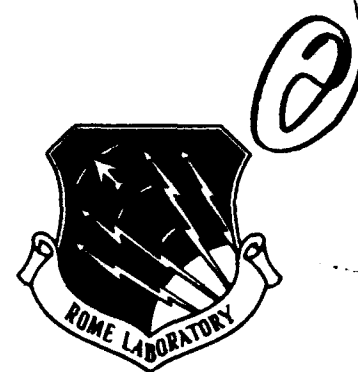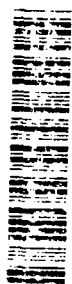AD-A270 954

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RL-TR-93-139, Vol II (of two)
Final Technical Report
July 1993

IMPROVED HF DATA NETWORK SIMULATOR, Software User's Manual

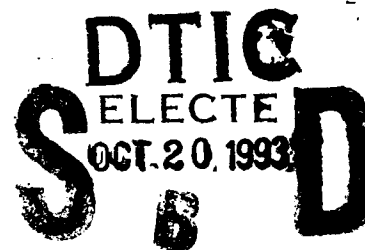Harris Corporation

Marvin C. Baker

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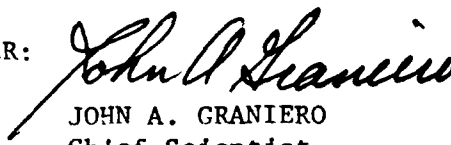
Rome Laboratory
Air Force Materiel Command
Griffiss Air Force Base, New York

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13. ABSTRACT (Maximum 200 words) This effort advances the state-of-the-art in networking for both data/voice communications in the HF (2- 30 MHZ) band. This is contained in a PC portable simulation called the Improved HF Data Network Simulator (INS). INS algorithms emphasize a decentralized, distributed architecture and interoperability for both military and civilian air-land-sea mobile users. Up to 100 users are contained in up to 10 nets that make up one network. The intended radii for the nets/network are 400 and 4000 miles respectively.
Technical issues addressed are improved HF networking, LQA techniques, LPD/LPE waveforms for OPSEC, and frequency hop (FH) frequency management. The INS provides the means for configuring a network to any user's protocols/architectures with node, path and network results available over the 24 hour time period of the propagation model (IONCAP).
To receive the INS, you must complete a STATEMENT OF TERMS AND CONDITIONS FOR RELEASE OF USAF OWNED DEVELOPED SOFTWARE. Contact the RL program manager to obtain this.
A Phase II effort titled "Adaptive Network Controller (ANC)" will put the Phase I algorithms into use on real-time over-the-air HF networks to demonstrate the improvement in HF communications.

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TABLE OF CONTENTS

1 Scope

1.1 Identification

This document is the Improved HF Data Network Simulator Software Users Manual. It applies to software Version 2.1.

1.2 System Overview

The Improved HF Data Network Simulator (INS) software is designed to be a tool that can be used to determine the probable effects of various parameters on the performance of a given HF communications network. The software resides on a PC compatible computer with an EGA color monitor and a Microsoft compatible mouse. The user specifies the network configuration to be simulated. The software simulates the network, based on the user's input, and provides results indicating expected network performance.

1.2.1 Network Configuration

The user enters global network parameters and nodal parameters through the user's interface. Once the network configuration nas been entered, the user may save the configuration in a *.net file or run the simulation. The *.net file is an ASCII text file which may be viewed with the DOS Type command or through other text editors.

1.2.2 Simulation

The user may simulate a new network configuration, a previously defined and stored network configuration, or a modified version of either. Prior to simulation, the network is checked for the inclusion of the necessary parameters. The simulator generates a listing of the best paths for message transmission, simulates the network with different path combinations and message allocation methods to determine the optimized transmission topology.

1.2.3 Results

Once the simulation has been completed, the user is able to view the primary nodal, path, and network results through the user's interface. Additional results are available in ASCII text files for viewing using the DOS Type command or through the use of other text editors.

1.3 Document Overview

The remainder of this document is organized into the following sections:

- Section 2 lists the documents referenced in this document.

- Section 3 describes the process of using this software.

- Section 4 lists the error messages which may be produced by the software.

- Section 5 contains the general background information which will aid in the understanding this manual. Included in this section is a glossary and a list of acronyms.

2 Referenced Documents

DOS Manual - Dependent on the host machine and the installed Disk Operating System.

Ionospheric Communications Analysis and Prediction Program User's Manual

Software Design Document - Improved HF Data Network Simulator (INS)

3 Using the Improved HF Data Network Simulator

3.1 System Requirements

The system requirements are as follows:

- PC compatible computer with 640K of user memory at a minimum.

- EGA display adapter and monitor.

- Mouse
    - Microsoft compatible bus or serial mouse
    - Microsoft Driver
    - Mouse Systems compatible serial mouse

- Hard disk recommended
    - 345 KBytes of disk space is required for INS executable and image files.
    - 1.5 MBytes of disk space is required for the network configuration file, results data files, and text files for a single 2 hour interval simulation of a network with approximately 70 nodes and 70 source/destination pairs.
    - Additional 2 hour simulations require 155 KBytes each, for data files only, for the same network.

    - TOTAL DISK REQUIREMENTS = 3.5 MBytes for a 24 hour simulation of a network with 70 nodes and 70 source/destination pairs.

3.2 Setup

The three files, INS.EXE, NET.PCX, and WORLD.PCX, are required to execute the simulator. The simulator can be executed from a floppy disk, but the use of a hard disk is recommended. If a floppy disk is used, it should be a High Density drive as additional disk space is required for the *.net network configuration files and the simulation results files. The use of a hard disk will greatly increase execution speed of the user's interface and generally offer greater available disk space. An EGA monitor and mouse are required for and must be installed prior to execution. Keep in mind that all disk activity, such as file loading and storage, occurs in the directory or subdirectory in which the software resides.

Please review the file README.DOC prior to installation or execution. Installation assistance is provided in the README.DOC ASCII text file as are other changes to the INS software package made after this manual was completed.

3.3 Execution

Once the system is powered and DOS has been installed, the files INS.EXE, NET.PCX, and WORLD.PCX, may be placed in the directory or subdirectory desired. DOS commands may be used to install INS on a work disk or the user may type
"INSTALL <source disk>: <destination disk>:". INSTALL will create a subdirectory on the <destination disk> labeled INS. The files required to execute INS will be placed in the subdirectory and INS will be executed. If DOS commands are used to install INS or INS is already installed on a work disk, type INS at the DOS prompt to execute INS.

Again, all disk activity will occur in the chosen directory once the simulator has been executed.

INS automatically determines the type of mouse installed in the system. Due to incompatibilities with PC clones, INS may not properly identify the installed mouse. If problems occur using the mouse, terminate execution of INS and re-start INS by typing INS, followed by a <SPACE>, and one of the following commands dependent on the type of mouse installed:

Command	Mouse
/1	Mouse Systems Mouse, Comm1
/2	Mouse Systems Mouse, Comm2
/M	Microsoft Mouse, Bus version
/M:1	Microsoft Mouse, Serial, Comm1
/M:2	Microsoft Mouse, Serial, Comm2
/M:D	Microsoft Mouse Driver, Bus, Serial or compatible

The first two screens are the title screen and the rights legend. Each of these screens are removed by pressing any key. Now the software