components and terminals. The first step is to locate a DDN terminal and sign on to the command's account. A simple File Transfer Protocol (FTP) to the Columbia University Center for Computing will facilitate down loading all the necessary files to get KERMIT. The session follows:

* The star (*) below will indicate notes to the operator and provide details not otherwise available The <cr> will be used to indicate carriage return.

```
* Sign on to the DDN to get the welcome message:
WELCOME TO DDN. FOR OFFICIAL USE ONLY. TAC LOGIN REQUIRED.
CALL NIC 1-800-235-3155 FOR HELP.
MONTRY TAC   113 #: 61
@O 3/103
TAC Userid: XXXXX-XXXXX            * Site Specific
Access Code: XXXXX                 * Site Specific

Login OK
TCP Trying... Open

  ISI-SYSTEM-A, TOPS-20 Monitor 6.1(4050)
  There are 31+15 jobs and the Load Average is   2.20
```

After login, type "HELP ?" followed by a carriage return for
a list of on-line help topics.

* After login enter the following:
@FTP CU20B. COLUMBIA. EDU

* The system responds with:
Connection opened (Assuming TYPE L 36, MODE S, STRU P)
< CU20B. COLUMBIA. EDU FTP Server Process 5Z(46)-7
  at Fri 15-Jan-88 12: 28-EST
CU20B. COLUMBIA. EDU>

* Enter:
LOGIN ANONYMOUS <cr>

* The system will request a password:
Password:

* Enter GUEST <cr> and the response follows:
< User ANONYMOUS logged in at Fri 15-Jan-88 12: 28-EST, job 207.
CU20B. COLUMBIA. EDU>

* At this point request access to the KERMIT disks :
CD PK: <KERMIT> <cr>

* The response will be:
< Default name accepted. Send password to connect to it.
CU20B. COLUMBIA. EDU>

* Now enter DIR <cr> to see the list of files (it is very long)
DIR <cr>
< List started.
PK: <KERMIT>
AAAREAD. ME. 6
AAAUPD. HLP. 5

     .
     .
     .
AANETW. HLP. 29   *This file is included as Appendix D
     .
     .
     .
XXU. C. 2
CU20B. COLUMBIA. EDU>

* At this point just follow the instructions in appendix C and D to obtain the correct
files and KERMIT is now in your DDN account for the Heath/Zenith Z-100.

* to quit and get back to your home terminal is standard procedure from here:
Enter BYE <cr> :

33

```
BYE <cr>
< QUIT command received. Goodbye.
FTP>QUIT
@LOGOUT
Killed Job 39, User BISHOPR, TTY 162, at 15-Jan-88 12:33:46
 Used 0:00:08 in 0:07:54
Host closing connection
Closed
```

2. KERMIT in Hand

With a usable copy of KERMIT on site, one can set up a communications network between any other computer that has a copy of KERMIT. As can be seen by the simple session above, there are virtually no problems associated with obtaining the necessary files and the program itself is self documenting. The KERMIT program provides virtually error free transmission for data files and other programs between computers.

The KERMIT program is the central pivot for sending not only the map data files but for the terminal emulator, play back and printing programs which make up the LO-CO-GRAF system.

B. TERMINAL EMULATOR

Invoking the terminal emulator requires entering the program name if a compiled version is available. If not, then an interpreted version may be used but will run a little slower. To invoke an uncompiled version, enter Z-BASIC and then the program name. After loading the emulator it is necessary to access a source program for generating the graphics products. For this portion the DDN was again chosen. Using the Briefing Aid System (BAS) on the DDN as the remote source provided an excellent example of the networking capability of the LO-CO-GRAF system.

A working session will demonstrate how to access the graphics generating program but first it is necessary to put an instruction file in the DDN directory which identifies the type of terminal used.[22] Enter and name a file that will reside in the directory to provide connection instructions for the backend device protocol in the BAS. This file name will be requested during the graphics session. The data must be entered as follows:

```
backend=(tektronix),device=(d,tty: )
```

After the file is created on the DDN and put in the directory, the BAS program files can be used.

---

22 Appendix H provides specific instruction for accessing the DDN with a Z-100 and then using the LO-CO-GRAF system.

```
┌─────────────────────────────────────────────────────────────────┐
│         TEKTRONIX 4006/4010 GRAPHICS TERMINAL EMULATOR            │
│                                                                   │
│         BAUD  :  1200    PARITY :  N    BITS   :   8              │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│                                                                   │
│   1SAVE   2FUTURE   3FUTURE 4CLS   5QUIT 6FUTURE 7CTRL-C 8XOFF    9XON │
│                                                                   │
└─────────────────────────────────────────────────────────────────┘
```

Figure 7.   Emulator Screen

1. Emulator Screen Size

After accessing the DDN, set the terminal screen size to 24 lines long. This will keep it from killing the program and dumping out of the emulator back to the operating system on the Z-100. The problem seems to stem from filling the screen with data or alphanumerics and running out of space. When running the emulator this problem can be avoided by clearing the screen before any major new operation. A preset function key (F-4) is programmed to do this easily.

2. Emulator Session

After invoking the emulator, the sign on the screen, as shown in Figure 7, appears. Clear the screen before continuing and enter the correct codes to dial the DDN and sign on. This works very well with an auto- dial modem by entering:

```
 ATDTXXXXXXX        *The phone number varies with location
```

The next step was to access the program in the following manner:

* Again signing on to the DDN
```
WELCOME TO DDN. FOR OFFICIAL USE ONLY. TAC LOGIN REQUIRED.
```

35

```
* After complete login enter:
@DIR<LEVEL2>

   PS: <LEVEL2>
2400-SLIDE. GPX. 1
   .
   .
   .

AIRROUTES. GPX. 1   * This slide is provided as example
   .
   .
   .

ETHIOPIAN-CONFLICT. GPX. 1   * Some of these slides are provided
FALKLAND-ISLANDS. GPX. 1     * in appendix H
HORMUZ. GPX. 1
MEDIT. GPX. 1
PACKET-RADIO-SLIDE. GPX. 6
RHORMUZ. GPX. 1
```

* Above is a list of maps available to be downloaded from the BAS in the level2 directory. To download one just enter:
<level2>Viewer <cr>

The main menu will appear and ask for the name of the device instruction file[23] and then which map to generate. An example of the AIRROUTES.GPX map is in Figure 8. As can be seen, there is no way to distinguish between the two colors that indicate the two routes. This is not a problem with most maps because a single color is usually all that is available. The quality is comparable to a similar map generated on the NPS IBM mainframe computer using DISSPLA's World Coast Utilities option.

C. MAP QUALITY

The resolution of maps currently being produced electronically is sufficient for small scale, large area planning. These maps remain highly dependent on the number of data points available for generating the cartographic projection. Figures 9 and 10 represent typical products of mainframe resident mapping programs. The differences are partially due to printer capability; Figure 9 being produced on an Epson-based dot matrix, while Figure 10 was done on IBM 3800 laser printer capable of 270 dpi. These maps are could be ideal for strategic and operational levels of command and staff planning.

---

23 This is the file placed in the DDN directory above.
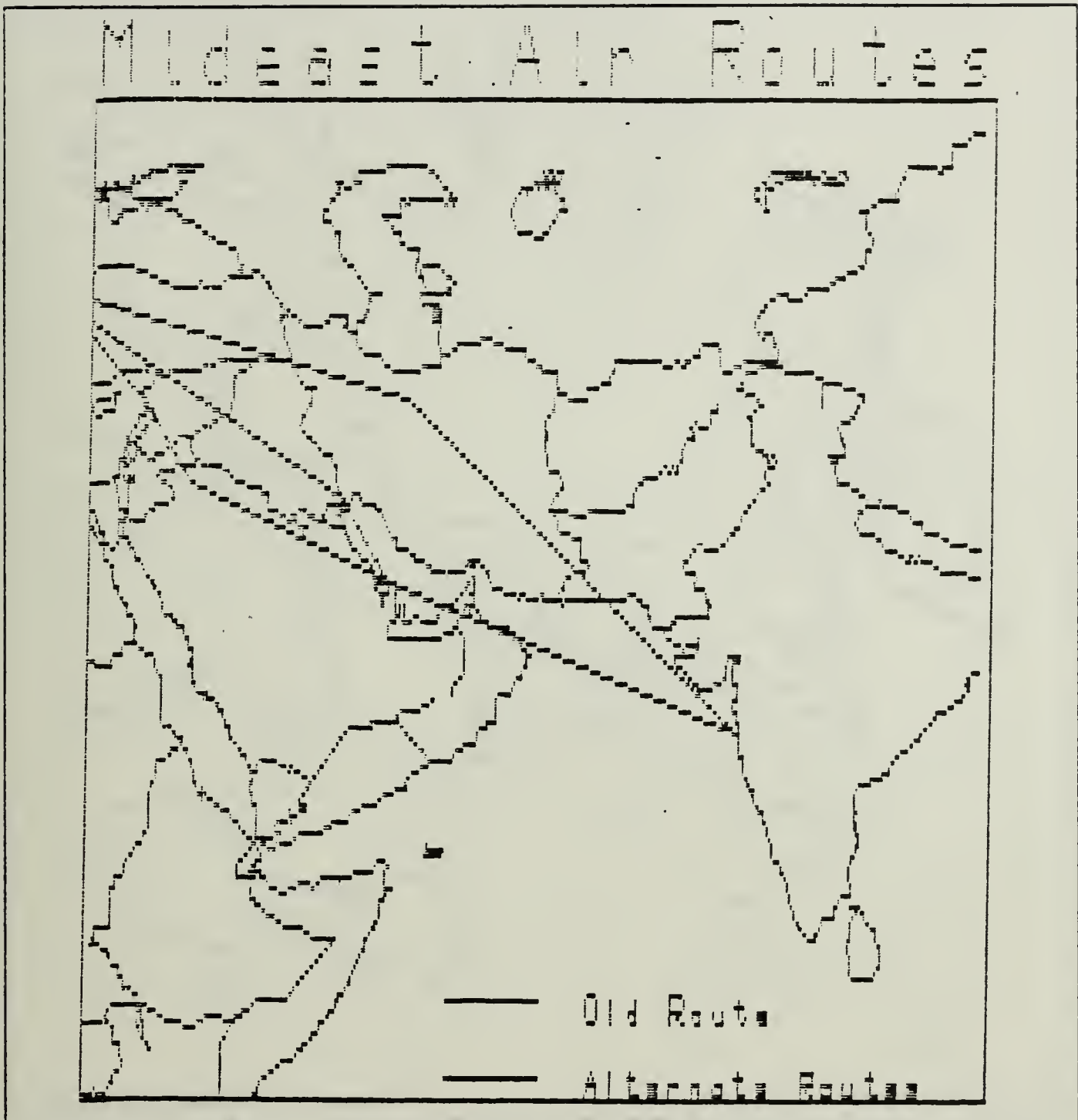
Figure 8. Example AIROUTES.GPX Map

1. LO-CO-GRAF and Briefing Aid System maps

There were many maps to choose from for this test and some of them are in Appendix I along with a comparative set of maps generated on the NPS mainframe, which are included at Appendix J. The maps that are filled in, like those in Figures 13 through 15, require a very long time to draw; averaging approximately 30 minutes each. The long time is required because each line vector must be calculated and drawn

37
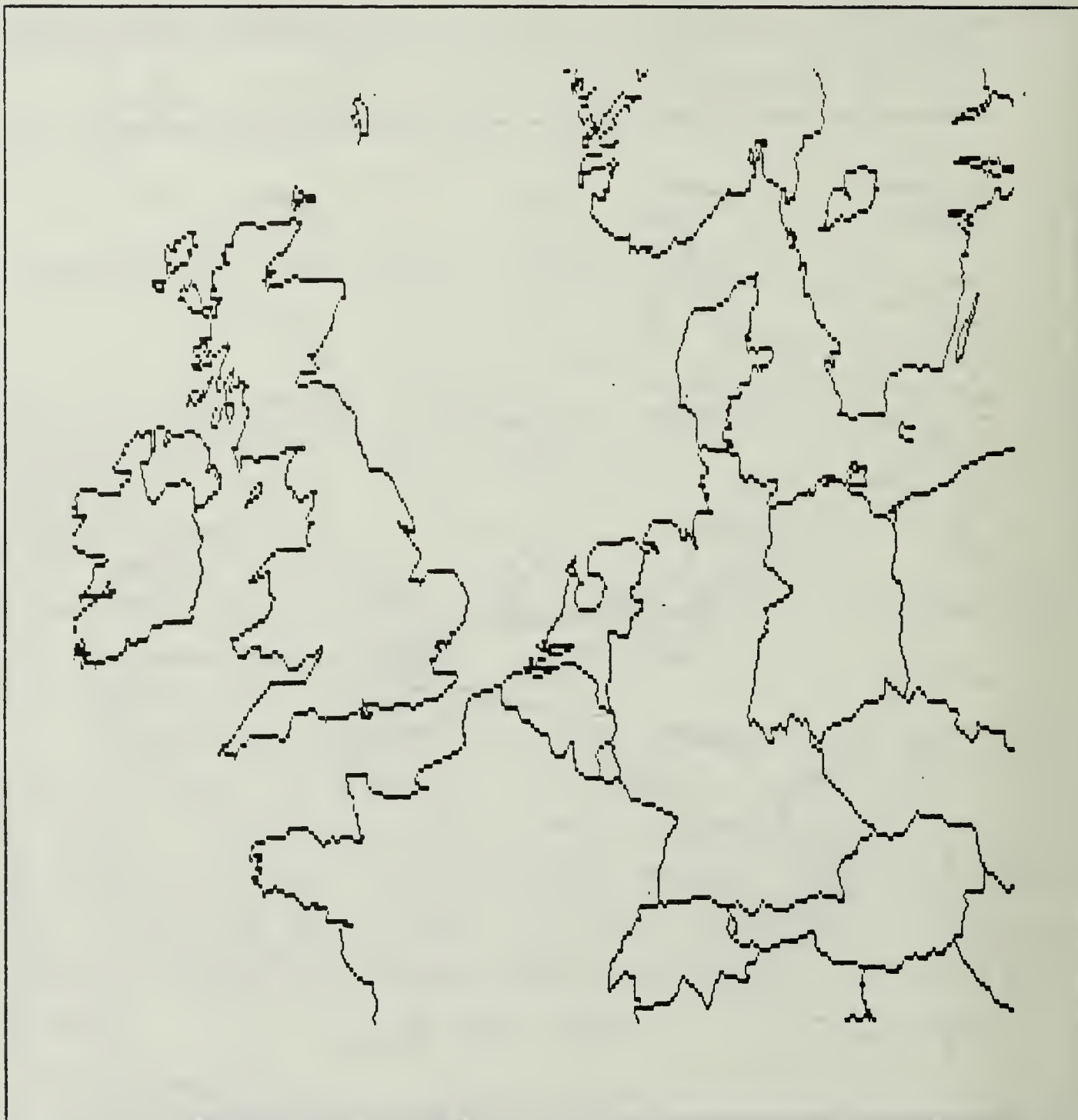
Figure 9. Map generated by Briefing Aid System/DDN: Area map of the North Sea region.

seperately to fill in an area. Although this time is relatively long, it is not an unacceptable period. When the maps were saved to disk and played back later, it did not make a difference in redraw times whether they were filled in or not. The redraw times were very fast, three to six seconds.
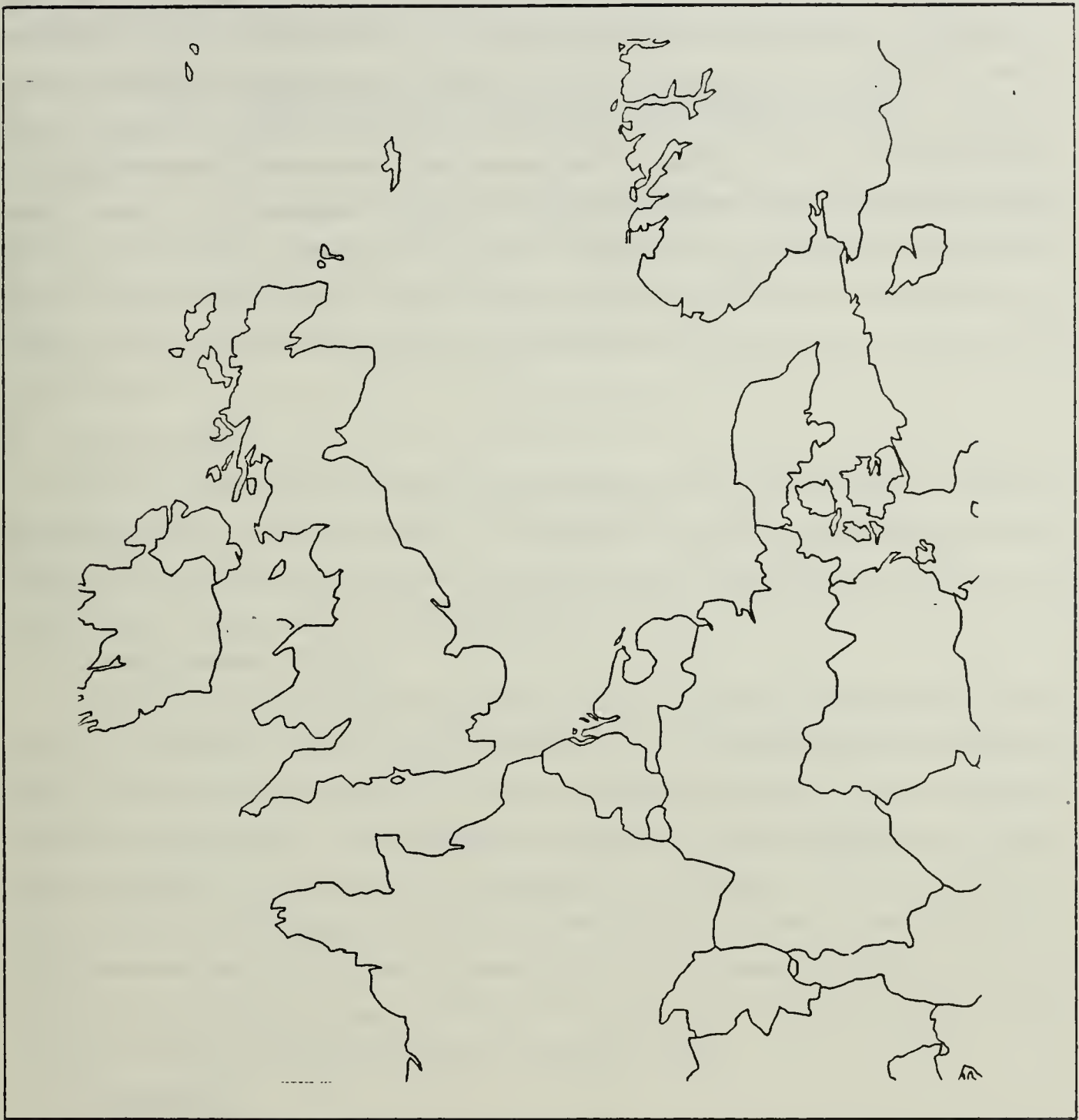
Figure 10. Map generated by DISSPLA World Coast Utilities: Area map of the North Sea and English Channel region.

2. DISSPLA maps

The typical map generation times for DISSPLA was seventy seconds. The time for a metafile to generate a map from its stored data was thirty seconds, but was more dependent on system loading. The longest recall time for a metafile was 210 seconds in a program where DISSPLA used many of its self-correcting features. The maps would

be suitable for strategic and operational level planners, however possible tactical uses are negligible. The metafiles transport via any file transfer protocol and the DISSPOP option of DISSPLA can display them on an extremely wide selection of graphics devices. The times required to generate these maps were acceptable. Better cartographic resolution created by a greater number of data points could increase the times for map generation, but this probably would also be in the acceptable range.

V. CONCLUSIONS AND RECOMMENDATIONS

The premise of this thesis is that: (1) access to maps via electronic means is currently feasible and desirable, and (2) combining a standard dot matrix printer with the Z-100 microcomputer (purchased en masse between 1982 and 1986) and developing a few software programs which could provide a low cost graphics and map generating capability which would greatly enhance the command and control process. These premises were achieved.

A. VALIDATION

The goal of this thesis, to show that the Zenith Z-100 will emulate a Tektronix graphics terminal, has been validated. The specific C2 objective of electronically transferring maps and charts has also been achieved. Another command and control tool has been developed which can be further exploited.

1. Large Screen Displays

The current cartographic representations used in situation rooms and command centers for their large screen displays lack resolution. The preliminary steps have been taken in this thesis to make maps and charts available at the desk of every microcomputer user requiring them. The benefits are significant to the commander and decision makers, intelligence, logistics, and communications personnel. With the addition of more resources and research to microcomputer graphics emulation, operationally oriented personnel and tactical levels of command will soon benefit equally. An example of this is the current maps used in WWMCCS displays and in command centers which use other strategic and operational level cartographic tools.

2. Simplicity

A self-imposed requirement to attain this command and control tool at no cost has been achieved. This constraint was levied in order to make it accessible to all DOD commands as soon as possible. The no-cost alternative for having a local graphics terminal capability is highly desirable. Many commands which have placed their Z-100's on shelves, in storage, or marked for disposal could reconsider that decision. The variety of graphics products which can be displayed, sent, or received is very significant and will become more important to the C2 process in the future. The no-cost decision also limited the number of options that could be considered to software already purchased by the DOD or in the public domain.

B. RECOMMENDATIONS FOR FUTURE EFFORTS

The scope of this project was sufficient to occupy the available time. It did, however, surface many future areas of endeavor to be expanded. Below are listed a few of the interest areas uncovered:

1. User Friendly

The requirement to be more user friendly will surface continuously until the machines are as smart as people are and will do what is required without being told. Specific areas which could use more smoothing are: (1) Map generating packages on mainframe computers operating interactively, requiring only page or screen dimensions, level of resolution, and location and scale of the map or chart, and (2) the graphics terminal emulator, though designed to be friendly, should not intimidate the user. Selection of devices and capabilities should be menu driven and include error and fault checking.

2. Applications to Tactical Users/C2 Centers

Access to tactical level maps and charts remains the real requirement. The only centralized source of this cartographic information continues to be DMA and NOAA. Therefore, DMA or NOAA must devise a system for accessing their digitized mapping databases and allowing the users to custom build their own maps and charts. A possible approach to solving the shortcoming of not having the ability to transfer maps and charts electronically, would be to develop programs for many microcomputers to construct and display the cartographic plots. The microcomputer would need to have a graphics capability sufficient for this type of display. The example of maps or charts required for a command and control center is given above. A more significant requirement is the ability to pass tactical level maps. Many units will have ready brigades, specific ships, or air squadrons in an alert status. When these units are required to "fly-away", they possibly may not have gotten to the point on the logistics checklist for tactical maps. The necessary graphics products could be prepared for the unit and transmitted to it while in transit. Similarly, intelligence updates and other information could be transmitted as soon as available.

3. NPS Applications

The Naval Postgraduate School's academic program has many uses for cartographic products. For example, the National Security Affairs Department uses some of the microcomputer's map generation programs discussed in Chapter I. These are used for strategic level discussions and as aids in geographic analysis. The Administrative Sciences Department uses similar products to allow graphical analysis of sta-

tistical data. The Meteorology and the Air-Ocean Science Department commonly use the map generation program maintained on the DEC mainframe computers at Fleet Numerical and Oceanographic Center across the highway. The biggest user of maps and charts would probably be the Operations Research Department, specifically the Wargaming and Analysis Laboratory. Their current system uses video disc technology to display maps in the Joint Theater Level System (JTLS) and low resolution digitized maps for Naval Warfare Integrated Simulation System/Integrated Battle Group Tactical Trainer (NWISS/IBGTT).

a. Specific Uses for DISSPLA Maps

One suggested area for further study is the generation of flat earth maps to use in battle planning or deployment exercises. These maps could be bounded and sized in a standard way, by latitude and longitude, so that they could be cut and pasted to expand as operational maneuvers move from one map section to another. This would be especially useful to those who must respond to crisis situations world wide but who have limited knowledge of world geography or no access to existing maps.

b. Increased use of DISSPOP

The ability to save graphics in a compressed version, a metafile, is very significant. Preparation by students or instructors could be made readily available and with little specialized training. More output device options would need to be added to the current DISSPOP selection. Examples of these could include IBM PC's with CGA, EGA, or Hercules upgrades added in. Most home computers with a significant graphics capability could also be included.

c. NPS War Lab

A desirable output of this thesis was to make the map generation program, and the Z-100 graphics terminal emulator, portable so they could be transferred into the Wargaming Laboratory. The communications package and screen dump routines would also have to be customized to equipment existing in the laboratory. This portion was not attempted due to lack of time. Significant equipment differences exist between the wargaming laboratory and the main computer center which would require reworking of all phases of this project. A partial listing of the necessary changes follows:

1. The computer center uses an IBM mainframe, the War Lab uses a VAX computer.

2. DISSPLA with the map generation option is maintained on-line with the computer center. The War Lab requires that advance notice be provided so DISSPLA, and the necessary operating environment for it, can be scheduled.

3. The map generation programs and its interactive version are written in VS Fortran which is IBM exclusive. The programs would need to be modified so they are compatible with Fortran 77 in the VAX environment.

4. A different version of the communications program (KERMIT) would need to be employed. As the discussion in Chapter III indicates, the version of KERMIT to talk between a VAX and almost any microcomputer is available. The protocols remain the same, which is the reason KERMIT, in particular, was chosen for use in this project.

5. The screen dump program chosen for this project was designed with most of the industry standard printer protocols available. The correct version would need to be chosen for the printers connected to the Z-100's in the War Lab.

d. *DOD distributed wargaming system*

A future addition to the NPS War Lab is a connection to the DOD Distributed Network (DISNET) subnet for C3 research. This system will serve NPS and four other research and development centers and engineering activities. Gateways to other classified and unclassified capabilities on the DDN would have to be identified. The opportunity exists with this system to have available more expertise and, probably, a greater desire to access high resolution digitized maps and charts or, if desired, to develop tactical ones for specific circumstances. The use of electronically transmitted maps could prove to be valuable research in the C3 wargaming and evaluation networks. Research conducted to aid the command decision maker by overlayed maps or maps with imbedded symbology could also be conducted.

APPENDIX A.   EXAMPLE PROGRAM SHOWING DISSPLA'S INTERACTIVE MAPPING CAPABILITY

The following Fortran program uses DISSPLA's map generation option. It has been written to be user friendly and "sailor-proof". The program needs to be performed at a graphics workstation which includes a TEK 618. In order to run this program on different equipment, some modification would be necessary.

A.   HOW TO RUN THE DISSPLA MAP GENERATOR

After you have copied the following program you can generate any of the listed maps at any time you wish:

NOTE: You must be using an NPS terminal that has a Tektronics 618

graphics monitor attached.

1. Enter "DISSPLA"   The program will respond with a welcome message.

2. When the program requests the name of the program you wish to run, enter the file name you have given this program and then press "PF-10/22" to execute. There are other options at this point for help (PF-1/13), to quit (PF- 3/15), or to view or edit a map file (PF-4/16).

3. After pressing the PF-10/22 key (execute) you will see several messages, in- dicating compiler passes, flash across the screen.   This will be followed by a mes- sage indicating what file deffinitions are in effect and asking you if you would like to execute the program with those deffinitions or exit.   After DISSPLA calls up all the supporting programs, you will be asked to press the enter key to continue. This step loads the Fortran program to be executed and compiles it.

4. The program has been written to guide you through the selection of a map to plot and plot it for you. You will then be asked to enter the name of the map you have chosen.   As the data for the map is called from disk storage you will see the plot being generated on the TEK-618.   After the map is plotted on the graphics monitor, you will receive a prompt on the IBM terminal monitor in- structing you to press "enter" to continue. If you want a hard copy of the map, you can press the HARD COPY button on the bottom of the graphics monitor first.

B.   INTERACTIVE MAP GENERATION FORTRAN PROGRAM

```
C****************************************************************************  MAP00010
C*          "THE POWER OF DISSPLA's MAP PROJECTION OPTION"              *  MAP00030
C*                                                                     *  MAP00040
C*                        BRETTE WALKER                                *  MAP00050
C*                        GENE BISHOP                                  *  MAP00060
C*                        ROB SABO                                     *  MAP00070
C****************************************************************************  MAP00080
```

45

```fortran
C                                                                      MAP00100
C   INITIALIZE                                                         MAP00110
      INTEGER CHOICE, ANSWER                                           MAP00120
      CHOICE = 0                                                       MAP00130
      ANSWER = 0                                                       MAP00140
C                                                                      MAP00150
C   MENU                                                               MAP00160
      WRITE (6,10)                                                     MAP00170
10    FORMAT (' THIS PROGRAM DEMONSTRATES THE MAP GENERATION ',/       MAP00180
     1' CAPABILITY OPTION OF THE DISSPLA PROGRAM.')                    MAP00190
      WRITE (6,20)                                                     MAP00200
20    FORMAT (' CERTAIN MAPS HAVE BEEN PREPROGRAMMED INTO THIS ',/     MAP00210
     1' DEMONSTRATION AND ARE AVAILABLE FOR YOUR VIEWING ONLY ',/      MAP00220
     2' ON THE TEK618 DISPLAY.')                                       MAP00230
25    WRITE (6,30)                                                     MAP00240
30    FORMAT (' PLEASE SELECT FROM THE MENU BELOW THE EXAMPLE MAP ',/  MAP00250
     1' YOU WOULD LIKE TO VIEW.')                                      MAP00260
      WRITE (6,40)                                                     MAP00270
40    FORMAT ('                    MENU')                              MAP00280
      WRITE (6,50)                                                     MAP00290
50    FORMAT (' 1.   NORTH AND SOUTH AMERICA.')                        MAP00300
      WRITE (6,60)                                                     MAP00310
60    FORMAT (' 2.   CARIBBEAN AREA.')                                 MAP00320
      WRITE (6,70)                                                     MAP00330
70    FORMAT (' 3.   NORTHERN FLANK.')                                 MAP00340
      WRITE (6,80)                                                     MAP00350
80    FORMAT (' 4.   MEDITERRANEAN AREA.')                             MAP00360
      WRITE (6,90)                                                     MAP00370
90    FORMAT (' 5.   JAPAN AREA.')                                     MAP00380
      WRITE (6,92)                                                     MAP00390
92    FORMAT (' 6.   QUIT.')                                           MAP00400
      WRITE (6,100)                                                    MAP00410
100   FORMAT (' PLEASE ENTER YOUR CHOICE:   1,2,3,4,5 OR 6.')          MAP00420
      READ *,CHOICE                                                    MAP00430
C                                                                      MAP00440
C ERROR CHECK OF CHOICE                                                MAP00450
C                                                                      MAP00460
C IF THE CHOICE IS ONE OF THE ALLOWABLE CHOICES THEN CONTINUE          MAP00470
      IF (CHOICE.GT.0.AND.CHOICE.LT.7) GO TO 110                       MAP00480
                                                                       MAP00490
C ELSE IF AN ERRONEOUS CHOICE THEN REENTER CORRECT CHOICE              MAP00500
      WRITE (6,105)                                                    MAP00510
105   FORMAT (' YOU HAVE MADE AN INCORRECT ENTRY.')                    MAP00520
      GO TO 25                                                         MAP00530
C                                                                      MAP00540
C CONTINUE                                                             MAP00550
110   IF (CHOICE.EQ.1) CALL NSAMER                                     MAP00560
      IF (CHOICE.EQ.2) CALL CARMAP                                     MAP00570
      IF (CHOICE.EQ.3) CALL NORMAP                                     MAP00580
      IF (CHOICE.EQ.4) CALL MEDMAP                                     MAP00590
      IF (CHOICE.EQ.5) CALL JAPMAP                                     MAP00600
      IF (CHOICE.EQ.6) GO TO 145                                       MAP00610
C                                                                      MAP00620
C TRY AGAIN?                                                           MAP00630
      WRITE (6,120)                                                    MAP00640
120   FORMAT (' WOULD YOU LIKE TO TRY AGAIN?')                         MAP00650
```

```
125    WRITE (6,130)                                              MAP00660
130    FORMAT (' ENTER 1 FOR YES OR 2 FOR NO.')                   MAP00670
       READ *,ANSWER                                              MAP00680
C                                                                 MAP00690
C CHECKING INPUT FOR ERROR                                        MAP00700
       IF (ANSWER.GT.0.AND.ANSWER.LT.3) GO TO 140                 MAP00710
       WRITE (6,135)                                              MAP00720
135    FORMAT (' YOU HAVE MADE AN INCORRECT ENTRY.')              MAP00730
       GO TO 125                                                  MAP00740
C                                                                 MAP00750
C CONTINUE BY CHECKING FOR YES OR NO                              MAP00760
C                                                                 MAP00770
C CHECK FOR YES                                                   MAP00780
140    IF (ANSWER.EQ.1) GO TO 25                                  MAP00790
C                                                                 MAP00800
C ELSE ANSWER IS NO AND PROGRAM IS EXITED                         MAP00810
145    WRITE (6,150)                                              MAP00820
150    FORMAT (' HAVE A NICE DAY.')                               MAP00830
       STOP                                                       MAP00840
       END                                                        MAP00850
C--------------------------------------------------------------   MAP00880
C   SUBROUTINE FOR MAP OF NORTH & SOUTH AMERICA                   MAP00890
C   THIS SUBROUTINE WILL CREATE A MAP OF NORTH & SOUTH AMERICA INCLUDING MAP00900
C   CENTRAL AMERICA, HAWAII, AND THE CARRIBEAN                    MAP00910
C                                                                 MAP00920
       SUBROUTINE NSAMER                                          MAP00930
C LEVEL 0                                                         MAP00940
C          CALL GRAPHICS DEVICE                                   MAP00950
C                                                                 MAP00960
       CALL TEK618                                                MAP00970
       CALL HWSCAL ('SCREEN')                                     MAP00980
C                                                                 MAP00990
C LEVEL 1                                                         MAP01000
C          SET PAGE SIZE AND PROJECTION SPECIFICATIONS            MAP01010
C                                                                 MAP01020
       A=11                                                       MAP01030
       CALL PAGE (A,8.5)                                          MAP01040
       CALL PROJCT ('MERCA')                                      MAP01050
       CALL MAPOLE (-120, 0.)                                     MAP01060
       CALL AREA2D (10,8)                                         MAP01070
C                                                                 MAP01080
C LEVEL 2                                                         MAP01090
C          DEFINE MAP PARAMETERS                                  MAP01100
C                                                                 MAP01110
       CALL MAPGR (-180.,30.,10.,-55.,30.,75.)                    MAP01120
C                                                                 MAP01130
C LEVEL 3                                                         MAP01140
C          CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION    MAP01150
C                                                                 MAP01160
       CALL MAPFIL ('COAS')                                       MAP01170
C                                                                 MAP01180
C          RETURN TO LEVEL 2                                      MAP01190
C                                                                 MAP01200
       CALL ENDPL(0)                                              MAP01210
C                                                                 MAP01220
       RETURN                                                     MAP01230
```

```
      END                                                             MAP0124
C------------------------------------------------------------------   MAP0127
      SUBROUTINE NORMAP                                                MAP0128
C                     .                                                MAP0129
C         THIS IS THE NORTHERN FLANK OF NATO                           MAP0130
C                                                                      MAP0131
C     THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF THE NORTHERN   MAP0132
C     FLANK AND INCLUDES ALL THE SCANDINAVIAN COUNTRIES.               MAP0133
C                                                                      MAP0134
C            LEVEL 0                                                   MAP0135
C            CALL GRAPHICS DEVICE                                      MAP0136
C                                                                      MAP0137
      CALL TEK618                                                      MAP0138
C                                                                      MAP0139
C             LEVEL 1                                                  MAP0140
C             SET PAGE SIZE AND PROJECTION SPECIFICATIONS              MAP0141
C                                                                      MAP0142
      CALL PAGE(15.,11.)                                               MAP0143
      CALL SCMPLX                                                      MAP0144
      CALL PROJCT('MERCA')                                             MAP0145
      CALL MAPMDE('STRAI')                                             MAP0146
      CALL AREA2D(13.,9.)                                              MAP0147
      CALL XNAME(' ',1)                                                MAP0148
      CALL YNAME(' ',1)                                                MAP0149
      CALL XAXANG(0.)                                                  MAP0150
      CALL HEADIN('NORTHERN FLANK OF NATO',22,1.5,1)                   MAP0151
C                                                                      MAP0152
C             LEVEL 2                                                  MAP0153
C             DEFINE MAP PARAMETERS                                    MAP0154
C                                                                      MAP0155
      CALL MAPGR(-15.,5.,55.,55.,5.,75.)                               MAP0156
C                                                                      MAP0157
C             LEVEL 3                                                  MAP0158
C             CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION      MAP0159
C                                                                      MAP0160
      CALL MAPFIL('PEUR')                                              MAP0161
      CALL MAPFIL('EURO')                                              MAP0162
      CALL MAPFIL('ASIA')                                              MAP0163
      CALL MAPFIL('PASI')                                              MAP0164
      CALL FRAME                                                       MAP0165
      CALL DASH                                                        MAP0166
      CALL GRID(1,1)                                                   MAP0167
      CALL MARKER(-1)                                                  MAP0168
C                                                                      MAP0169
C             RETURN TO LEVEL 2                                        MAP0170
C                                                                      MAP0171
      CALL ENDPL(0)                                                    MAP0172
C                                                                      MAP0173
      RETURN                                                           MAP0174
      END                                                              MAP0175
C------------------------------------------------------------------   MAP0178
      SUBROUTINE JAPMAP                                                MAP0179
C THIS IS A MAP OF THE OPERATING AREAS AROUND JAPAN                    MAP0180
C                                                                      MAP0181
C     THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF THE SEA OF     MAP0182
C     JAPAN.                                                           MAP0183
```

```
C                                                                MAP01840
C          LEVEL 0                                               MAP01850
C          CALL GRAPHICS DEVICE                                  MAP01860
C                                                                MAP01870
      CALL TEK618                                                MAP01880
C                                                                MAP01890
C            LEVEL 1                                             MAP01900
C            SET PAGE SIZE AND PROJECTION SPECIFICATIONS         MAP01910
C                                                                MAP01920
      CALL PAGE(15.,11.)                                         MAP01930
      CALL SCMPLX                                                MAP01940
      CALL PROJCT('MERCA')                                       MAP01950
      CALL MAPMDE('STRAI')                                       MAP01960
      CALL AREA2D(13.,9.)                                        MAP01970
      CALL XNAME(' ',1)                                          MAP01980
      CALL YNAME(' ',1)                                          MAP01990
      CALL XAXANG(0.)                                            MAP02000
      CALL HEADIN('JAPAN AND THE KURILE ISLANDS',28,1.5,1)       MAP02010
C                                                                MAP02020
C          LEVEL 2                                               MAP02030
C          DEFINE MAP PARAMETERS                                 MAP02040
C                                                                MAP02050
      CALL MAPGR(125.,5.,160.,30.,5.,55.)                        MAP02060
C                                                                MAP02070
C          LEVEL 3                                               MAP02080
C          CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION   MAP02090
C                                                                MAP02100
      CALL MAPFIL('ASIA')                                        MAP02110
      CALL MAPFIL('PASI')                                        MAP02120
      CALL FRAME                                                 MAP02130
      CALL DASH                                                  MAP02140
      CALL GRID(1,1)                                             MAP02150
      CALL MARKER(-1)                                            MAP02160
C                                                                MAP02170
C          RETURN TO LEVEL 2                                     MAP02180
C                                                                MAP02190
      CALL ENDPL(0)                                              MAP02200
C                                                                MAP02210
      RETURN                                                     MAP02220
      END                                                        MAP02230
C----------------------------------------------------------------MAP02260
      SUBROUTINE MEDMAP                                          MAP02270
C                                                                MAP02280
C     THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF THE      MAP02290
C     MEDITERRANEAN SEA.                                         MAP02300
C          LEVEL 0                                               MAP02340
C          CALL GRAPHICS DEVICE                                  MAP02350
C                                                                MAP02360
      CALL TEK618                                                MAP02370
C                                                                MAP02380
C            LEVEL 1                                             MAP02390
C            SET PAGE SIZE AND PROJECTION SPECIFICATIONS         MAP02400
C                                                                MAP02410
      CALL PAGE(15.,11.)                                         MAP02420
      CALL SCMPLX                                                MAP02430
      CALL PROJCT('MERCA')                                       MAP02440
```

49

```fortran
      CALL MAPMDE('STRAI')                                              MAP0245
      CALL AREA2D(13.,9.)                                              MAP0246
      CALL XNAME(' ',1)                                                 MAP0247
      CALL YNAME(' ',1) ·                                               MAP0248
      CALL XAXANG(0.)                                                   MAP0249
      CALL HEADIN('MEDITERRANEAN SEA',17,1.5,1)                         MAP0250
C                                                                       MAP0251
C           LEVEL 2                                                     MAP0252
C           DEFINE MAP PARAMETERS                                       MAP0253
C                                                                       MAP0254
      CALL MAPGR(-10.,5.,40.,25.,5.,50.)                               MAP0255
C                                                                       MAP0256
C           LEVEL 3                                                     MAP0257
C           CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION         MAP0258
C                                                                       MAP0259
      CALL MAPFIL('PEUR')                                               MAP0260
      CALL MAPFIL('EURO')                                               MAP0261
      CALL MAPFIL('ASIA')                                               MAP0262
      CALL MAPFIL('PASI')                                               MAP0263
      CALL MAPFIL('PAFR')                                               MAP0264
      CALL MAPFIL('AFRI')                                               MAP0265
      CALL FRAME                                                        MAP0266
      CALL DASH                                                         MAP0267
      CALL GRID(1,1)                                                    MAP0268
      CALL MARKER(-1)                                                   MAP0269
C                                                                       MAP0270
C           RETURN TO LEVEL 2                                           MAP0271
C                                                                       MAP0272
      CALL ENDPL(0)                                                     MAP0273
C                                                                       MAP0274
      RETURN                                                            MAP0275
      END                                                               MAP0276
C----------------------------------------------------------------------MAP0280
      SUBROUTINE CARMAP                                                 MAP0281
C                                                                       MAP0282
C    THIS IS A MAP OF THE CARRIBEAN OPERATING AREAS                     MAP0283
C                                                                       MAP0284
C    THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF THE CARIBBEAN    MAP0285
C    SEA AND THE GULF OF MEXICO. ALL OF CENTRAL AMERICA IS INCLUDED.    MAP0286
C                                                                       MAP0287
C           LEVEL 0                                                     MAP0288
C           CALL GRAPHICS DEVICE                                        MAP0289
C                                                                       MAP0290
      CALL TEK618                                                       MAP0291
C                                                                       MAP0292
C            LEVEL 1                                                    MAP0293
C            SET PAGE SIZE AND PROJECTION SPECIFICATIONS                MAP0294
C                                                                       MAP0295
      CALL PAGE(15.,11.)                                               MAP0296
      CALL SCMPLX                                                       MAP0297
      CALL PROJCT('MERCA')                                              MAP0298
      CALL MAPMDE('STRAI')                                              MAP0299
      CALL AREA2D(13.,9.)                                              MAP0300
      CALL XNAME(' ',1)                                                 MAP0301
      CALL YNAME(' ',1)                                                 MAP0302
      CALL XAXANG(0.)                                                   MAP0303
```

```
       CALL HEADIN('CARIBBEAN SEA',13,1.5,1)                              MAP03040
C                                                                         MAP03050
C          LEVEL 2                                                        MAP03060
C          DEFINE MAP PARAMETERS                                          MAP03070
C                                                                         MAP03080
       CALL MAPGR(-100.,5.,-60.,5.,5.,35.)                                MAP03090
C                                                                         MAP03100
C          LEVEL 3                                                        MAP03110
C          CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION            MAP03120
C                                                                         MAP03130
       CALL MAPFIL('PNOR')                                                MAP03140
       CALL MAPFIL('NORT')                                                MAP03150
       CALL MAPFIL('PSOU')                                                MAP03160
       CALL MAPFIL('SOUT')                                                MAP03170
       CALL FRAME                                                         MAP03180
       CALL DASH                                                          MAP03190
       CALL GRID(1,1)                                                     MAP03200
       CALL MARKER(-1)                                                    MAP03210
C                                                                         MAP03220
C          RETURN TO LEVEL 2                                              MAP03230
C                                                                         MAP03240
       CALL ENDPL(0)                                                      MAP03250
C                                                                         MAP03260
       RETURN                                                             MAP03270
       END                                                                MAP03280
```

APPENDIX B. DISSPLA MAP GENERATION PROGRAMS

The following Fortran programs can be used by DISSPLA to generate maps. Some modification could be necessary in order to ensure compatibility to the mainframe and graphics terminals they would be run on. As written, they were developed using VS Fortran. The version of DISSPLA being used must include the World Coast Utilities Option and the DISSPOP option which causes compression and decompression of the map files. Table 2 lists the maps that can be generated by the VS Fortran/DISSPLA programs and the pages they can be found on.

Table 2. GUIDE TO DISSPLA MAPPING PROGRAMS

Map description	Page
Carribean Operating Area	53
Northern Flank of NATO	54
North and South America	55
Washington, DC	56
World Mercator Projection	57
Cape Canaveral/Kennedy Space Center	59
Japan and the Kurile Islands	60
Mediterranean Operating Area	61
North-West Europe	62

```
C    THIS IS A MAP OF THE CARRIBEAN OPERATING AREAS               CAR00030
C                                                                 CAR00040
C       THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF THE CARIBBEAN   CAR00050
C       SEA AND THE GULF OF MEXICO. ALL OF CENTRAL AMERICA IS INCLUDED.   CAR00060
C                                                                 CAR00070
C            LEVEL 0                                              CAR00080
C            CALL GRAPHICS DEVICE                                 CAR00090
C                                                                 CAR00100
      CALL COMPRS                                                 CAR00110
C                                                                 CAR00120
C             LEVEL 1                                             CAR00130
C             SET PAGE SIZE AND PROJECTION SPECIFICATIONS         CAR00140
C                                                                 CAR00150
      CALL PAGE(15.,11.)                                          CAR00160
      CALL SCMPLX                                                 CAR00170
      CALL PROJCT('MERCA')                                        CAR00180
      CALL MAPMDE('STRAI')                                        CAR00190
      CALL AREA2D(13.,9.)                                         CAR00200
      CALL XNAME(' ',1)                                           CAR00210
      CALL YNAME(' ',1)                                           CAR00220
      CALL XAXANG(0.)                                             CAR00230
      CALL HEADIN('CARIBBEAN SEA',13,1.5,1)                       CAR00240
C                                                                 CAR00250
C            LEVEL 2                                              CAR00260
C            DEFINE MAP PARAMETERS                                CAR00270
C                                                                 CAR00280
      CALL MAPGR(-100.,5.,-60.,5.,5.,35.)                         CAR00290
C                                                                 CAR00300
C            LEVEL 3                                              CAR00310
C            CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION  CAR00320
C                                                                 CAR00330
      CALL MAPFIL('PNOR')                                         CAR00340
      CALL MAPFIL('NORT')                                         CAR00350
      CALL MAPFIL('PSOU')                                         CAR00360
      CALL MAPFIL('SOUT')                                         CAR00370
      CALL FRAME                                                  CAR00380
      CALL DASH                                                   CAR00390
      CALL GRID(1,1)                                              CAR00400
      CALL MARKER(-1)                                             CAR00410
C                                                                 CAR00420
C            RETURN TO LEVELS 2, 1, AND 0                         CAR00430
C                                                                 CAR00440
      CALL ENDPL(0)                                               CAR00450
      CALL DONEPL                                                 CAR00460
      STOP                                                        CAR00470
      END                                                         CAR00480
```

```
C         THIS IS THE NORTHERN FLANK OF NATO                          NOROC
C                                                                     NOROC
C     THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF THE NORTHERN   NOROC
C     FLANK AND INCLUDES ALL THE SCANDINAVIAN COUNTRIES.              NOROC
C                                                                     NOROC
C         LEVEL 0                                                     NOROC
C         CALL GRAPHICS DEVICE                                        NOROC
C                                                                     NOROC
      CALL COMPRS                                                     NOROC
C                                                                     NOROC
C          LEVEL 1                                                    NOROC
C          SET PAGE SIZE AND PROJECTION SPECIFICATIONS                NOROC
C                                                                     NOROC
      CALL PAGE(15.,11.)                                              NOROC
      CALL SCMPLX                                                     NOROC
      CALL PROJCT('MERCA')                                            NOROC
      CALL MAPMDE('STRAI')                                            NOROC
      CALL AREA2D(13.,9.)                                             NOROC
      CALL XNAME(' ',1)                                               NOROC
      CALL YNAME(' ',1)                                               NOROC
      CALL XAXANG(0.)                                                 NOROC
      CALL HEADIN('NORTHERN FLANK OF NATO',22,1.5,1)                  NOROC
C                                                                     NOROC
C          LEVEL 2                                                    NOROC
C          DEFINE MAP PARAMETERS                                      NOROC
C                                                                     NOROC
      CALL MAPGR(-15.,5.,55.,55.,5.,75.)                              NOROC
C                                                                     NOROC
C          LEVEL 3                                                    NOROC
C          CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION        NOROC
C                                                                     NOROC
      CALL MAPFIL('PEUR')                                             NOROC
      CALL MAPFIL('EURO')                                             NOROC
      CALL MAPFIL('ASIA')                                             NOROC
      CALL MAPFIL('PASI')                                             NOROC
      CALL FRAME                                                      NOROC
      CALL DASH                                                       NOROC
      CALL GRID(1,1)                                                  NOROC
      CALL MARKER(-1)                                                 NOROC
C                                                                     NOROC
C          RETURN TO LEVELS 2, 1, AND 0                               NOROC
C                                                                     NOROC
      CALL ENDPL(0)                                                   NOROC
      CALL DONEPL                                                     NOROC
      STOP                                                            NOROC
      END                                                             NOROC
```

```
C   THIS PROGRAM WILL CREATE A MAP OF NORTH & SOUTH AMERICA INCLUDING    NSA00010
C   CENTRAL AMERICA, HAWAII, AND THE CARRIBEAN                           NSA00020
C                                                                        NSA00030
C   LEVEL 0                                                              NSA00040
C           CALL GRAPHICS DEVICE                                         NSA00050
C                                                                        NSA00060
      CALL COMPRS                                                        NSA00070
      CALL HWSCAL ('SCREEN')                                             NSA00080
C                                                                        NSA00090
C LEVEL 1                                                                NSA00100
C           SET PAGE SIZE AND PROJECTION SPECIFICATIONS                  NSA00110
C                                                                        NSA00120
      A=11                                                               NSA00130
      CALL PAGE (A,8.5)                                                  NSA00140
      CALL PROJCT ('MERCA')                                              NSA00150
      CALL MAPOLE (-120, 0.)                                             NSA00160
      CALL AREA2D (10,8)                                                 NSA00170
C                                                                        NSA00180
C LEVEL 2                                                                NSA00190
C           DEFINE MAP PARAMETERS                                        NSA00200
C                                                                        NSA00210
      CALL MAPGR (-180.,30.,10.,-55.,30.,75.)                            NSA00220
C                                                                        NSA00230
C LEVEL 3                                                                NSA00240
C           CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION          NSA00250
C                                                                        NSA00260
      CALL MAPFIL ('COAS')                                               NSA00270
C                                                                        NSA00280
C RETURN TO LEVEL 2                                                      NSA00290
C                                                                        NSA00300
      CALL ENDPL(0)                                                      NSA00310
C                                                                        NSA00320
C RETURN TO LEVEL 1                                                      NSA00330
C                                                                        NSA00340
      CALL DONEPL                                                        NSA00350
C                                                                        NSA00360
C RETURN TO LEVEL 0                                                      NSA00370
C                                                                        NSA00380
      STOP                                                               NSA00390
      END                                                                NSA00400
```

```
C  THIS IS A MAP GENERATED TO COMPARE RESOLUTION BETWEEN DISSPLA      DCMO
C  GENERATED MAPS AND OTHER DIGITIZED MAPPING PROGRAMS.               DCMO
C                                                                     DCMO
C    THIS IS A MAP OF THE WASHINGTON DC AREA                          DCMO
C                                                                     DCMO
C          LEVEL 0                                                    DCMO
C          CALL GRAPHICS DEVICE                                       DCMO
C                                                                     DCMO
      CALL COMPRS                                                     DCMO
C                                                                     DCMO
C           LEVEL 1                                                   DCMO
C           SET PAGE SIZE AND PROJECTION SPECIFICATIONS               DCMO
C                                                                     DCMO
      CALL PAGE(8.5,11.)                                              DCMO
      CALL SCMPLX                                                     DCMO
      CALL PROJCT('MERCA')                                            DCMO
      CALL MAPMDE('STRAI')                                            DCMO
      CALL AREA2D(6.,8.)                                              DCMO
      CALL XNAME(' ',1)                                               DCMO
      CALL YNAME(' ',1)                                               DCMO
      CALL XAXANG(0.)                                                 DCMO
      CALL HEADIN('WASHINGTON DC AREA',18,1.5,1)                      DCMO
C                                                                     DCMO
C          LEVEL 2                                                    DCMO
C          DEFINE MAP PARAMETERS                                      DCMO
C                                                                     DCMO
      CALL MAPGR(-78.,0.5,-76.,38.,0.5,40.)                           DCMO
C                                                                     DCMO
C          LEVEL 3                                                    DCMO
C          CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION        DCMO
C                                                                     DCMO
      CALL MAPFIL('PNOR')                                             DCMO
      CALL MAPFIL('NORT')                                             DCMO
      CALL MAPFIL('USAH')                                             DCMO
      CALL FRAME                                                      DCMO
      CALL DASH                                                       DCMO
      CALL GRID(1,1)                                                  DCMO
      CALL MARKER(-1)                                                 DCMO
C                                                                     DCMO
C          RETURN TO LEVEL 2                                          DCMO
C                                                                     DCMO
      CALL ENDPL(0)                                                   DCMO
C                                                                     DCMO
C          RETURN TO LEVEL 1                                          DCMO
      CALL DONEPL                                                     DCMO
C                                                                     DCMO
C          RETURN TO LEVEL 0                                          DCMO
C                                                                     DCMO
      STOP                                                            DCMO
      END                                                             DCMO
```

The following program will generate a world map.

```
      DIMENSION DAT(72,46),RHITE(72,46)                         WLD00010
      COMMON WORK(5000)                                         WLD00020
      CALL COMPRS                                               WLD00030
C                                                               WLD00040
      DO 10 N=12,72,12                                          WLD00050
      M=N-11                                                    WLD00060
      READ(10,1000) ((DAT(I,JJ),I=M,N),JJ=1,46)                WLD00070
 1000 FORMAT(F6.0,11F5.0)                                       WLD00080
   10 CONTINUE                                                  WLD00090
      DO 11 J=2,45                                              WLD00100
      JP1=J+1                                                   WLD00110
      JM1=J-1                                                   WLD00120
      DO 11 I=1,72                                              WLD00130
      IP1=MOD(I,72)                                             WLD00140
      IM1=MOD(I+70,72)+1                                        WLD00150
      S=0.90                                                    WLD00160
      RHITE(I,J)=(1.-S)*DAT(I,J)+(S/4.)*(DAT(IM1,J)+DAT(IP1,J)+ WLD00170
     *DAT(I,JP1)+DAT(I,JM1))                                    WLD00180
   11 CONTINUE                                                  WLD00190
      DO 12 I=1,72                                              WLD00200
      RHITE(I,1)=DAT(I,1)                                       WLD00210
   12 RHITE(I,46)=DAT(I,46)                                     WLD00220
C                                                               WLD00230
      CALL BLOWUP (2.2)                                         WLD00240
      CALL BASALF ('STAND')                                     WLD00250
      CALL MIXALF ('L/CSTD')                                    WLD00260
C                                                               WLD00270
      CALL PROJCT ('AITOF')                                     WLD00280
C                   FOR AITOFF PROJECTION                       WLD00290
      CALL PAGE (10.0,8.0)                                      WLD00300
C                   SET PAGE FOR VIEWGRAF                       WLD00310
      CALL AREA2D (8.5,4.0)                                     WLD00320
C                                                               WLD00330
      CALL XNAME (' ',1)                                        WLD00340
      CALL YNAME (' ',1)                                        WLD00350
      CALL SCMPLX                                               WLD00360
   48 CALL HEADIN ('THE WORLD$',100,1.5,1)                      WLD00370
C                                                               WLD00380
   99 CALL YAXANG (0.)                                          WLD00390
C                                                               WLD00400
      CALL MAPGR (-300.,30.,60.,-90.,30.,90.)                   WLD00410
      CALL GRID (1,1)                                           WLD00420
      CALL MAPFIL ('HERSHEY')                                   WLD00430
      CALL FRAME                                                WLD00440
      CALL HEIGHT(0.05)                                         WLD00450
      CALL COMPLX                                               WLD00460
      CALL BCOMON(5000)                                         WLD00470
C                                                               WLD00480
```

Fortran program WLDPLT continued.

```
        CALL  CONMAK(RHITE,72,46,'SCALE')                                    WLD008
        CALL  CONMAK(RHITE,72,46,'SCALE')                                    WLD004
C                              PLOT SMOOTHED CONTOURS                        WLD005
        CALL  CONLIN (0,'SOLID','LABELS',1,5)                                WLD005
        CALL  CONANG(90.)                                                    WLD005
        CALL  RASPLN(0.25)                                                   WLD005
        CALL  CONTUR(1,'LABELS','DRAW')                                      WLD005
        CALL  COMPLX                                                         WLD005
        CALL  HEIGHT(.2)                                                     WLD005
        CALL  MESSAG('DISSPLA MAP$',100,3.5,-1.)                             WLD005
        CALL  RESET('COMPLX')                                                WLD003
        CALL  RESET('HEIGHT')                                                WLD005
        CALL  ENDPL(0)                                                       WLD006
        CALL  DONEPL                                                         WLD006
        STOP                                                                 WLD008
        END                                                                 WLD008
```

Fortran program WLDPLT continued.

```
        CALL  CONMAK(RHITE,72,46,'SCALE')
        CALL  CONMAK(RHITE,72,46,'SCALE')
        CALL  CONLIN (0,'SOLID',
```

58

```
C   THIS IS A MAP GENERATED TO COMPARE RESOLUTION BETWEEN DISSPLA       EZM00010
C   GENERATED MAPS AND OTHER DIGITIZED MAPPING PROGRAMS.                EZM00020
C                                                                       EZM00030
C    THIS IS A MAP OF THE KENNEDY SPACE CENTER/CAPE CANAVERAL AREA       EZM00040
C                                                                       EZM00050
C           LEVEL 0                                                     EZM00060
C           CALL GRAPHICS DEVICE                                        EZM00070
C                                                                       EZM00080
      CALL COMPRS                                                       EZM00090
C                                                                       EZM00100
C            LEVEL 1                                                    EZM00110
C            SET PAGE SIZE AND PROJECTION SPECIFICATIONS                EZM00120
C                                                                       EZM00130
      CALL PAGE(11.,8.5)                                                EZM00140
      CALL SCMPLX                                                       EZM00150
      CALL PROJCT('MERCA')                                              EZM00160
      CALL MAPMDE('STRAI')                                              EZM00170
      CALL AREA2D(8.,6.)                                                EZM00180
      CALL XNAME(' ',1)                                                 EZM00190
      CALL YNAME(' ',1)                                                 EZM00200
      CALL XAXANG(0.)                                                   EZM00210
      CALL HEADIN('CAPE CANAVERAL FLA',18,1.5,1)                        EZM00220
C                                                                       EZM00230
C           LEVEL 2                                                     EZM00240
C           DEFINE MAP PARAMETERS                                       EZM00250
C                                                                       EZM00260
      CALL MAPGR(-81.,0.5,-80.,28.,0.5,29.)                             EZM00270
C                                                                       EZM00280
C           LEVEL 3                                                     EZM00290
C           CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION         EZM00300
C                                                                       EZM00310
      CALL MAPFIL('PNOR')                                               EZM00320
      CALL MAPFIL('NORT')                                               EZM00330
      CALL MAPFIL('USAH')                                               EZM00340
      CALL FRAME                                                        EZM00350
      CALL DASH                                                         EZM00360
      CALL GRID(1,1)                                                    EZM00370
      CALL MARKER(-1)                                                   EZM00380
C                                                                       EZM00390
C           RETURN TO LEVEL 2                                           EZM00400
C                                                                       EZM00410
      CALL ENDPL(0)                                                     EZM00420
C                                                                       EZM00430
C           RETURN TO LEVEL 1                                           EZM00440
      CALL DONEPL                                                       EZM00450
C                                                                       EZM00460
C           RETURN TO LEVEL 0                                           EZM00470
C                                                                       EZM00480
      STOP                                                              EZM00490
      END                                                               EZM00500
```

```fortran
C THIS IS A MAP OF THE OPERATING AREAS AROUND JAPAN                     JAP00
C                                                                       JAP00
C       THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF THE SEA OF     JAP00
C       JAPAN.                                                          JAP00
C                                                                       JAP00
C           LEVEL 0                                                     JAP00
C           CALL GRAPHICS DEVICE                                        JAP00
C                                                                       JAP00
      CALL COMPRS                                                       JAP00
C                                                                       JAP00
C            LEVEL 1                                                    JAP00
C            SET PAGE SIZE AND PROJECTION SPECIFICATIONS                JAP00
C                                                                       JAP00
      CALL PAGE(8.5,11.)                                                JAP00
      CALL SCMPLX                                                       JAP00
      CALL PROJCT('MERCA')                                              JAP00
      CALL MAPMDE('STRAI')                                              JAP00
      CALL AREA2D(6.,8.)                                                JAP00
      CALL XNAME(' ',1)                                                 JAP00
      CALL YNAME(' ',1)                                                 JAP00
      CALL XAXANG(0.)                                                   JAP00
      CALL HEADIN('JAPAN AND THE KURILE ISLANDS',28,1.5,1)              JAP00
C                                                                       JAP00
C           LEVEL 2                                                     JAP00
C           DEFINE MAP PARAMETERS                                       JAP00
C                                                                       JAP00
      CALL MAPGR(125.,5.,160.,30.,5.,55.)                               JAP00
C                                                                       JAP00
C           LEVEL 3                                                     JAP00
C           CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION         JAP00
C                                                                       JAP00
      CALL MAPFIL('ASIA')                                               JAP00
      CALL MAPFIL('PASI')                                               JAP00
      CALL FRAME                                                        JAP00
      CALL DASH                                                         JAP00
      CALL GRID(1,1)                                                    JAP00
      CALL MARKER(-1)                                                   JAP00
C                                                                       JAP00
C           RETURN TO LEVELS 2, 1, AND 0                                JAP00
C                                                                       JAP00
      CALL ENDPL(0)                                                     JAP00
      CALL DONEPL                                                       JAP00
      STOP                                                              JAP00
      END                                                               JAP00
```

```
C       THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF           MED00030
C       MEDITERRANEAN SEA.                                          MED00040
C                                                                   MED00070
C             LEVEL 0                                               MED00080
C             CALL GRAPHICS DEVICE                                  MED00090
C                                                                   MED00100
        CALL COMPRS                                                 MED00110
C                                                                   MED00120
C             LEVEL 1                                               MED00130
C             SET PAGE SIZE AND PROJECTION SPECIFICATIONS           MED00140
C                                                                   MED00150
        CALL PAGE(15.,11.)                                          MED00160
        CALL SCMPLX                                                 MED00170
        CALL PROJCT('MERCA')                                        MED00180
        CALL MAPMDE('STRAI')                                        MED00190
        CALL AREA2D(13.,9.)                                         MED00200
        CALL XNAME(' ',1)                                           MED00210
        CALL YNAME(' ',1)                                           MED00220
        CALL XAXANG(0.)                                             MED00230
        CALL HEADIN('MEDITERRANEAN SEA',17,1.5,1)                   MED00240
C                                                                   MED00250
C             LEVEL 2                                               MED00260
C             DEFINE MAP PARAMETERS                                 MED00270
C                                                                   MED00280
        CALL MAPGR(-10.,5.,40.,25.,5.,50.)                          MED00290
C                                                                   MED00300
C             LEVEL 3                                               MED00310
C             CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION   MED00320
C                                                                   MED00330
        CALL MAPFIL('PEUR')                                         MED00340
        CALL MAPFIL('EURO')                                         MED00350
        CALL MAPFIL('ASIA')                                         MED00360
        CALL MAPFIL('PASI')                                         MED00370
        CALL MAPFIL('PAFR')                                         MED00380
        CALL MAPFIL('AFRI')                                         MED00390
        CALL FRAME                                                  MED00400
        CALL DASH                                                   MED00410
        CALL GRID(1,1)                                              MED00420
        CALL MARKER(-1)                                             MED00430
C                                                                   MED00440
C             RETURN TO LEVELS 2, 1, AND 0                          MED00450
C                                                                   MED00460
        CALL ENDPL(0)                                               MED00470
        CALL DONEPL                                                 MED00480
        STOP                                                        MED00490
        END                                                         MED00500
```

```
C   THIS PROGRAM WILL GENERATE A THEATER LEVEL MAP OF NORTH-WEST EUROPE    UKMO(
C                                                                          UKMO(
C            LEVEL 0                                                       UKMO(
C            CALL GRAPHICS DEVICE                                          UKMO(
C                                                                          UKMO(
      CALL COMPRS                                                          UKMO(
C                                                                          UKMO(
C              LEVEL 1                                                     UKMO(
C              SET PAGE SIZE AND PROJECTION SPECIFICATIONS                 UKMO(
C                                                                          UKMO(
      CALL PAGE(8.5,11.)                                                   UKMO(
      CALL SCMPLX                                                          UKMO(
      CALL PROJCT('MERCA')                                                 UKMO(
      CALL MAPMDE('STRAI')                                                 UKMO(
      CALL AREA2D(6.,8.)                                                   UKMO(
      CALL XNAME(' ',1)                                                    UKMO(
      CALL YNAME(' ',1)                                                    UKMO(
      CALL XAXANG(0.)                                                      UKMO(
      CALL HEADIN('NORTH-WESTERN EUROPE',20,1.5,1)                         UKMO(
C                                                                          UKMO0
C            LEVEL 2                                                       UKMO0
C            DEFINE MAP PARAMETERS                                         UKMO0
C                                                                          UKMO0
      CALL MAPGR(-10.,5.,15.,45.,5.,62.)                                   UKMO0
C                                                                          UKMO0
C            LEVEL 3                                                       UKMO0
C            CALLS FOR CARTOGRAPHIC DATA AND LEVEL OF RESOLUTION           UKMO0
C                                                                          UKMO0
      CALL MAPFIL('PEUR')                                                  UKMO0
      CALL MAPFIL('EURO')                                                  UKMO0
      CALL FRAME                                                           UKMO0
      CALL DASH                                                            UKMO0
      CALL GRID(1,1)                                                       UKMO0
      CALL MARKER(-1)                                                      UKMO0
C                                                                          UKMO0
C            RETURN TO LEVELS 2, 1, AND 0                                  UKMO0
C                                                                          UKMO0
      CALL ENDPL(0)                                                        UKMO0
      CALL DONEPL                                                          UKMO0
      STOP                                                                 UKMO0
      END                                                                  UKMO0
```

APPENDIX C.   KERMIT ON-LINE HELP FILES

This is a printout of a help file which is resident on the Columbia University Computer. It is updated about once a year. This version is accurate to 28 Jan 88.

COLUMBIA UNIVERSITY KERMIT DISTRIBUTION

This file explains what files are in the Kermit distribution and gives the naming conventions for them.

If you are reading this from a handout supplied with a Kermit distribution tape, please note that this information might not be quite up to date -- there may be files on the tape that are not listed here. The copy of this file, AAFILES.HLP, on the tape might be more current.

The file AAFILx.DIR contains an up-to-date alphabetical directory listing of all the files in the respective Kermit distribution area (KER:, Tape A; K2:, Tape B; K3:, Tape C; etc.) -- one such file is created in each area by a nightly batch job (x is A, B, C, etc). The directory listing supplied on paper with your tape should reflect exactly which files are on the tape, and in what order.

The Kermit distribution areas include all the versions of Kermit which are in our possession. The files have names of the form

    NAME.TYPE

where NAME is the name of file, and TYPE is its type
(program source, documentation, executable core image,
etc). No NAME is more than 9 characters long (the
maximum accepted by VAX/VMS), and every NAME starts with
a letter and is unique in the first 6 characters (the
maximum under TOPS-10, RSTS/E, etc). On TOPS-10 BACKUP

Interchange tapes, names longer than 6 will be truncated

to 6.   No type is longer than 3 characters.   NAME and

TYPE are separated by a period.

* Types

The files types don't follow a strict convention because the files originate on so many
different systems. But there are some patterns; here are some commonly used file types
--

For Text Files:


```
.BLD - Instructions for building
.BWR - A "beware" file, listing known bugs, limitations,
       or other problems
.DIF  - Differences (produced  by  file   comparison
       program)
.DOC - Documentation (usually long)
.HLP - Help message (like DOC but usually shorter)
.INS - Installation instructions
.MAN - A manual
.MEM - Documentation ("memo") produced by DEC Runoff
.MSG - A text or mail message of some kind
.MSS  - Scribe text formatter source (for some of  the
       .DOC files)
.NR   - Nroff text formatter source
.RNH - Runoff text formatter source for .HLP files
.RNO - Runoff text formatter source for .MEM files
.TEX - TeX source
.TXT - Text (usually shorter,  sometimes in electronic
             mail message format)
.UPD - Program update history
```

For Program Source:

.A   - Assembler

.A68 - Algol-68

.A86 - 8086 assembler

.ADA - Ada

.ALG - Algol-60

.ASM - Assembler

.B   - B language

.BAS - Basic

.BLI - Bliss

.BOO - "boo" format printable encoding of object or executable program

.C   - C language

.CLU - CLU language

.F   - Fortran (Unix)

.F77 - Fortran-77

.FOR - Fortran

.FTN - Fortran

.H   - Header file for C or ASM program

.H86 - 8086 hexadecimal encoding of object or executable program

.HEX - Hexadecimal encoding of object or executable program

.HQX - "binhex" encoding of object or executable program

.LSP - Lisp source code

.MAC - Macro assembler

.MAR - VAX assembler

.PAS - Pascal

.PL1 - PL/I

For Program Source (con't):

      .PLC - PL/C
      .PLI - PL/I
      .PLM - PL/M
      .REQ - VAX "require" (header) file
      .SAI - Sail
      .SCR - A FORTH "screen"
      .SRC - Source program

For System or Command Files:

      .BAT - A batch control file (e. g. for MS-DOS)
      .CMD - A command file of some kind
      .COM - VAX or PDP-11 DCL command file
      .CTL - A batch control file (e. g. for DEC-10/20)
      .INI - Initialization command file
      .JCL - Job control language (e. g. for Harris)

* Prefixed File Names:

The file names for files associated with each implementation of Kermit are prefixed by a few characters denoting the implementation. Although the files are kept in separate areas, each prefix is unique among all the Kermit files, so that areas can be combined into a single area without any confusion. The following are presently used, (Items marked with asterisk have fuller explanations below):

--"micros" (tape A) --

Prefix	Machine(s)	Operating System	Language
APP	Apple II	DOS 3.3 or ProDos	6502 Asm
AST	Atari ST Series	GEM	C
ATA	Atari Home Computer	DOS	Action!
C64	Commodore 64	DOS	CROSS
*C86	8086/8088 (see below)	CP/M-86	ASM86
CC	TRS-80 Color Computer	Disk-Extended Color BASIC	EDTASM
*CP4	8080,8085,Z80(see below)	CP/M-80	LASM
*CPM	8080,8085,Z80 -- obsolete, see below --		
CX	Experimental new release of CP/M-80 Kermit		LASM
K6	OS9/68000 Portable	various	Assembler
M4	TRS-80 Model 4	TRSDOS	ASM
*MS	Various (see below)	MS-DOS or PC-DOS	MASM
QK	(various, see below)		Turbo Pascal
TA2	Tandy 2000	MS DOS	MASM
TRS	TRS-80 I and III	TRSDOS	Z80 Ass.
TR2	TRS-80 Model II	TRSDOS	Z80 Ass.
WIN	IBM PC, etc	MS-DOS w/MS-Windows	Microsoft C4.0
WK	IBM PC family	PC DOS	Lattice C

* See below for notes about MS-DOS and CP/M Kermits.

67

```
--"mainframes" (Tape B) --

Prefix    Machine(s)              Operating System      Language

*CK    VAX, SUN, many others   UNIX                  C
*CK    VAX                     VMS                   C
*CK    Apple Macintosh         Mac OS                C
*CK    Commodore Amiga         AmigaDOS/Intuition    C
*CK    Data General MV Series  AOS/VS                C
*CK    Apollo                  Aegis                 C
CM2    IBM 370 Series          VM/CMS                Pascal/VS
IK     IBM 370 Series          VM/CMS                IBM Ass.
K10    DECsystem-10            TOPS-10               MACRO-10
*K11   DEC PDP-11              RSX11,RSTS/E,RT11,TSX MACRO-11
*K11   DEC PDP-11              P/OS, Pro/RT, IAS 3.1 MACRO-11
K20    DECSYSTEM-20            TOPS-20               MACRO-20
MP     DEC PDP-11              MUMPS (M/11)          MUMPS
*TSO   IBM 370-series/3705     MVS/TSO               Assembler
*TS2   IBM 370-series/Series1  MVS/TSO               Pascal/VS,PL/I,etc.
*TS3   IBM 370-series/3708     MVS/TSO               Assembler
*TSN   IBM 370-series/3705     MVS/TSO               Ass./ALP
UX     Old, old, small Unix Kermit                   C
*VMS   VAX                     VMS                   Bliss-32
```

* C-Kermit (Prefix CK, Tape B):

C-Kermit is a transportable version of Kermit written in the C language. It is composed of many modules, some system- independent, some system-specific. C-Kermit has been implemented on many systems, some "mainframes" and some "micros". In particular, the Unix version runs on machines ranging from large IBM mainframes to VAX and other minicomputers to small PC's, and Kermit programs for the Apple Macintosh, the Commodore Amiga, VAX/VMS, DG AOS/VS, Apollo Aegis, CDC VX/VE, and many other systems can also be generated from C-Kermit. All the C-Kermit source files are kept together on tape B to avoid the problems that

would be introduced by splitting up the files or keeping duplicate copies.   See the file
CKAAAA.HLP for an explanation of the file naming conventions for C-Kermit.

* The K11 files include support for RSX, RSTS, RT11, TSX+, IAS,
    and P/OS -- See K11INS.DOC for details.

* The VAX/VMS Bliss version is also provided in MACRO-32 (.MAR)
    source form for those sites that do not have a Bliss
    compiler, as well as in a hexadecimal encoding of the task
    image. YOU DON'T NEED TO HAVE BLISS IN ORDER TO RUN THIS
    VERSION. See VMSAAA.HLP.

* Among the TSO Kermits, you should probably try the TSN version
    first. The TSO versions (one for linemode, a separate one
    for Series/1-style 3270 emulation) are very old and
    primitive. The Pascal version requires a Pascal compiler
    and supports only linemode connections. The TSN version,
    from NIH, supports only linemode connections, but includes
    many advanced features. There's also version with the
    prefix TS3, which supports the 3708 front end. Many of
    these will be replaced by "portable 370" Kermit soon, under
    prefix IK0 and IKT.

    For VM/CMS, please try the new IK*.* version. This is "portable 370"   Kermit,
which is a very advanced Kermit implementation, to which support for   other IBM 370
operating systems, like MVS/TSO, DOS/VSE, MTS, MUSIC, etc, should be easy to add.
It supports most of the advanced Kermit options (long packets, etc), and both line mode
and full screen connections.

-- Less popular micros & workstations (tape C) --

Prefix	Machine(s)	Operating System	Language
AC	Acorn BBC Workstation	Panos	C
AM	Alpha Micro 68000	AMOSL	Alpha Asm 68K
APL	Apollo	Aegis	Pascal
APO	Apollo	Aegis	Pascal
BBC	Acorn BBC Micro	OS1,2,3,Panos	(various)
CIE	CIES 680/XX	REGULUS	C
CN8	(various)	Concurrent CP/M-86	ASM86
EXP	TI Explorer		Common Lisp
FL	Motorola 6809	FLEX-09 or SK*DOS	C or 6809 Asm
HL6	Honeywell L6/10	MS-DOS	MASM
HP2	HP-264x	?	8080 Asm
HP8	HP-86, HP-87	HP BASIC	HP BASIC
HP9	HUCSD p-System	HP Pascal	
I86	Intel 86/380	iRMX-86	PL/M
IRMX	Intel 86/380	iRMX-86	PL/M
LM	LMI or Symbolics	Lisp Machines	ZetaLisp
LUX	Luxor ABC-800	ABCDOS	BASIC-II
M2	Lilith Workstation	Medos	Modula-2
MD2	Intel Development System ISIS		PL/M
MDS	Intel Development System ISIS		PL/M
OS9	Various	Os9	C
PQK	ICL/3 Rivers PERQ	PERQ OS	Pascal
PRO	DEC Professional-350	P/OS	Bliss
QLK	Sinclair QL	QDOS	C
QL2	Sinclair QL	QDOS	BCPL

-- Less popular micros & workstations (tape C) (con't) --

Prefix	Machine(s)	Operating System	Language
QNX	IBM PC, Rainbow, etc	QNX	C
RML	Research Machines	ROS, ...	C
RMX	Intel 286/10, etc	RMX-86	PL/M
TRI	various	TRIPOS	BCPL
UCA	Apple II	UCSD p-System	Pascal
UCI	IBM PC	UCSD p-System IV.x	Pascal
UCJ	Joyce Loebl Magiscan 2	UCSD p-System	Pascal
UCM	Pascal Microengine	UCSD p-System	Pascal
UCT	Terak 8510a	UCSD p-System II.0	Pascal,Macro-11
UM	U-Micro U-Man 1000	CP/M-68K	C & 68000
VIC	Sirius 1/Victor 9000	MS-DOS	C

-- Less popular minis & mainframes (tape D) --

Prefix	Machine(s)	Operating System	Language
AOS	Data General	AOS, AOS/VS	Fortan, Pascal
B68	Burroughs B6800	?	Algol
B78	Burroughs B7800 & A	?	Algol
B79	Burroughs B7900	?	Algol
CDC	CDC Cyber 170	NOS	Fortran-77
CD3	CDC Cyber	NOS	Fortran 5
CR	Cray-1, Cray-XMP	CTSS	Fortran-77
*CUC	(various)	Unix	C
CVK	Computervision	CGOS	Fortran S
CYB	CDC Cyber	NOS 2.2	Compass
DGM	Data General	AOS/VS with MV/UX	C
DTS	Honeywell 6000	DTSS	Virtual PL/I
GEC	GEC 4000 Series	OS-4000 (RAL)	SERC
GM	Gould/SEL-32	MPX-32	Fortran 77+
GUTS	IBM 370 Series	GUTS	Assembler
H1	Harris 100	VOS	Fortran
H8	Harris 800	VOS	Pascal, Asm
HC6	Honeywell DPS 8, 66	CP6	PL/6
HCP	Honeywell DPS 8, 66	CP6	Pascal
HD6	Honeywell DPS 6	GCOS 6	?(no source)
HDP	Honeywell DPS 8, 66	GCOS	B
HG	Honeywell DPS 8, 66	GCOS3 or 8	C
HP3	Hewlett-Packard 3000	MPE	SPL
HPM	Hewlett-Packard 1000	RTE-6/VM & RTE-A	F-77 & Asm

Prefix	Machine(s)	Operating System	Language
IBM	370 Series	MUSIC	Assembler
K08	DEC PDP-8	OS8, RTS8	PAL-8
DEC	PDP-8	OS-278	PAL-8
MOD	MODCOMP Classic	MAX IV	Fortran/ASM
MTS	IBM 370 Series	MTS	Asm, Pascal
MT2	IBM 370 Series	MTS	PLUS
MU	Honewyell	MULTICS	PL/I
ND	ND-10/100/500	Simtran III Rev J	ND Pascal J
	CDC Cyber	NOS 2.4	Compass
PER	Perkin-Elmer 3200	OS/32	Fortran
	Perkin-Elmer 3200	OS/32 MT72	Fortran
PE7	Perkin-Elmer 7000	IDRIS	C
PIC	Microdata (McD-Dougl)	REALITY (PICK)	DATA/BASIC
PRI	PRIME	PRIMOS	PL/P (PL/I)
RDOS	Data General Nova	RDOS	Fortran
RD2	Data General Nova	RDOS	Basic
RT	PDP-11	RT-11	OMSI Pascal
SP9	Sperry 90/60	VS9	Assembler
ST	HP3000, Univac, etc	Software Tools	Ratfor
TAN	Tandem	Nonstop	TAL
TI9	TI-990	DX10	Pascal
UN	Sperry/Univac-1100	EXEC	Assembler
VME	ICL 2900	VME	S3
VX	VAX	VMS	Pascal and Fortran

* UCL C-Kermit (Prefix CUC, Tape D):

A trim version of Kermit from England, written in C, without all the fancy features of the above C-Kermit, but possibly somewhat more efficient. Runs on Berkeley and ATT Unix systems.

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BY      Byte Mag Kermit Article, Jun-Jul 84        English
GER     Kermit documentation in...                  German
IBM     IBM mainframe Kermit discussion panel       English
KP      Kermit Protocol Manual                      English
KU      Kermit User Guide                           English
MA      Info-Kermit Electronic Mail Digests '83-now English
NEW     Kermit Newsletters                          English
POR     Kermit documentation in...                  Portuguese
```

* Manuals and other documentation (Tape E):

Note: The protocol manual and user guide were recently moved to Tape E due to lack of space on the other tapes.

There are two Kermit manuals: KUSER and KPROTO, a user's guide and a protocol manual, respectively. They are provided in three forms:

.MSS Scribe (UNILOGIC Ltd text formatter) source.
.DOC No special effects, suitable for reading at a terminal.
.FOR Fortran carriage control for overprinting, etc.

If you have Scribe and the appropriate Scribe device drivers, you can run the .MSS files through it to produce output suitable for printing on any device supported at your site, including the Xerox-9700, Imagen, Apple LaserWriter, or other multifont laser printers or photocomposers. Note that some parts of the user manual rely on underlining to clarify examples; the underlines are missing from the .DOC files, but will be produced if you run the .MSS files through Scribe for a device capable of underlining (line printer, daisy wheel, laser printer, etc).

The user's guide is intended for users of Kermit (including those who want to install it), the protocol manual is for those who would like to write a new implementation (i.e. a Kermit program for a new machine or operating system).

IMPORTANT: The Users Guide is always out of date. New implementations of Kermit, and new versions of old ones, arrive in a steady stream. It's impossible to keep the manual totally current. The general description of Kermit operation remains valid, but detailed descriptions of the various versions are better obtained from the accompanying help (.HLP), beware (.BWR), documentation (.DOC), memo (.MEM), or manual (.MAN) files. Look to these files for information missing from the user manual.

For a detailed presentation of Kermit, from tutorials on computers, files, and data communications, to a thorough description of the protocol itself, plus a command reference, command summary, troubleshooting guide, glossary, index, and many tables and illustrations, see the book "Kermit, A File Transfer Protocol," by Frank da Cruz, Digital Press (1986), ISBN 0-932376- 88-6, available from Kermit Distribution at Columbia, or directly from Digital Press, 12A Esquire Road, Billerica, MA 01862, order number EY-6705E-DP, $25.00.

ASCII.MSS is the ASCII/EBCDIC character table, which is included as an appendix in both manuals.

KUSER.HYP is a hyphenation dictionary for building the
    manuals with Scribe.

BYTE.MSS is the manuscript of the KERMIT article that
    was published in BYTE Magazine in June and July,
    1984.   -
BYTE.DOC is suitable for reading at the terminal,
    BYTE.MSS may be run through Scribe to produce
    output for various printing devices, BYTE.BIB is
    the bibliography.

MAIL.* is the archive of the CCNET/BITNET/ARPANET KERMIT
    discussion group.
MAIL.TXT is the current, active mail file, found on Tape A.

75

MAIL.yyx (e.g. MAIL.83A) files contain older messages, and these are kept on Tape C.

MAIL.HLP describes the format of the mail files.

*** IMPORTANT ***

Before doing anything with any particular version, look for an associated file with the suffix ".HLP" (help) or ".BWR" (beware). These files will often tell you special things you should know before starting to put together a working program from the distribution.

* MS-DOS Kermit Implementations (Prefix MS, Tape A):

See the file MSAAAA.HLP for an explanation of MS-DOS Kermit file naming conventions. The following .BOO files are provided for current MS-DOS implementations. BOO files are downloaded and decoded into .EXE files using MSBOOT.FOR on the mainframe and MSBPCB.BAS on the MS-DOS system, or downloaded directly to the PC and translated to .EXE files using MSBPCT.BAS or MSBPCT.EXE (compiled from MSBPCT.C), or MSBPCT.PAS (Turbo Pascal). Some of the MSV*.BOO files correspond to version 2.30 of MS-DOS Kermit, others to 2.29, and still others perhaps even to earlier version. It depends on which was the latest version successfully tested on that machine. For fallback purposes, BOO files for old releases for some systems may be found in MSO*.BOO. Beta tests of new releases are in MST*.BOO.

    MSV55X.BOO   Sanyo MBC-550 with IBM compatible
            video board
    MSVAP3.BOO   NEC APC3
    MSVAPC.BOO   NEC APC
    MSVAPR.BOO   ACT Apricot
    MSVDM2.BOO   DECmate-II,III with XPU (MS-DOS)
            option

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MSVGEN.BOO        Generic MS-DOS
MSVGRI.BOO        Grid Compass II
MSVHP1.BOO        Hewlett-Packard 150
MSVHPX.BOO        HP-110 and HP Portable Plus
MSVIBM.BOO        IBM PC, Portable PC, XT, AT, PCjr**,
                    and compatibles
MSVMBC.BOO        Sanyo MBC-550
MSVRB1.BOO        DEC Rainbow 100 Series
MSVRB2.BOO        A special fancy Rainbow version  that
                    does VT220 emulation
MSVRMX.BOO        Intel 300 series with iRMX-86
MSVTIP.BOO        Texas Instruments Professional PC
MSVWNG.BOO        Wang PC
MSVZ10.BOO        Heath/Zenith 100
MXVV90.BOO        Victor 9000 (Sirius 1)
```

Source and other MS-DOS Kermit files:

```
MSSDEF.H,MSS*.ASM Sources
MSG*.ASM          System dependent graphics terminal
                    emulation
MSU*.ASM          System dependent keyboard support
MSX*.ASM          System dependent source modules
MSY*.ASM          Terminal emulation modules
MSZ*.ASM          Continuation of terminal emulation
                    when MSY module too big
MSKERM.DOC        Kermit User Guide chapter for  MS-DOS
                    Kermit (long)
MSKERM.HLP        Brielf list of MS-Kermit commands
MSKERM.BWR        "Beware  File" -- Known  bugs  &
                    limitations. Read it!
MS*.HLP, MS*.BWR  Help and Beware files  for  specific
                    systems.
```

The IBM version runs on the entire IBM PC and PS/2 families, clones and compatibles (e.g. Compaq, AT&T 6300, DEC VAXmate), and near-clones like the Heath/Zenith 100 with UCI EZPC board, Olivetti M24, Seequa Chameleon, and Data General/1.

The generic version (MSVGEN) should run on any MS-DOS system, because it operates using only DOS calls. But this means it runs slowly (usually 1200 baud or less), and cannot do fancy screen management or terminal emulation.

The Tandy, Honeywell, and some other MS-DOS versions listed above under their own prefixes are based on older versions of IBM PC Kermit; these have yet to be merged with the current MS/PC-DOS version. Volunteers?

* WKERMIT (Tape A):

An adaptation of an early version of C-Kermit to run on the IBM PC family and compatibles. It is the first PC implementation of Kermit with the sliding window protocol extension. The .EXE file is formatted as a .BOO file (see above). It requires a modem, or a null modem cable that provides normal modem signals. The source code for WKERMIT should not be used as the basis for any development, as it is several releases behind C-Kermit.

* WINKERM (Tape A):

A version of Kermit specifically tailored for the multitasking Microsoft Windows environment.

* CP/M-80 Kermit Implementations (Tape A):

The following .HEX files for specific CP/M-80 implementations are included:

CP4*.ASM   The current, working source files for CP/M
            KERMIT.

78

CP4KER.DOC   User documentation (chapter from the
        manual).

CP4KER.HEX   System-independent portion, to be combined
        with one of the following system-dependent
        "overlays":

CP4380.HEX   Research Machines RM380Z
CP438M.HEX   Research Machines RM380Z
CP4820.HEX   Xerox 820
CP4ACC.HEX   Access-Matrix
CP4ADV.HEX   North Star Advantage
CP4APC.HEX   Apple II, Z80 Softcard, CPS serial card
CP4APL.HEX   Apple II, Z80 Softcard, 6551 ACIA in
        serial interface
CP4APM.HEX   Apple II, Z80 Softcard, Micromodem II in
        slot 2
CP4BB2.HEX   BigBoard II (terminal required)
CP4BBC.HEX   Acorn BBC Micro, Z80 second processor
CP4BRA.HEX   Intertec SuperBrain, aux port.
CP4BRM.HEX   Intertec SuperBrain, main port.
CP4BRN.HEX   Intertec SuperBrain.
CP4CIF.HEX   Cifer 1886
CP4COM.HEX   Comart Communicator
CP4CP3.HEX   "generic": CP/M 3.0 (CP/M Plus) systems
        (terminal req'd)
CP4CPT.HEX   CPT-85xx word processors with CompuPak
        CP/M
CP4CRO.HEX   Cromemco
CP4DEL.HEX   Digicomp Delphi 100 (terminal required)
CP4DIS.HEX   Action Computer Enterprises Discovery
CP4DM2.HEX   DECmate II with CP/M option
CP4GEN.HEX   "generic": CPM 2.2 systems with IOBYTE
        (terminal req'd)

CP4H89.HEX   Heath/Zenith H89.

CP4HOR.HEX   North Star Horizon without SIO board

CP4HP1.HEX   Hewlett-Packard 125

CP4KPR.HEX   Kaypro-II (and 4; probably supports all
        Kaypro systems)

CP4LOB.HEX   Lobo Max-80

CP4MDI.HEX   Morrow Decision I (terminal required)

CP4MIK.HEX   MikroMikko

CP4NST.HEX   Northstar Horizon with Northstar CP/M and
        SIO-4 board

CP4OSB.HEX   Osborne 1

CP4OSI.HEX   Ohio Scientific

CP4PMM.HEX   Personal Micro Computer MicroMate

CP4PX8.HEX   Epson PX8 Portable

CP4ROB.HEX   DEC VT180

CP4TEL.HEX   TELCON Zorba portable

CP4TLB.HEX   TRS-80 model II with Lifeboat 2.25C CP/M
        Display

CP4TOR.HEX   BBC Torch Series

CP4TPT.HEX   TRS-80 model II with Pickles + Trout CP/M
        Display

CP4TTK.HEX   Teletek with ADM-22 terminal

CP4UDI.HEX   Morrow Micro Decision I (terminal required)

CP4VEC.HEX   Vector Graphics.

CP4Z00.HEX   Z-100 under CP/M-85

The following are standalone hex files that can be directly loaded (not combined
with CP4KER.HEX):

CPMH8.HEX   Heath H8 (based on version 3.5 of CP/M-80   ·
        Kermit)

CPMPRO.HEX   Compupro Interfacer 3/4 (based on version
        3.9)

CPMSYO.HEX   Sanyo MBC 1100 (version 3.9)

The Kermit User Guide contains instructions for installing or bootstrapping the various versions of CP/M Kermit. The bootstrapping program is also stored in the files CP4FET.*. A BASIC program, CP4HEX.BAS, can be used on the CP/M system to verify and edit a downloaded hex file prior to loading.

* CP/M-86 Kermit Implementations (Tape A):

The CP/M-86 Kermit file names all start with C86. Those whose fourth character is X are system-dependent files for particular systems:

C86XAP	NEC APC
C86XFJ	Fujitsu Micro 16s
C86XFU	Future FX20/FX30
C86XRB	DEC Rainbow, CP/M-86/80 V2 (C86XR2 is an
	alternate version)
C86XTX	Tektronix 4170
C86XV9	Victor 9000/Sirius 1

The .H86 files are hex files, convertible to runnable .CMD files by running them through GENCMD on the micro. There's also a Concurrent CP/M-86 version under the prefix CN8 (on Tape C).

* Queen's University Turbo Pascal Kermit (Tape A)

Runs on several systems. All source files concatenated together into a big source file, QKKER.PAS, with component file separated by lines like

(* +FILE+ filename *)

The runnable program image (.COM file) is encoded into straight hexadecimal (2 hex digits for one byte from the .COM file) for the following systems:

QKMSTV.HEX   IBM PC family, MS-DOS, with VT100 &

81

Tektronix 4010 emulation

QKMSVT.HEX   IBM PC family, MS-DOS, with VT100
                 emulation

QKCPK2.HEX   Kaypro II, CP/M-80

QKAPP2.HEX   Apple II, DOS

A   simple Turbo Pascal program is provided to convert   these hex   files back into
.COM files -- QKHEXC.PAS.   Key definition files are   also provided; you need to
have one on your ·current disk in order to run the program.

* Other Files (All tapes):

AAAREAD.ME is a file that describes some other files
        which can help you find your way among the
        hundreds of Kermit files.

AAFILES.HLP is this file.

AATAPE.HLP explains the format and layout of Kermit ·
        tapes.

AAXFLY.DOC is the Kermit "brochure" and order form.

AAVNEW.HLP is a list of the current versions of Kermit
        in reverse chronological order, to help you see
        what has changed since the last time you looked.

AAWAIT.HLP is a list of Kermit versions reportedly under
        development, for which we are still waiting.

AAXCOM.HLP is a policy statement concerning commercial
        use of Kermit.

AABLIND.HLP is a list of hints for use of Kermit, and

microcomputers in general, by the blind or people with other disabilities.

KERMIT.FOR is a short receive-only version of Kermit written in Fortran, to be used for bootstrapping Kermit onto systems that don't have a real Kermit from a system that does.

* Tools (Tape A):

LASM and MLOAD are the public-domain CP/M-80 linking assembler and loader, that run on the CP/M system, and may be used to build Kermit-80.

UUDECO.C is a version of UUDECODE that has been changed to supply any trailing blanks on lines in UUENCODEd files that may have had them stripped off by electronic mail (like on BITNET).

XXU.C is a program for use on Unix systems that renames files with "foreign" names (e.g. uppercase, or including directory or path information, generation numbers, etc), to have normal Unix-style names.

XXTAPE.* is a program to write ANSI and EBCDIC labeled tapes on a Unix system. Also needs XXATOE.C.

APXA*.* is a program written in C that does what CROSS does, but only produces 6502 output (CROSS can produce many formats). This program can assemble Apple DOS Kermit (APPLEK.M65). (Actually, there might be minor differences in syntax, like whether or not a colon is required after a label...)

* DEC-10/20 Tools:

The following tools are specific to DECsystem-10 and DECSYSTEM-20 computers, and will not appear on distribution tapes for other kinds of systems, and will

only appear at the end of DEC-10/20 tapes if there is sufficient room. The tools files are stored separately in KT:, < KERMIT-TOOLS > .

The files MAC80.*, M80UNV, etc, are an 8080/8085/Z80 cross assembler that runs on the DEC-10 or DEC-20; MAC80.DOC is a brief description. TORTUR.M80 is an 8080 instruction set "torture test" for MAC80, which illustrates its features.

ZORTUR.M80 is a Z80 instruction set torture test. MAC80 is used to assemble CP/M KERMIT, and is mostly compatible with the standard CP/M 8080 assembler, D.R. ASM.

HEXIFY.* is a program for converting a CP/M .COM file resident on the DEC-10 or DEC-20 to a CP/M .HEX file. This is handy when binary file transfers are failing to work for some reason. The .HEX file can be LOADed on the CP/M system in the normal way to reconstruct the original .COM file. HEXCOM.* is the inverse of HEXIFY, and provides .HEX-to-.COM file conversion.

The files CROSS.* are a general purpose cross assembler that runs only on the DEC-10 and -20; CROSS.DOC is the manual. CROSS is used to assemble Apple DOS and Commodore-64 Kermits.

WRITEL is a program to write ANSI labeled ASCII tapes on the DEC-20; it is written in Rutgers Pascal, and requires that you have the Rutgers Pascal runtime library on your system.

* Finally...

If you make any significant modifications to Kermit, fix any major bugs, or write any new implementations or documentation, please send them back to us onmagnetic tape (or IBM PC DOS format diskettes) so we can distribute them toother Kermit users:

Kermit Distribution
Columbia University

Center for Computing Activities
612 West 115th Street
New York, NY 10025

We'll return your tapes back to you with the latest
Kermit distribution (if you send full-size reels).
Specify format and tape selection according the Kermit
order form (copy in AAXFLY.DOC).

* OTHER WAYS TO GET KERMIT *

To get Kermit on magnetic tape from Columbia
University, follow the directions in the file
AAXFLY.DOC. There are also other ways to get Kermit:

. Network Distribution:

The file AANETW.HLP contains instructions for
accessing the Kermit distribution over a variety of
computer networks and dialup hosts. AANOKS.DOC tells in
detail how to access the Kermit archive at Oklahoma
State University.

. Floppy Disk Distribution:

A list of volunteer individuals and organizations distributing Kermit on
floppy disks of various formats can be found in the file AADISK.HLP.   Kermit
diskettes may also be ordered in several formats from Columbia University (see
AAXFLY.DOC).

. Overseas sources for Kermit Distribution tapes:

UK and Ireland (ANSI and VAX/VMS BACKUP tapes, selected diskettes):

Alan Phillips
Communications Group
Department of Computing
Computer Building
Lancaster University
Lancaster LA1 4YW, ENGLAND
Phone 0524-65201 x 4881

France, Belgium, etc (European ANSI tape distribution tree)

Jean Dutertre
Institut Francais du Petrole
BP 311
92506 Rueil Malmaison Cedex, FRANCE
Phone +33 1 749.02.14

West Germany (ANSI tapes):

Dr. Hans-Magnus Aus
Institut fuer Virologie und Immunbiologie
Universitaet Wuerzburg
Versbacherstrasse 7
D-8700 Wuerzburg
WEST GERMANY
Phone (931) 201-3954

Australia:

Rodney Van Cooten (or The Kermit Coordinator)
University Computing Services
University of Melbourne,
Parkville,
Victoria, 3052,

AUSTRALIA

E-Mail: "munnari!murdu.oz!rvc"@SEISMO.CSS.GOV

Japan

Ken-ichiro Murakami

NTT Basic Research Laboratories

3-9-11 Midori-cho, Musashino-shi

Tokyo, 180

JAPAN

Telephone : 0422-59-3589

E-mail address : "nttlab!murakami"@Shasta   (from
   ARPA) or murakami@nttlab.ntt.junet   (from   JUNET,   the
      Japanese domestic network.)

APPENDIX D. ACCESSING KERMIT FILES VIA COMPUTER NETWORKS

This file is resident on the Columbia University Center for Computing and was accurate as of 20 Jan 88. It is up-dated yearly.

This file describes how to get Kermit files over computer networks, including BITNET, CCNET (a DECnet network), the Internet (Arpanet and the networks connected to it), plus various dialup accesses including UUCP. You should also read AAFILES.HLP if you need more complete descriptions of the Kermit files themselves.

* BITNET from the Columbia University CUVMA System:

BITNET is a network of computers, mostly at universities, connected with leased phone lines, using IBM mainframe RSCS protocols (VAX VMS and Unix systems and other systems that can imitate these protocols are also on BITNET). BITNET covers North America, Europe (where it is called EARN), and has recently spread to the Far East. Information about joining BITNET may be obtained from EDUCOM Networking Activities, P.O. Box 364, Princeton, NJ (USA) 08540, Phone 609-734-1878.

KERMSRV at CUVMA is a file server for the BITNET user community which accepts commands via messages or spool files, and sends the requested KERMIT files over the network. Most spool file formats are accepted including those used by SENDFILE, NOTE, PUNCH, PRINT, CARD DUMP, or DISK DUMP commands.

To learn how obtain Kermit files from the Columbia IBM mainframes via BITNET, type the following command to your BITNET host:

VM/CMS: TELL KERMSRV AT CUVMA HELP (or SMSG RSCS

MSG CUVMA KERMSRV HELP)
MVS/TSO/E: TELL KERMSRV AT CUVMA HELP (syntax may be
        site dependent)
VMS JNET: SEN/REM CUVMA KERMSRV HELP
UNIX UREP: netexec cuvma msg cuvma kermsrv help

The Kermit files available from BITNET may be some days or weeks behind the
announcements that appear in Info-Kermit (see below).

Here is a brief summary of KERMSRV operation;   see the   HELP message for
greater detail:

The following file request commands are accepted: SEND, MAIL, PUNCH,
PRINT, DISK, and CARD. These commands expect a file name or "DIR" or "?" as
an operand.   The DIR operand accepts an optional file name also.   File names may
contain * or % wildcard characters, but the filename portion may not consist of those
characters only.

Note that KERMSRV will always respond with some message; if you get a response
please do not resubmit your request.   If your request was received as a spool file, error
messages are sent in a spool file, also.

The NEWS command   returns news about latest   features and changes in
KERMSRV.

* BITNET from the University of Toledo VAX/VMS system UOFT02:

The Kermit file server KERMSRV is not the same one as the one running at
Columbia -- this is a VAX, and CUVMA is an IBM mainframe.   The collection is
maintained by Brian Nelson, author of PDP-11 Kermit, mail to BRIAN@UOFT02 on
BITNET.

for instance, from VM/CMS:

<pre>
       CP SMSG RSCS MSG UOFT02 KERMSRV DIR
       CP SMSG RSCS MSG UOFT02 KERMSRV SEND K11*.*
       (or TELL KERMSRV AT UOFT02 DIR, etc.)
</pre>

from VMS Jnet: S SEN/REM UOFT02 KERMSRV SEND K11*.*

Attempts to see if Kermsrv is 'logged in', e.g. SEN/COM UOFT02 CPQ U KERMSRV or SM RSCS MSG UOFT02 KERMSRV CPQ U KERMSRV will AL-WAYS fail. This is a VMS node running JNET and JNET treats server processes in a manner unlike VM does.

For all pratical purposes, KERMSRV is always running. If a message is sent to it, and for some reason it's not there, JNET will tell you.

Secondly, KERMSRV can ONLY respond to interactive messages, it can not process mail.

Additional "satellite" BITNET KERMSRV sites may be established in the future to relieve congestion at the major US East Coast hubs. The need is particularly great on the West Coast and in Europe. Volunteers? There is also some possibility of converting from KERMSRV to the more general and powerful LISTSERV facility.

* Internet from the Columbia University CU20B System:

"Internet" means the Arpanet and any network connected to it using TCP/IP protocols, including parts of CSnet, many campus local networks, etc. Access to the Columbia Internet Kermit distribution is through FTP, the Internet File Transfer Program; consult the FTP manual for your own system in order to learn how to use your FTP program.

To get Kermit files via the Internet, use FTP (not TELNET), connect to host CU20B (Internet Host number fff128.59.32.128"), login as user ANONYMOUS,

password KERMIT, and use the GET or MULTIPLE GET commands to retrieve the desired files from the area KER:, e.g. "GET KER:AAAREAD.ME", "MULTIPLE GET KER:CK*.*". Network users may consult the file KER:AAVNEW.HLP from time to time to see what new versions of Kermit have been installed recently. Sites whose FTP programs do not support the DIRECTORY or MULTIPLE GET commands may GET the file AAFILx.DIR from the desired Kermit area (see below) to obtain an up-to-date directory listing.

After logging in anonymously, you may also attempt to set your default path to the desired Kermit directory, KER:, K2:, K3:, K4:, or K5: (see below), using FTP's CWD or CD command. If you are prompted for a password, provide a null one; if a message advises you to send a password, ignore the message. Since our network software is always in a state of transition, this operation may or may not work. The following discussion assumes it does not work; if it does, you can follow the same instructions, but leave off the prefix KER:, K2:, K3:, etc, from any file specifications. (But if an operation fails, then try again but with the prefix.)

Internet access to CU20B is currently unrestricted, but if sufficiently large numbers of anonymous FTP logins occur regularly during prime (eastern) time hours to interfere with our own user community, some restrictions on anonymous logins will have to be imposed.

Those accessing CU20B via network should note the existence of several Kermit file areas:

KER: - Popular microcomputer, PC, workstation Kermit
        implementations.
K2: - Popular mainframe and minicomputer Kermit
        implementations.
K3: - Less popular micro & PC Kermits (spillover
        from KER:).
K4: - Less popular mini & mainframe Kermits
        (spillover from K2:).
K5: - Mail archives, full-text user guide, protocol

manual, etc.

KB: - True binary (executable) files for selected
implementations.

KE: - "Extra", old, redundant, or "limited-edition"
Kermit implementations.

KT: - Tools -- cross assemblers and linkers, etc.,
mostly to run on DEC-20.

KO: - Old releases superseded by new ones.

KER: corresponds to Tape A, K2: corresponds to Tape B,
to Tape C, K4: to Tape D, K5: to Tape E.

These areas are "logical device names", which should be used rather than physical DEC-20 DEVICE: < DIRECTORY > names, which may change from time to time as our systems are rearranged. The logical name KER: includes all the others (K2:, KB:, etc) in its search path in the order listed above, so to obtain a single file you should prefix its name by KER:.

When getting either single or multiple files, and your own system is a DEC-20, then it is also sufficient to prefix the file specification by KER:.

When getting multiple files from CU20B's FTP server from non-DEC-20 systems, you should first change working directory (CWD or CD) to the area containing the files you want to get, e.g. KER: or K2:. If you don't, then each file will be sent back to you with its fully qualified name which in some cases may be longer than the longest permissible filename on your system, which in turn can cause files whose names differ only in the last few characters to overwrite each other as they arrive.

Alphabetic case is insignificant in DEC-20 file names (lowercase is mapped to upper). The dot separating the file name and file type is significant; the name and type are separate fields.

File groups may be specified in MULTIPLE GET commands using the following "wildcard" notation:

* matches any string of 0 or more characters in the
current field

% matches any single character in the current position

For instance, KER:CK*.* matches all files whose names start with CK. KER:CK*.% matches all files whose names start with CK and whose types are exactly one character long (like KER:CKUCMD.C). The dot in DEC-20 filenames separates the filename from the filetype. KER:* will NOT match all the files in KER: (as Unix users might expect), but rather, all the files in KER: that have null filetypes. Use *.* to match all files.

Each implementation of Kermit has a additional prefix imbedded in the name. All files relating to that implementation have names that start with that prefix. Since the dot is significant in DEC-20 file names, the way to refer to all the files in a specific implementation is "KER:xx*.*", where xx is the prefix, e.g. KER:MS*.* for all the MS-DOS Kermit files.

A few cautionary words about DEC-20 logical names: the search path is followed only so long as files are not found that match the given file specification. This can cause some confusion; for instance, the command "DIRECTORY KER:" will only list the files in the primary (Tape A) Kermit directory, because when no file specification is given, "*.*" is assumed, and all files in the primary directory match "*.*", so subsequent directories are not searched. Similarly, "KER:C*.*" will not search subsequent directories if the primary directory contains any files that start with "C". Note that "KER:*.DOC" (whose intention might be to refer to all the Kermit documentation files) would only find .DOC files in the primary Kermit directory.

Care has been taken to ensure that files are arranged so that if they are referred to by prefix, they will be found in the KER: search path. For instance, the C-Kermit files, having the prefix "CK" will be found if referred to as "KER:CK*.*", even though they are really in K2:. However, this principle applies only to the principal directories,

KER:, K2:, K3:, K4:, and K5:. It does not apply to KB:, which is used to separate binary files from "printable" files. Therefore, KER:MS*.* will find all of the printable MS-DOS Kermit files, but will not find the .EXE files, which are in KB:, and must be referred to separately as KB:MS*.*.

Before you attempt to get binary files from the KB: or KT: directories with FTP, you should know something about the way the DEC-20 stores these files:

. Native DEC-10 or DEC-20 programs are stored in 36-bit binary format, and will be transferred correctly to other DEC-10 or -20 systems without doing anything special. They probably can't be transferred to other kinds of systems, except maybe 36-bit Honeywells or Sperrys.

. "Foreign" 8-bit binary files are stored four 8-bit bytes left justified within the 36-bit word. You can get these files from another DEC-10 or -20 without doing anything special, but to get them from some other kind of system, you have to give FTP the command "TYPE L 8", "type binary", and/or "TENEX" first.

If you are originating your FTP requests from a DEC-20 or TENEX system, no special precautions are necessary regarding file types or name conversion. If you are coming from another kind of system, you will probably find that the files you obtain are stored with names contrary to your system's naming conventions. For instance, if you tell Unix FTP to "mget ker:ck*.*", you may find the files stored in your directory with names like

PK: < KERMIT > CKAAAA.HLP.2

when you really want stored with names like

ckaaaa.hlp

94

A special program is available to Unix sites for doing the appropriate file name conversions, called xxu.c ("get ker:xxu.c"). The recommended procedure for FTP'ing files to a Unix system is to make a new directory for them, cd to it, then get the files, including ker:xxu.c, then build xxu.c (just type "cc -o xxu xxu.c"; the result should run under any version of Unix), then do "xxu *" to convert the names. See the xxu.c source comments for details.

USING KERMIT WITH AN INTERNET TERMINAL ACCESS CONTROLLER (TAC).

(Thanks to Edward Haines < haines@BBNCCI.ARPA> for these hints)

There are some conditions that must be met to successfully use Kermit on a personal computer through a TAC.

Flow Control

The buffer size for a terminal port on a TAC is typically about 64 bytes. (The size is a configuration parameter.) Since the default packet size in Kermit is usually 80-96 bytes it is quite likely that buffer overflow will occur.

Some possible solutions:

1. Enable flow control in Kermit on the PC and on the TAC. Many PC versions of Kermit implement XON/XOFF flow control, including the MS-DOS version for the IBM PC. To enable flow control on the TAC issue the TAC commands

@Flow Input Start
@Flow Output Start

These are usually abbreviated @f i s and @f o s. Note

that flow control is not compatible with binary mode (except see note below). .

2. Make the packet size on the PC Kermit small enough to not overflow the TAC buffer, e.g. 60 bytes. The normal command is "set receive packet-length 60", which you give to the Kermit that is about to receive files.

3. Increase the buffer size in the TAC. This is not usually practical and won't be considered further.

TAC Intercept Character.

The default TAC intercept character is the AT-sign. The AT- sign is also required by the Kermit Protocol, so unless you take one of the measures listed below, Kermit packets won't get through the TAC.

Solutions

1. Have the PC Kermit automatically double AT-signs on output. This is probably the best solution in general. This feature is available on some PC implementations of Kermit. It is not yet available on the MS-DOS version. fflEd. - It's available in CP/M-80 Kermit 4.0x."

2. Change the TAC Intercept character with the command

@Intercept < decimal ASCII value >

For instance, "@I 6" sets the intercept character to Ctrl-F.

3. Put the TAC into Binary mode. This has the side effect of disabling the Intercept character. It also

96

will allow you to transfer binary files without special encoding. The TAC can be put into Binary mode with the commands

@Binary Input Start   (@b i s)
@Binary Output Start   (@b o s)

Some host systems allow you to engage the binary mode from the host. DEC-20 Kermit has a command for this.

There are several problems with binary mode:
Some host systems don't support it.
You lose the ability to control the TAC from the PC.
You lose the ability to do XON/XOFF flow control.

Binary Files

It is sometimes desireable to be able to transmit an 8-bit binary file between a host and a PC. The TAC (which implements the DDN Telnet Protocol) normally provides just a 7-bit ASCII path.

Solutions

1. Enable binary mode (if possible) as described above.

2. Enable 8th bit prefixing (if available) in both Kermits. (This is usually done by enabling parity via Kermit's SET PARITY command.)

Notes

1. You will probably get the best throughput for ASCII files by keeping the

97

packet size as large as possible and using flow control.

2. There is not much advantage in increasing the baud rate between the PC and the TAC beyond 1200 baud because of the relatively long turnaround time for the acknowledgement packet.

3. You may have problems when going through satellite hops or multiple gateways due to the occasional very long delays. This may result in Kermit giving up. The problem can be circumvented to by increasing the timeout interval; many Kermits have commands to allow this: SET SEND/RECEIVE TIMEOUT.

4. Only the first letter of a TAC command is required.

5. It is possible to set binary mode in only one direction. For example you can set Inbound binary and retain input flow control (XON/XOFF flow is in the opposite direction). You probably don't need outbound (input to the PC) flow control when using the Kermit protocol.

* CCnet:

CCnet is a DECnet network of cooperating universities. Kermit files may be accessed using NFT to CU20B::KER:xxx.yyy, where xxx.yyy is the name of the file or file group you want to get. Some sites (regarded as "secure") may specify

/USER:ANONYMOUS, but most sites will have to supply a valid CU20B user ID and password. If your system is on CCnet and you cannot get anonymous NFT access to CU20B, you'll have to ask your system manager to get the files for you. Read the Internet section above about device, directory, and wildcard conventions.

* United Kingdom (Information from Alan Phillips, Lancaster University):

Though there is a central registry of UK site names known as NRS, it is not automatic and many people have no access to it, so include the actual DTE addresses if you can. Details for mail:

JANET network : SYSKERMIT @ UK.AC.LANCS.VAX1
           (actual   address   is
           000010404000.FTP.MAIL)

PSS network : SYSKERMIT@234252400101.
           000010404000.FTP.MAIL or to
           the JANET address via the
           Rutherford gateway

BITNET : SYSKERMIT%LANCS.VAX1 @ UK.AC

ARPA : SYSKERMIT%LANCS.VAX1 @ CS.UCL.
           AC.UK

We do not support file transfer to BITNET/ARPA - users have to log in as a terminal and use KERMIT. Over PSS and JANET we support ftp using Blue Book protocol: For details pull file 00INFO.TXT from user KERMIT, quoting password KERMIT. FTP address is

JANET : 000010404000.FTP

PSS : 234252400101.000010404000.FTP"

Or people can just mail me and I'll send details. Afraid we have no equivalent of the BITNET KERMSRV server or Arpa anonymous ftp over here. Dial-up ports are available; I'll send details to anyone wanting them.

While we're very happy for anyone to ftp from us or log in to us from anywhere, and we'll put anyone on the mailing list, we can't handle letters and phone calls from outside the UK and Eire. Nor can we send files to people who can't ftp them.

* Mail:

There is a network mailing list for Kermit information; it is available to users of BITNET and the Internet and most networks that are connected to them, inclusing CSnet, Usenet, Mailnet, CCnet, and others. To get on the mailing list, send mail:

```
- From -           - To -
BITNET           KERMIT@CUVMA
CCNET            Info-Kermit-Request@CU20B
Arpa      Internet           Info-Kermit-
          Request@CU20B.COLUMBIA.EDU
CSNET            Info-Kermit-Request%CU20B.COLUMBIA.
          EDU@CSNET-RELAY
Mailnet          Info-Kermit-Request%CU20B.COLUMBIA.
          EDU@MIT-MULTICS
Usenet           ...!uunet!columbia!cu20b!info-
          kermit-request
DEC Easynet      DECWRL::"Info-Kermit-Request@CU20B.
          COLUMBIA.EDU"
UK JANET         SYSKERMIT@UK.AC.LANCS.VAX1
```

If your system won't let you use long names or names with dashes in mail addresses, then just substitute "KERMIT" for "Info-Kermit-Request".

Also, as of December 1988, the Kermit mailing list is available via BITNET LISTSERV. This is a facility that lets you subscribe and unsubscribe yourself. To subscribe via LISTSERV, send an electronic mail message to LISTSERV@CUVMA. The body of the message should contain the line:

    SUBSCRIBE I-KERMIT your personal name

For instance

SUBSCRIBE I-KERMIT Fred C. Dobbs

  To remove yourself from the list, send the following message:

UNSUBSCRIBE I-KERMIT

To learn more about LISTSERV, send it a message "HELP" or "INFO ?".

* Dialup:

    Several publicly accessible dialup Kermit collections are available in the US:

1. The University of Toledo allows limited dialup access to its UOFT02 VAX/VMS system:

    (419) 537-4411
    Service class VX785A
    User: KERMIT
    Password: KERMIT

    Source and hex files are in KER:, binaries are in KERBIN:

2. Oklahoma State University:

UUCP and Kermit access to the complete Kermit distribution is available from the Department of Computing and Information Sciences, Oklahoma State University, Stillwater, Oklahoma. The procedures are somewhat complicated, and are described in a separate file, AANOKS.DOC.

APPENDIX E.   KERMIT USER'S GUIDE

This is a step-by-step guide for using KERMIT to access the NPS mainframe from a Heath/Zenith 100 or 89 microcomputer. The procedures were developed by the long proven scientific trial and error method and some very old notes from a 1984 file on the mainframe titled "Z100h89 fullscrn B". If you happen upon improvements and/or corrections to this guide, please provide them and any other comments to the computer department so they can be added. This and the other KERMIT text files were written by R. G. Bishop in April 1987 at the request of the NPS Computer Center.

A.   KERMIT IN GENERAL

There are many help files and documents avaliable to help you become familiar with KERMIT commands and attributes. These help files and KERMIT User Guides can be accessed through the BITNET, Defense Data Network (DDN) and the mainframe. Rather than attempt to duplicate them here, you should access them yourself if you are in need of further information. This instruction sheet will provide all the information you need to access the mainframe and from there you can learn more.

1.   Versions of KERMIT

There are more than 200 versions of KERMIT circulating around for over 50 specific machines and more than 5 for MS-DOS in general. This instruction set is written for KERMIT version 2.27 which is avaliable from the computer department with several special changes set up to communicate with the mainframe using a Z-100/89.

2.   Required Files

You will need both MSZ100.EXE and MEKERMIT.INI on your disk to use these procedures. The original disk for this instruction sheet includes KERMIT.DOC and READ.ME.

B.   BRIEF OVERVIEW OF PROCEDURES

1. Dial into the Mainframe accessing SIM3278.

2. Choose the VT100-in-the-VT52-mode terminal emulator package.

3. Set up your Z-100/89 in the alternate keypad mode.

4. Log on exactly as you would from a terminal at school.

5. Decide whether to transfer files or do screen editing.

6. Use substitute keys to imitate the PF keys.

1. The Details

   a. *Loading KERMIT for MS-DOS*

   NOTE: For this instruction sheet "<CR>" means carrage return key, <esc> means escape key and <ctrl> means control key.   Under most circumstsnces you will use the <ctrl> key simultaneously with another key.

Put the disk containing KERMIT in the active drive and enter:

MSZ100 <CR>   This loads KERMIT and the system
                    will respond with with:

                        Heath-Zenith Z-100 Kermit-MS V2.27
                        Type ? for help

                        KERMIT-MS>

When the prompt appears enter:

DO IBM <CR>   This will set up the communications
                    protocall to the correct values and
                    return the prompt, KERMIT-MS>.

   b. *Set Up Modem*

Now turn your modem on and enter:

Connect or C <CR> This begins the connect sequence.

Next "dial" the mainframe. For an auto-dial modem enter:

ATD6462709 < CR >   This will call-up the computer for
                                1200 or 300 baud operation.

NOTE: If you do not have an auto-dial modem follow your modem's
          instructions for call or dial-up.

The system will respond with:

    CONNECT 1200
    VM/370 ONLINE--   --PRESS BREAK KEY TO BEGIN SESSION
    ! Enter < CR >

The system will respond with:

 Enter one of the following commands:

    LOGON userid   (Example: LOGON VMUSER1)
    DIAL userid   (Example: DIAL VMUSER2)
    MSG userid message   (Example: MSG VMUSER2 GOOD MORNING)
    LOGOFF

    .   This is the mainframe dot prompt.

DO NOT GO FURTHER UNTIL YOU READ THE NEXT SECTION

DO NOT GO FURTHER UNTIL YOU READ THE NEXT SECTION

c. *What do you want to do this session ?*

At this point you must make a decision about what you want to do. If you wish to transfer files, see TRANSFERRING FILES, if you wish to do full screen editing (same as being on a terminal at school) continue with the section, SCREEN WORK.

(1) *Screen work.* You have dialed up the Mainframe and must now get to the period prompt. DON'T log on with your user id yet. Instead enter the following:

DIAL SIM3278 < CR >   This will connect you to the
mainframe's communications
protocall software.

The system will respond with:

 DIALED TO SIM3278   091 S I M 3 2 7 8 (C) Simware Inc. 1984 VERSION 3.4
Please Enter Your Terminal ID; '?' for menu, 'L' for LOGOFF

When asked what type of terminal you are, enter:

9 < CR >   You may look at the menu if you
want by entering ? You enter 9 to
choose the DEC VT100 in the VT52
mode, and press RETURN.

 The screen will clear and the large NPS logo will appear like the one on the 3270 console's at school.

Now you must enter a sequence which will turn your keypad on and place your Z-100 keypad in the Alternate character mode. Enter:

< esc > x7 < CR >   Note the small (lower case) x.
Place the H-89 in the shifted

keypad mode by pressing <ESC> x6.
(Note the lower case x.)

= = > The Z-100 has separate arrow keys on the keypad. Use
these to move the cursor around.
= = > On the H-89, the shifted keypad mode allows the arrow
keys to work as is. To access the rest of the functions,
you must press the shift key with the keypad key.

The system will respond with:

Enter one of the following commands:

    LOGON userid   (Example: LOGON VMUSER1)
    DIAL userid   (Example: DIAL VMUSER2)
    MSG userid message   (Example: MSG VMUSER2 GOOD MORNING)
    LOGOFF

    .   This is the mainframe dot prompt.

Logon as you would normally do at a terminal by entering:

logon XXXXP <CR>   Where XXXX is your user Number.
Your password WILL show up on the
srceen, but no matter. This should
also execute your exec files as
normal after logon. If not press
return again.

The system will respond with the LOGON message and leave you with the system
prompt "dot".

There is an attachment to this instruction which shows the key equivalents for the Z-100. In all cases you must enter the keys (in sequence if more than one) and end with a carriage return < CR >.

   (2)   Transferring files.   To transfer files you must "set the mainframe up" to send or receive a file first . Then "drop" down to your KERMIT and do the transferring. To drop down, you must enter control, right bracket, < ctrl > ", simultaneously, and then enter the appropriate send or receive on your KERMIT.

Logon as you would normally do at a terminal by entering:

logon XXXXP < CR >   Where XXXX is your user Number.
                        Your password WILL show up on the
                        srceen, but no matter. This should
                        also execute your exec files as
                        normal after logon. If not press
                        return again.

The system will respond with the LOGON message and leave you with the system prompt "dot".

Now link to the mainframe's KERMIT by entering:

Linkto KERMIT < CR > The system will respond with:
                        Linked to user kermit disk 191...
                        and will give you the KERMIT-CMS >
                        prompt. There is no help file
                        avaliable, but ? displays the
                        KERMIT options avaliable. This may
                        again execute your exec files.

If you have forgotton which file you wanted to send or just want to look, you can see your filelist (directory) by entering the following sequence:

QUIT or **Q** < CR > Quits kermit and returns to cms at
which time you can enter:

listfile < CR > Which will display your directory.

to get back to kermit enter:

KERMIT < CR > The system will display KERMIT-CMS.

To send a file from the main frame to home computer enter:

send *filename filetype filemode* < CR >

< ctrl > -] < CR > Drops to your KERMIT-MS > prompt.

receive *filename.extension* < CR > ?

At this time you will see a file transfer status menu. This will give you a menu which shows how the transfer is working. When the transfer is complete it will tell you (along with some other ? facts about that file ?

d. Logging off

You logoff at the end of your session as normal and then enter:

<ctrl> -C] <CR>   The control, <ctrl>, and right
bracket " must be done at the same
time (simultameously) and then the
C and <CR>.

Now you are at the KERMIT-MS> prompt. Enter:

QUIT or **Q** <CR> This will bring you back to the
operating system.

2. Tips for 300 baud users

Since 300 baud can be very slow, try to minimize those actions which call for a complete screen update. Some examples:

1. In XEDIT, do most of your corrections on the whole page (using the arrow keys) before you move Up or Down. Then move a whole page if possible.

2. In the Input mode in XEDIT, use the NEWLINE function (ESC <cr>) to move the cursor down to column one of the next line instead of pressing <cr> alone. RETURN <cr> causes the whole screen to be updated as the lines you've entered so far, are moved up above the action. Once you have entered seven or so lines, then press <cr> to accept the lines and update the screen.

3. Z-100/IBM 3270 keyboard equivalence

Use Figure 11 to imitate the various function keys normally found on the 3270 terminals connected to the IBM at NPS.

```
                    HOME/SCHOOL KEY EQUIVALENCES
                    ---------------------------


         Here are some key equivalences:

             VT-52 (term 9)         IBM 3270         CODES
         H89 (KP=Keypad)  Z-100      KEYS            SENT        REMARKS
         -----------------------------------------------------------------


                   =======>   ARROW KEYS    <=========

         <--                <--            <--          <ESC> D
         shift 6            shift 6        shift 6      <ESC> A
            v                  v              v         <ESC> B
         -->                -->            -->          <ESC> C



                   =======> FUNCTION KEYS <=========

         BLUE<cr>           F6<cr>         PF1          <ESC> P
         RED<cr>            F7<cr>         PF2          <ESC> Q
         WHITE<cr>          F8<cr>         PF3          <ESC> R
         F1<cr>             F1<cr>         PF4          <ESC> S
         shft KP 7<cr>      KP 7<cr>       PF5          <ESC> ? w
         shft KP 8<cr>      KP 8<cr>       PF6          <ESC> ? x
         shft KP 9<cr>      KP 9<cr>       PF7          <ESC> ? y
         ESC ? m <cr>       KP -<cr>       PF8          <ESC> ? m
         shft KP 4<cr>      KP 4<cr>       PF9          <ESC> ? t
         shft KP 5<cr>      KP 5<cr>       PF10         <ESC> ? u
         shft KP 6<cr>      KP 6<cr>       PF11         <ESC> ? v
            ?                  ?           PF12             ?
         shft KP 1<cr>      KP 1<cr>       PA1          <ESC> ? q   Goes to CP
         shft KP 2<cr>      KP 2<cr>       PA2          <ESC> ? r      ?
         shft KP 3<cr>      KP 3<cr>       #GOTO(SIM)   <ESC> ? s      |
         ESC<cr>            ESC<cr>        Newline      <ESC>       3270 <--" key
         shft ENTER<cr>     ENTER<cr>      Alt Clear    <ESC> ? M   also PA2
         CTRL a             CTRL a         Insert char  <CTRL a>
         CTRL b             CTRL b         Delete char  <CTRL b>    once for each
                                                                    char to delete
```

Figure 11. Z100/IBM 3270 Key Equivalence: NOTE: Some of the function keys have not been located, If you find errors or more definitions, let us know.

4. The Quick'N'Dirty Version

After doing this several times you will get to the point when you do not need all this information to operate in the KERMIT environment. Figure 12 fits neatly on a three by five card which can be tucked into the jacket of your KERMIT disk.

111

```
+----------------------------------------------------------+
|  ---------------------------------------------------      |
|  |           " MAINFRAME'N KERMIT "              |        |
|  | - - - - - - - - - - - - -  - -  - - - - - - - - - - - |
|  |    MSZ100 <CR>                               |        |
|  |    DO IBM <CR>                               |        |
|  |    modem on    Connect <CR>   ATD6462709     |        |
|  |                                               |        |
|  |--- TO TX FILES ------------ SCREEN WORK ------|        |
|  |                                               |        |
|  |    LOGON XXXXP <CR>          DIAL SIM3278 <CR>|        |
|  |    LINKTO KERMIT <CR>        <esc>x7 <CR>     |        |
|  |    Q <CR>, LISTFILE <CR>     LOGON XXXXP <CR> |        |
|  |    KERMIT <CR>                                |        |
|  |    set mainframe first!      LOGOFF <CR>      |        |
|  |                                               |        |
|  |    LOGOFF <CR>               <ctrl>-C <CR>, QUIT |     |
|  ---------------------------------------------------      |
+----------------------------------------------------------+
```

Figure 12.   KERMIT Quick Reference (3 X 5 card) (for NPS only)

APPENDIX F.   TEKTRONIX TERMINAL EMULATOR

The following programs were developed on the Z-100 using Z-BASIC under MS-DOS version 2. The programs used to generate the pictures in Appendix I were compiled by the Z-BASIC compiler.

A.   TEKTRONIX GRAPHICS TERMINAL EMULATION PROGRAM

```
1     ' TECKTRONIX 4006 / 4010 GRAPHICS TERMINAL EMULATOR
2     ' FOR THE Z-100 UNDER MS-DOS MODIFIED FOR THE DDN
3     '
4     ' ORIGINALLY SUGGESTED BY GLEN ROBERTS APRIL 28, 1984
5     ' UNDER Z-DOS TO MAKE THE Z-100 COMPUTER EMULATE A
6     ' TEKTRONIX PROTOCOL GRAPHICS TERMINAL
7     ' THIS VERSION WILL RUN UNDER MS-DOS 2 AND HIGHER
8     ' MODIFIED BY R. SABO AND R. BISHOP JAN 1988
9     '
10    DEFINT A-Z: DIM P!(224): DEF SEG = &HE000
11    '
12    ' CHARACTER CONSTANTS
13    '
20    CTRLC=3: FF=12: XON=17: XOFF=19: ESC=27: GS=29: US=31: SPACE=32
21    '
22    ' INITIALIZE VARIABLES
23    '
30    FALSE=0: TRUE=NOT FALSE: GRMODE=FALSE: HAVLOY=FALSE: A=0
31    '
32    ' THE FOLLOWING COMMUNICATION PROTOCOL CONSTANTS MAY BE
33    ' MODIFIED AS NEEDED FOR THE APPLICATION YOU ARE UNDER
34    '
40    BAUD$="1200": PARITY$="N": BITS$="8"
41    '
42    ' HOME THE CURSOR AND CLEAR THE SCREEN
43    ' TURN KEY ASSIGNMENTS OFF
44    '
50    SCREEN 0,0: KEY OFF: CLS
51    '
52    ' INITIALIZE THE ARRAY TO INDEX THE BYTES
53    ' FOR BIT IMAGE PRINTING (NOT USED IN THIS VERSION)
54    '
55    '
60    R=0: FOR J=0 TO 392 STEP 16: FOR I=0 TO 8: P!(R)=(I+J)*128:
      R=R+1: NEXT I: NEXT J
61    '
62    ' ASSIGN KEY INTERRUPTS TO THE
63    ' APPROPRIATE SUBROUTINES
64    ' THIS AREA IS WHERE FURTHER WORK CAN TAKE PLACE
65    '
70    KEY(1) ON: ON KEY(1) GOSUB 530
80    KEY(2) ON: ON KEY(2) GOSUB 560
```

```
90   KEY(3) ON: ON KEY(3) GOSUB 590
100  KEY(4) ON: ON KEY(4) GOSUB 620
110  KEY(5) ON: ON KEY(5) GOSUB 740
120  KEY(6) ON: ON KEY(6) GOSUB 470
130  KEY(7) ON: ON KEY(7) GOSUB 760
140  KEY(8) ON: ON KEY(8) GOSUB 780
150  KEY(9) ON: ON KEY(9) GOSUB 800
151  '
152  ' PRINT 25th LINE AND TITLE HEADING ON SCREEN
153  '
160  GOSUB 620
170  PRINT "TEKTRONIX 4006 / 4010 GRAPHICS TERMINAL EMULATOR"
180  PRINT
190  PRINT "BAUD   : ";: SCREEN ,1: PRINT BAUD$;: SCREEN ,0
200  PRINT "     PARITY : ";: SCREEN ,1: PRINT PARITY$;: SCREEN ,0
210  PRINT "      BITS  : ";: SCREEN ,1: PRINT BITS$;: SCREEN ,0
211  '
212  ' OPEN SERIAL COMM CHANNEL AS FILE #1
213  ' OPEN SCREEN OUTPUT AS FILE #2
214  '
218  '
220  OPEN "COM1:"+BAUD$+","+PARITY$+","+BITS$ AS #1
230  OPEN "SCRN:" FOR OUTPUT AS #2
240  PAUSE=FALSE
241  '
242  ' THIS IS THE MAIN EXECUTION LOOP
243  ' FIRST CHECK FOR CHARACTERS IN THE COMM BUFFER
244  ' IF NONE THEN JUMP TO SEE IF SYSTEM IS WAITING
245  ' FOR AN X-ON ALSO CHECK COMM BUFFER TO SEE IF FULL
256  '
250  IF LOC(1)=0 THEN 430
251  '
252  ' HANDLE HANDSHAKING IF COMM BUFFER IS ALMOST FULL THEN
253  ' SEND AN XOFF TO THE REMOTE SYSTEM TO STOP DATA
254  ' TRANSMISSION AND SET PAUSE TO TRUE TO INDICATE THAT
255  ' THE REMOTE SYSTEM IS WAITING FOR AN X-ON
256  '
260  IF (LOC(1)>60) AND NOT PAUSE THEN PAUSE=TRUE: PRINT #1,CHR$(XOFF);
261  '
262  ' SAVE THE LAST RECIEVED CHARACTER, THE READ A NEW CHARACTER FROM
263  ' THE COMM BUFFER
264  ' (STRIP THE 8TH BIT IF ANY)
265  '
270  LASTA=A: A=ASC(INPUT$(1,#1)) AND 127
271  '
272  ' IF THE CHAR IS A CONTROL CHAR OR IF WE ARE
273  ' NOT IN THE GRAPHICS MODE THEN JUMP
274  '
280  IF A<SPACE THEN 390
290  IF NOT GRMODE GOTO 420
292  ' HANDLE THE GRAPHICS CHAR
293  ' PUT HIGH TWO BITS INTO MODE VARIABLE
294  ' THEN PUT LOW FIVE BITS INTO THE BITS VARIABLE
295  '
300  MODE=A 32: BITS=A AND 31
310  ON MODE GOTO 320,340,380
```

```
311 '
312 ' FOR THE CASE WHERE MODE = 01 (HIGH X OR HIGH Y)
313 '
314 ' IF WE ALREADY HAVE A LOW Y THEN THIS
315 ' MUST BE A HIGH X, ELSE IT MUST BE A HIGH Y.
316 ' SHIFT IT FIVE BITS SO THAT THE LOW VALUE
317 ' MAY BE ADDED LATER.
318 '
320 IF HAVLOY THEN HIX=BITS*32 ELSE HIY=BITS*32
330 GOTO 430
331 '
332 ' MODE = 10 (LOW X)
333 '
334 ' THE HIGH AND LOW DATA IS COMPLETE, START DRAWING THE
335 ' VECTOR ON THE SCREEN.  THIS IS DONE USING THE Z-BASIC
336 ' "DRAW" STATEMENT. SCALING IS 5/8 X AND 7/24 Y
337 ' IF THE VECTOR IS INVISIBLE ADD "B" TO BLANK IT.
338 '
340 Y=15*(780-(LOY+HIY)) 52:X=5*(BITS+HIX) 8
350 L$="M"+MID$(STR$(X),2)+","+MID$(STR$(Y),2)
360 IF BLANK THEN L$="B"+L$
370 DRAW L$: BLANK = FALSE: HAVLOY=FALSE: GOTO 430
371 '
372 ' FOR THE CASE WHERE MODE = 11 (LOW Y)
373 '
374 ' SAVE LOW Y VALUE AND REMMEMBER THAT WE HAVE
375 ' RECEIVED A LOW Y
376 '
380 LOY=BITS: HAVLOY=TRUE: GOTO 430
381 '
382 ' HANDLE COTROL CHARACTERS HERE
383 ' IF A GROUP SEPARATOR (GS) THEN ENTER THE
384 ' GRAPHICS MODE AND REMMEMBER THAT THE NEXT VECTOR
385 ' WILL BE INVISIBLE (YOU ALWAYS START WITH AN INVISABLE
386 ' VECTOR SO YOU CAN POSITION TO THE CORRECT STARTING PLACE)
387 '
390 IF A=GS THEN GRMODE=TRUE: BLANK=TRUE: CLS: GOTO 430
391 '
392 ' IF A UNIT SEPERATOR (US) THEN
393 ' EXIT THE GRAPHICS MODE
394 '
400 IF A=US THEN GRMODE=FALSE: LOCATE 25,1: GOTO 430
401 '
402 '
403 '
404 '
407 ' IF FORM FEED (FF) AND THE LAST WAS (ESC), THEN CLEAR SCREEN
408 ' AND THE 25TH LINE, THEN EXIT GRAPHICS MODE
409 '
410 IF A=FF AND LASTA=ESC THEN CLS: LOCATE 25,1:
    PRINT SPACE$(80);: GRMODE=FALSE: GOTO 430
411 '
412 ' THE CHAR IS EITHER A NORMAL CONTROL CHAR
413 ' OR WE ARE NOT IN GRAPHICS MODE
414 ' JUST SEND IT TO THE SCREEN
415 '
```

```basic
420 PRINT #2,CHR$(A);
421 '
422 ' IF X-OFF HAS BEEN SENT SEE IF BUFFER IS ALMOST EMPTY
423 ' IF IT IS, SEND AN X-ON
424 '
430 IF (LOC(1)<10) AND PAUSE THEN PAUSE=FALSE: PRINT #1,CHR$(XON);
431 '
432 ' NOW POLL THE KEYBOARD. IF A KEY HAS BEEN HIT
433 ' THEN TRANSMIT THAT CHARACTER TO THE REMOTE SYSTEM
434 ' AND GO BACK TO THE TOP OF THE LOOP
435 '
440 A$=INKEY$
450 IF A$<>"" THEN PRINT #1,A$;
460 GOTO 250
461 '
462 ' SUB TO PRINT SCREEN USING BIT IMAGE GRAPHICS ON C.ITOH PROWRITER
463 ' OTEHR SIMILAR PRINTERS.
464 '
470 BEEP
480 '
490 '
500 '
510 '
520 RETURN
522 '
523 ' ROUTINE TO NAME AND SAVE SCREEN PICTURES
524 '
530 LOCATE 1,1: INPUT"PICTURE NAME: ",SCNM$
531 '
532 '
535 BSAVE SCNM$,0,50256!
536 GOSUB 620
540 BEEP
550 RETURN
554 '
555 ' THE SPACES HERE CAN BE USED TO PROGRAM THE "FUTURE"
556 ' THINGS REMOVED FOR OUT PROOF OF CONCEPT VERSION
557 ' WHEN CALLED THEY WILL JUST BEEP FOR NOW
558 '
560 BEEP
570 BEEP
580 RETURN
590 BEEP
600 BEEP
610 RETURN
611 '
612 ' SUB-ROUTINE TO CLEAR SCREEN AND PRINT A REMINDER PROMPT
613 ' ON THE 25TH LINE.  THE PROMPT SHOWS THE FUNCTION KEYS
614 ' AND THEIR ASSIGNED STSTUS
615 '
620 CLS: LOCATE 25,1
630 PRINT " 1";: SCREEN ,1: PRINT "SAVE  ";: SCREEN ,0
640 PRINT " 2";: SCREEN ,1: PRINT "FUTURE";: SCREEN ,0
650 PRINT " 3";: SCREEN ,1: PRINT "FUTURE";: SCREEN ,0
660 PRINT " 4";: SCREEN ,1: PRINT "CLS   ";: SCREEN ,0
670 PRINT " 5";: SCREEN ,1: PRINT "QUIT  ";: SCREEN ,0
```

```
680 PRINT " 6";:SCREEN ,1:PRINT "FUTURE";:SCREEN ,0
690 PRINT " 7";:SCREEN ,1:PRINT "  C     ";:SCREEN ,0
700 PRINT " 8";:SCREEN ,1:PRINT "XOFF   ";:SCREEN ,0
710 PRINT " 9";:SCREEN ,1:PRINT "XON    ";:SCREEN ,0
720 LOCATE 1,1
730 RETURN
731 '
732 ' CLOSE ROUTINE
733 '
740 CLOSE:KEY OFF:CLS
750 STOP
751 '
752 ' ROUTINES NEEDED TO SEND CONTROL CHARS NORMALLY
753 ' TRAPPED IN ZBASIC INTEREPRETED VERSIONS. MAY NOT
754 ' BE NEEDED IN THE COMPILED VERSION
755 '
760 PRINT #1,CHR$(CTRLC);
770 RETURN
780 PRINT #1,CHR$(XOFF);
790 RETURN
800 PRINT #1,CHR$(XON);
810 RETURN
```

B. PLAYBACK PROGRAM LISTING

While this is not very elegant it does serve its purpose. Further work on this program could do much to improve its functions.

```
1   ' THIS IS THE LO-CO-GRAF "PLAY BACK" PROGRAM
2   ' IT PROMPTS FOR THE NAME OF THE PICTURE TO
3   ' GET FROM A FILE AND THEN PAINTS IT ON THE SCREEN
4   ' AT THAT POINT, YOU CAN PRINT IT TO PAPER WITH THE
5   ' SCREEN DUMP PROGRAM
6   '
10  '
20  CLS
30  DEF SEG=&HE000
31  '
33  ' LINES 40 THRU 70 GET THE NAME OF THE FILE DATA
34  ' TO BE DISPLAYED, PLAY BACK THE PICTURE AND
35  ' RINGS A BELL TO TELL YOU IT IS COMPLETE.
36  '
40  INPUT "NAME OF PICTURE FILE TO LOAD ";FILENAME$
50  CLS
60  BLOAD FILENAME$,0
70  BEEP
71  LOCATE 25,1: PRINT "ENTER ANY KEY TO QUIT        OR"
72  LOCATE 25,31:PRINT "            PRESS SHIFT F-12 TO PRINT"
90  A$=INKEY$: IF A$="" THEN 90
100 STOP
```

APPENDIX G. SCREEN DUMP ROUTINE

This documentation file is available on the distribution disk for the screen dump routine titled:

SCDMP.COM - Version 3.4 - 15-Oct-85
SCREEN DUMP UTILITY FOR H/Z-100
(for U. S. Government use only)

A.   INTRODUCTION

SCDMP is a utility that allows reproduction of a complete video screen on a dot matrix printer, including both text and graphics, without having to exit the current program. The SCDMP program may be loaded manually (by entering SCDMP < cr >) or automatically, via 'autoexec.bat', into memory at the   beginning of a session where it remains resident until needed.   To print a desired stationary screen,   simply   press < SHIFT-F12 > ,   which generates an interrupt-5 and activates the screen dump.

The   program allows a choice of which color bank of video RAM is dumped (if the user has all banks of color RAM in his Z100).   The   number of VRAM banks installed in   your computer is determined by SCDMP upon initial load.   For the color version, entering a < B > for blue, < R > for red, < G > for green, or < A > for all banks immediately after the < SHIFT-F12 > will select the VRAM bank to be printed.   If no character is entered, < A > ll banks is the default.   If only one bank of color RAM is installed, only the green bank can be dumped.

The   program also allows multiple density printing for some printers. Entering an < H > immediately after the < SHIFT-F12 > or color   selection would cause the printer to use a higher density mode for printing.   The default density is normal or standard density. The program also allows a choice of printing the twenty-fifth line, if displayed.   Entering a < D > immediately   after   the < SHIFT-F12 >   or color or density selection will cause SCDMP to dump the 25th line if it is dis-played.

The   program also allows the default values   for the switch settings to be changed at any time after the program is loaded. Entering a   < C >   after any of the

118

above settings will cause a change in the default values only. They will be reset as requested and a beep will sound to confirm the reset. The screen will not be dumped.

Approximately three seconds is allowed after initiation of SCDMP before the default values are assumed. The default values can also be changed at the time of initial load of screen dump, by entering the appropriate changes via the command line, such as

SCDMP xyz < cr >

where x = < B > lue, < R > ed, < G > reen, or < A > ll banks default
      y = < N > ormal or < H > igh density default
      z = < D > ump 25th line, if displayed

This will allow SCDMP to be setup with the proper defaults for your application. Activation would not require the switches after the < SHIFT-F12 >. This makes calling SCDMP from within another program more versatile.

In the event that it is necessary to stop the printing of a screen, entering < ESC > during printing of the screen will abort the dump (a 'Q' can also be used if called from within another program).

SCDMP can be activated from within many popular programs such as Multiplan, ZBASIC, Graftalk, ZDS Business Graphics, Z-Chart, Doodler, CHART, and others. SCDMP will not work with Lotus 123 or Watchword as these programs bypass the MSDOS 'get character' call. SCDMP conforms to the operational 'standard' created by Zenith's PSC.ASM, except that both graphics and text are reproduced.

B. REQUIREMENTS

This program requires the ZDOS/MSDOS operating system (Version 1.25 or higher) on a H/Z-100 computer. The printers currently supported for U. S. Government use are the Epson MX/RX/FX Series with Graftrax, the Okidata Microline 83A, and Zenith/MPI 99/150 Series.

C. DISTRIBUTION FILES

The following files are included on the distribution disks of SCDMP. Documentation for operation and modification of the programs is also included.

SCDMP   .DOC Screen Dump information

SCDMPEPS.COM Version for Epson MX Series

SCDMPOK2.COM Version for Okidata Microline Series

CDMPMPI .COM Version for Zenith/MPI 99/150 Series

SCDMP   .BAT Batch file for auto load of SCDMP.COM
            (rename the appropriate program to
            SCDMP.COM)

D.   INSTALLING THE PROGRAM

Choose   the   version of the screen dump   required   by   the specific   printer   application.   Rename   the   version   to SCDMP.COM   as follows:

    REN SCDMPxxx.COM = SCDMP.COM

Load the screen dump program into resident memory as follows:

    SCDMP < cr >   or   SCDMP xyz < cr >

A sign-on message will display the version number and the printer application with instructions for dumping the screen. Screen dump instructions will be similar to   the following:

    To dump screen, type: < SHIFT-F12 > fflW"fflX"fflY"fflZ"

            fflW =   < G > reen or < B > lue or < R > ed or < A > ll banks"
            fflX =   < N > ormal or < H > igh density"
            fflY =   < D > ump 25th line"
            fflZ =   < C > hange default settings"

defaults: VRAM bank = A print density = N

To abort dump during printing, type: < ESC >

Typing of < SHIFT-F12 > -W--X--Y--Z- will suspend execution of the current
program, dump the screen to the printer, and return to the current program with no
change.

NOTE: Versions of SCDMP are available for
other printers. Contact Mr. Les Bordelon at
(714) 793-8853 for additional information.

Program Author:
Leslie L. Bordelon
1453 Fernwood Drive
Redlands, CA 92374
714-793-8853

Additional Credits to:

Digital Information Systems (Original Graphics Routines)
Zenith Data Systems (Interrupt-5 Handling from PSC.COM)

APPENDIX H.   ACCESSING THE BRIEFING AID SYSTEM

This file is on the DDN viewer system for accessing the Briefing Aid System. It explains how to configure the information file which must be placed in your DDN directory. The file is titled:

<LEVEL2> USING-TAC-TERMINALS.DOC.3

Using a Graphics Terminal on the TAC
Revised 27-Sep-83

Before attempting to use a Graphics Terminal on a TAC, verify that port to be used is set in "Wild Mode" and "Quiet Mode". These settings must be authorized by the site liaison and executed by the Network Operations Center. Only if "Wild Mode" is enabled will the Graphics System be able to connect to the TAC; if not enabled, the Graphics System will simply minute during Initialization and then return an error (subcode = 64009).

"Quiet Mode" suppresses all messages on the TAC port. This means no "TCP Trying...", "Open", or "Closed" messages should appear when attempting to use the Graphics Terminal as a regular terminal.

Once you have determined that the port is correctly tailored, issue the following commands to the TAC from your Graphics Terminal:

@RESET <return>
>   (Theage similar to:)

@PROTOCOL TCP <return>
>   (This command should no longer be required)

@ECHO HALFDUPLEX
>   (Instructs the TAC not to echo characters)

Use another terminal to login and run your program using the string "DEVICE = (T,RAND-TAC-xxx)" in the INIT command. "xxx" should be the TCP port number, in octal, of the graphics terminal on the TAC. TCP port numbers may be calculated from the terminal port number in the herald after the RESET command (in the above case, the terminnumber is 3).

Terminal Port Number	TCP Port Number (Octal)
1	427
2	1027
3	1427
4	2027
5	2427
6	3027
.	.
.	.
.	.
p	$256 * p + 23$
	(expressed in octal)

For example, to run your program on a Tektronix connected to terminal port 4 on CCA-TAC use the initialization string:

BACKEND = (TEKTRONIX),DEVICE = (T,CCA-TAC-2027)

When you're done using the Graphics Terminal, you may have reset Echoing on the TAC porCHO REMOTE

APPENDIX I.   SAMPLE MAPS GENERATED BY LO-CO-GRAF AND THE BRIEFING AID SYSTEM

The following cartographic products were displayed by the LO-CO-GRAF terminal emulation system using the Briefing Aid System for map generation. The maps were transferred from USC-ISI via DDN to a Z-100 microcomputer and then printed on an Epson-equivalent dot matrix printer using a screen dump routine. Examples of maps and charts printed under these options are listed in Table 3.

Table 3.   GUIDE TO LO-CO-GRAF MAPS

Map Title	Page
Airroutes.GPX	37
North-West Europe	38
Atlantic Ocean and Caribbean Sea	125
Mediterranean Sea	126
Tyrrhenian Sea	127
North Sea	128
English Channel with political boundaries	129
Straits of Hormuz	130
Ethiopian Conflict	131
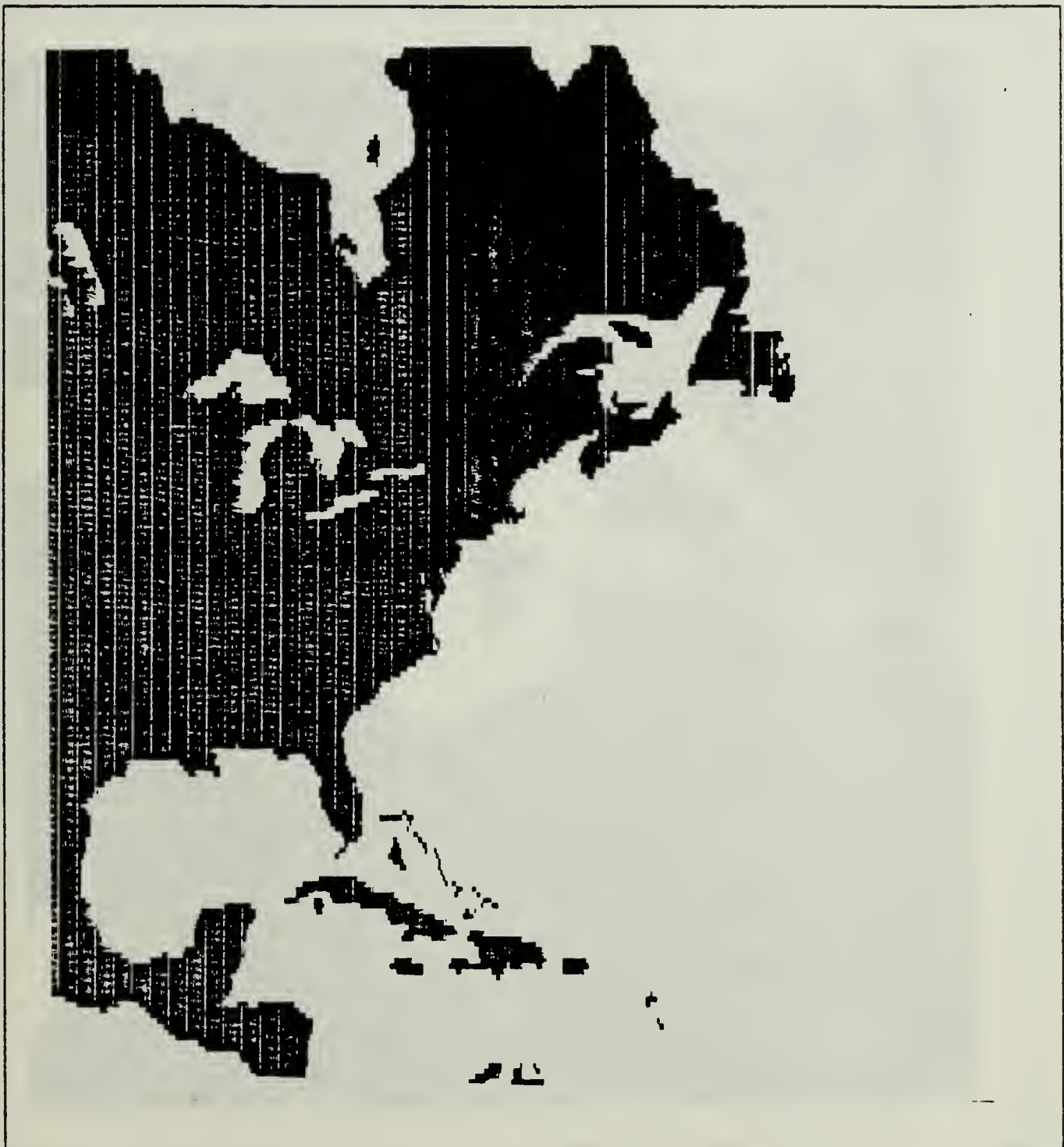
Figure 13.   Atlantic Ocean/Caribbean Sea (solid landfill)
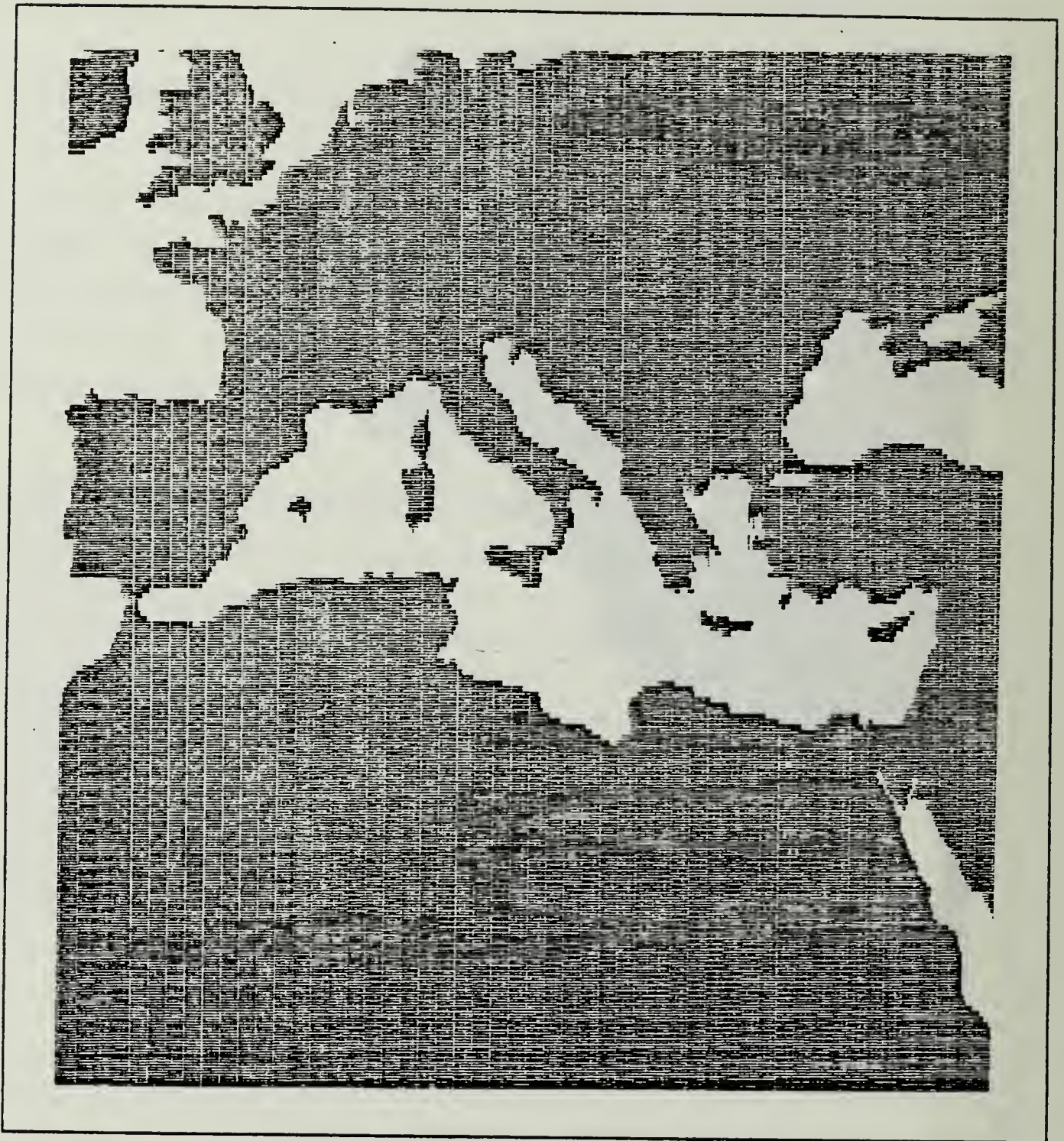
Figure 14. Mediterranean Sea (solid landfill)

Figure 15. Tyrrhenian Sea (solid landfill)

127

Figure 16.   North Sea (solid landfill)

Figure 17. English Channel (political boundaries)

129
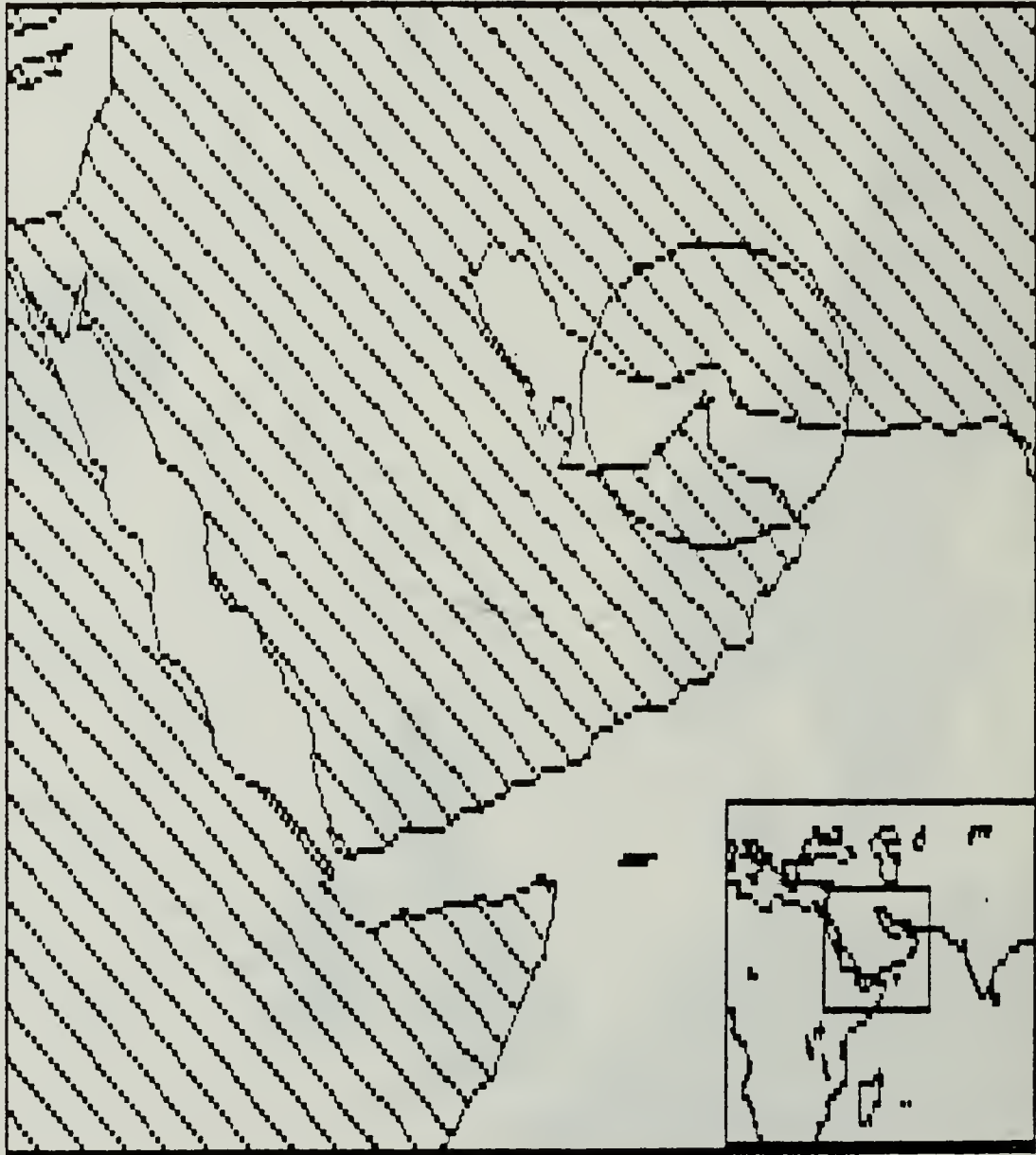
Figure 18.   Straits of Hormuz (Russian version)
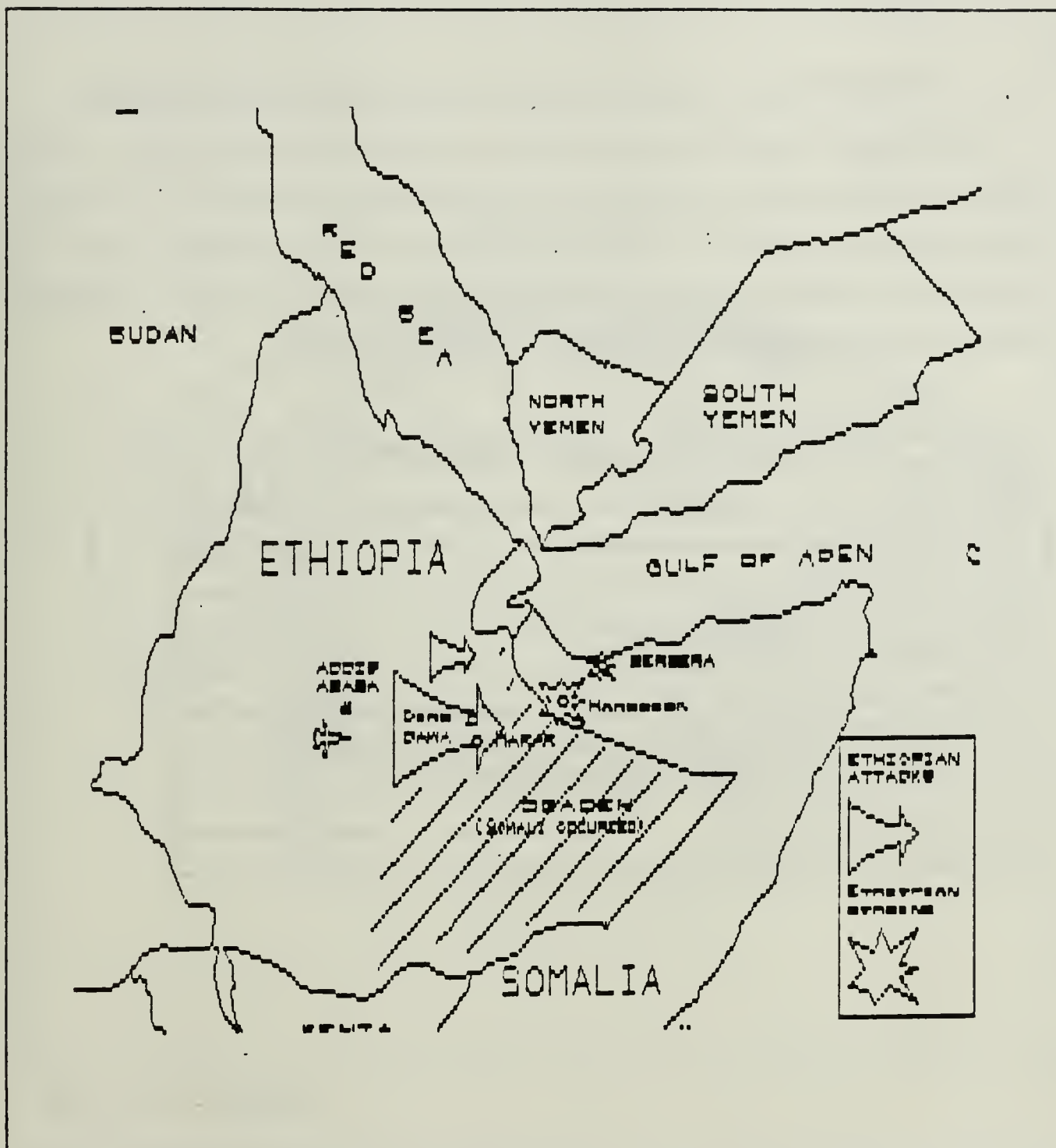
Figure 19.   Ethiopian Conflict (tactical map)

APPENDIX J. SAMPLE MAPS GENERATED BY DISSPLA

The generated maps for the major systems described in this thesis follow. The differences in line thickness is a function of the printer being used and does not reflect on the cartographic resolution. These maps were generated by DISSPLA version 10.2 World Coast Utilities Option and printed by an IBM 3800 laser printer. Examples of maps and charts printed under these options are listed in Table 4.

Table 4.   GUIDE TO DISSPLA GENERATED MAPS

Map Title	Page
Washington, DC	18
North-West Europe	39
World Mercator Projection	133
Cape Canaveral/Kennedy Space Center	134
Carribean Operating Area	135
Mediterranean Operating Area	136
Japan and the Kurile Islands	137
Northern Flank of NATO	138
North and South America	139

THE WORLD

90° N

60° N

30° N

0°

30° S

60° S

90° S

DISSPLA MAP
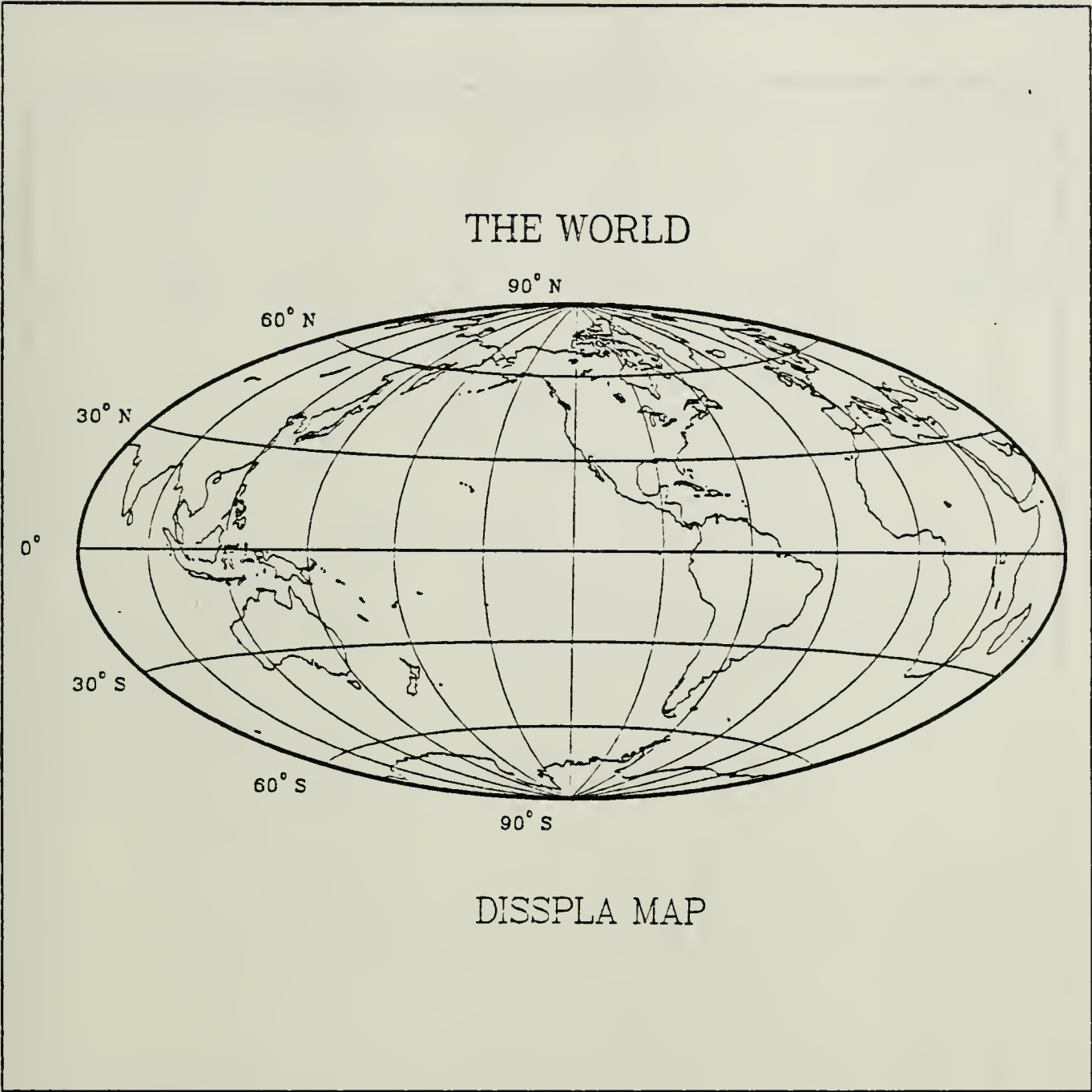
Figure 20.   World Map

133
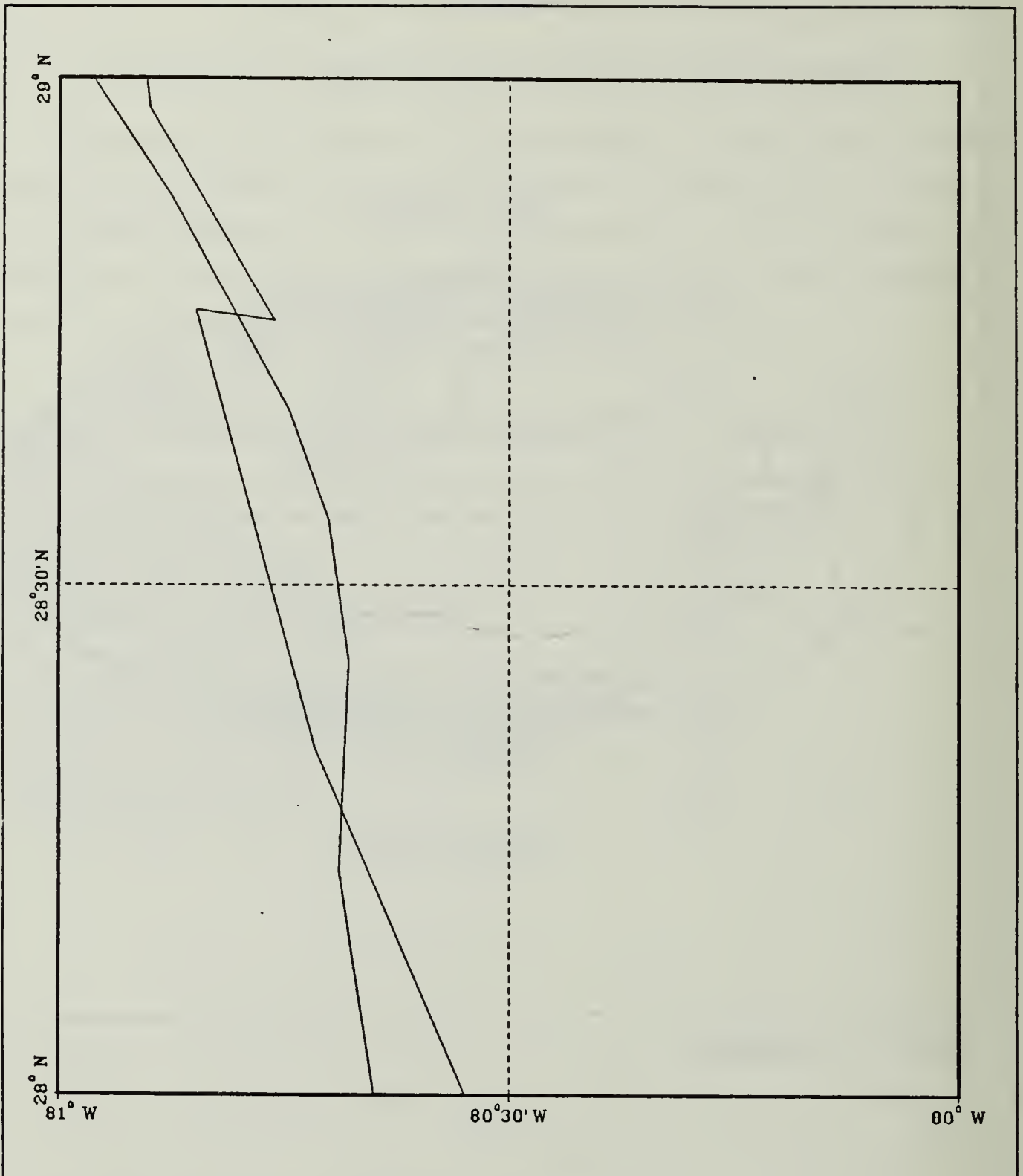
Figure 21.   Cape Canaveral/Kennedy Space Center Area

134

Figure 22.   Caribbean Sea

MEDITERRANEAN SEA
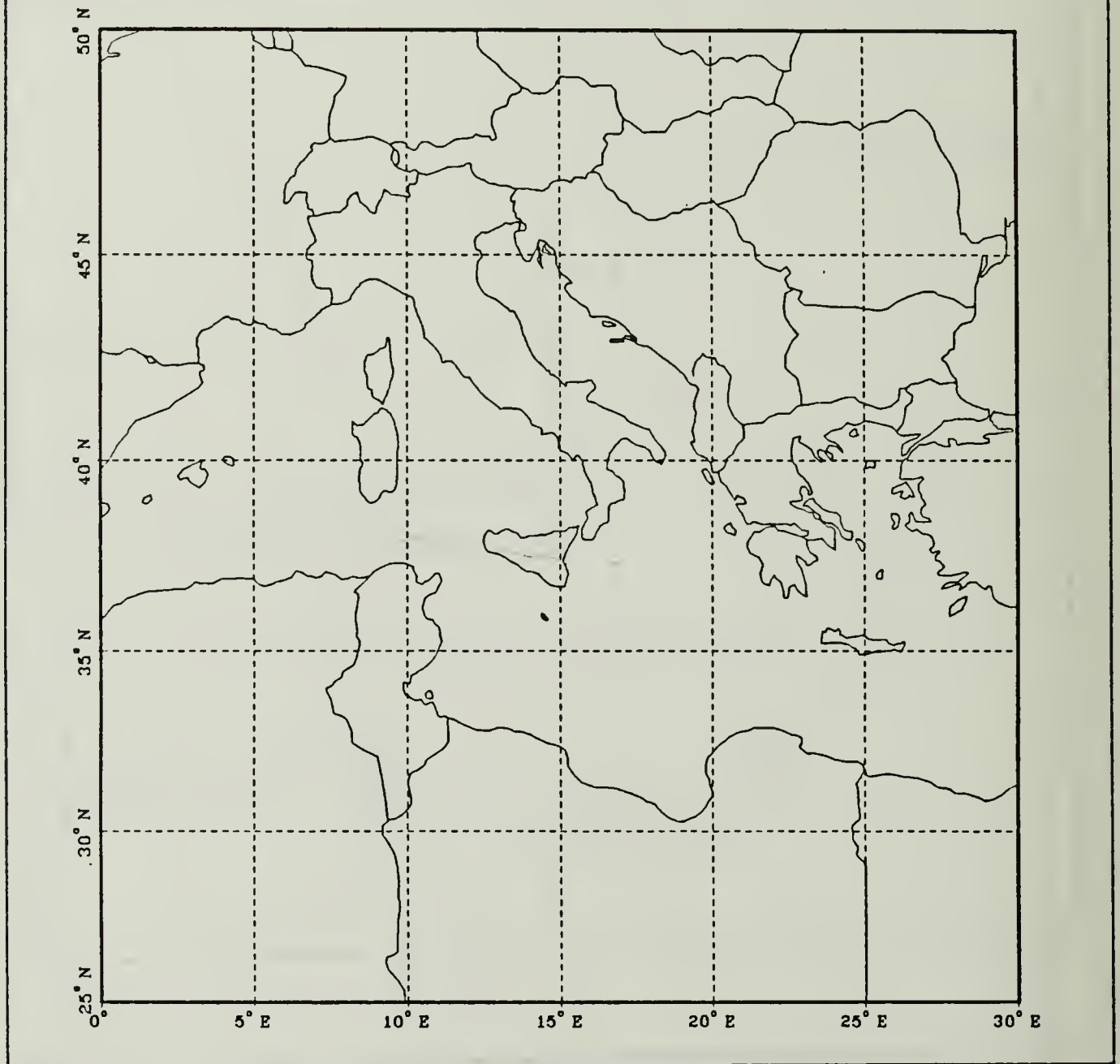
Figure 23.   Mediterranean Sea
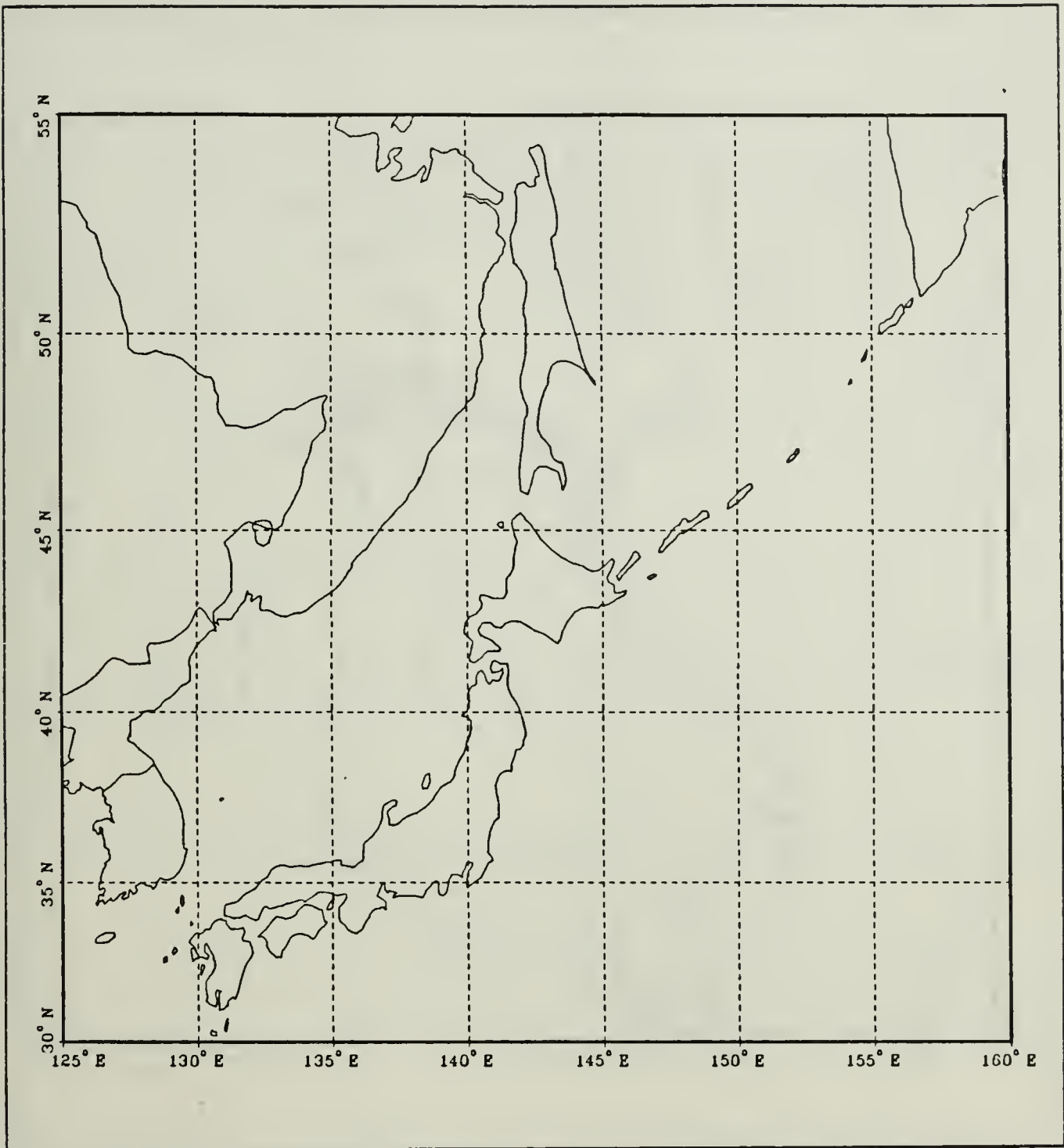
Figure 24.   Japan and the Kurile Islands
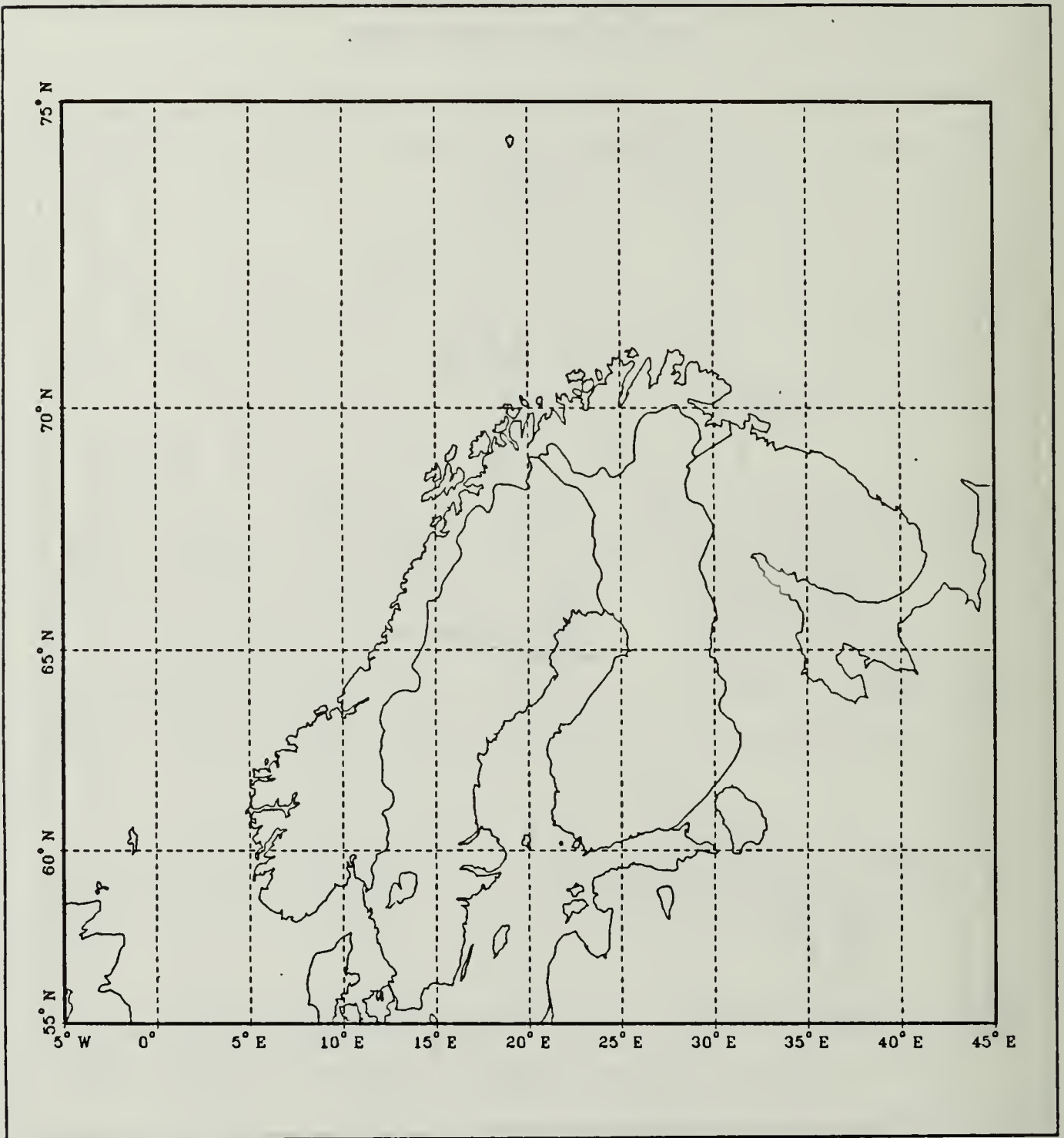
Figure 25.   Northern Flank of NATO
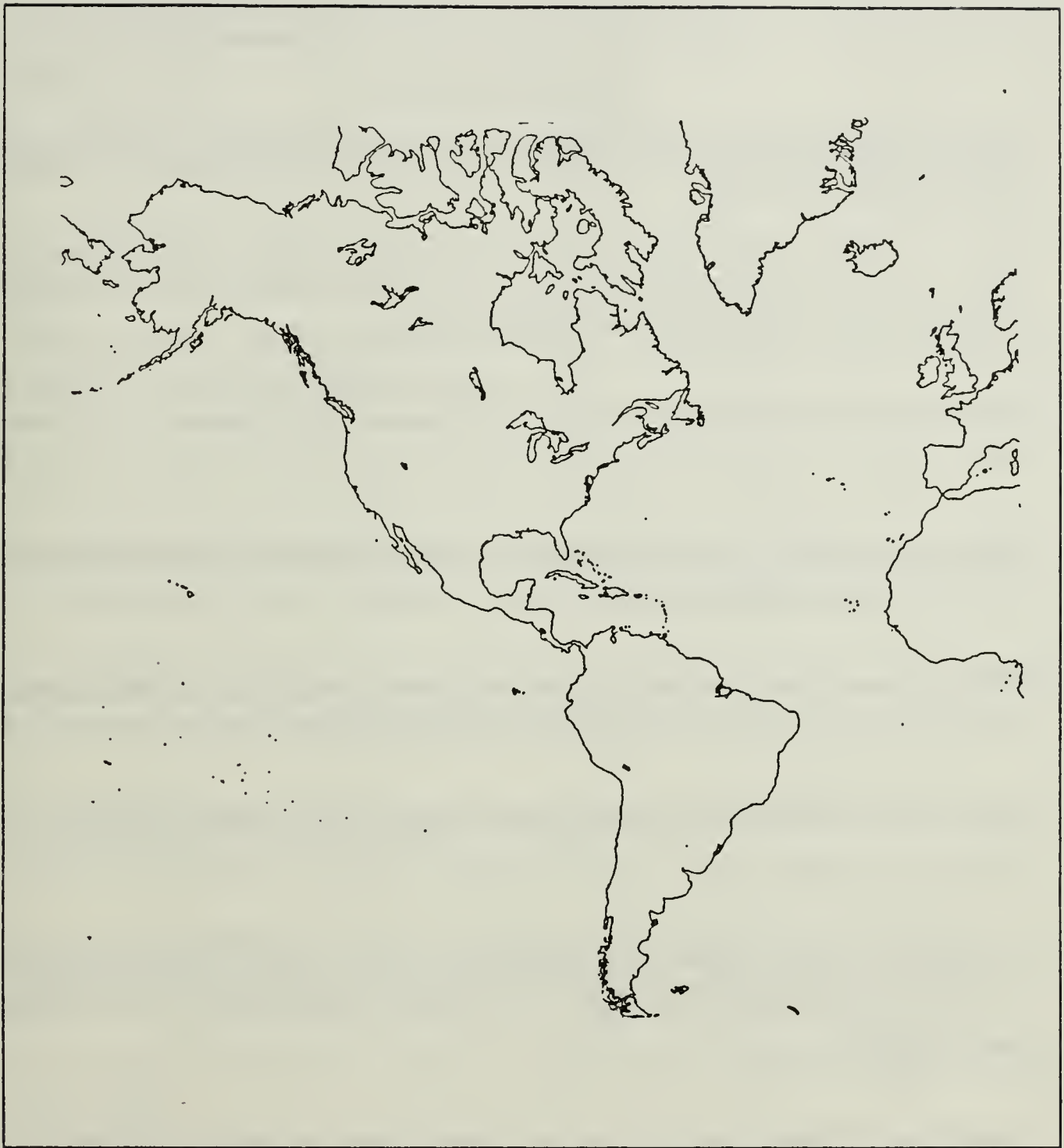
Figure 26.   North and South America

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143

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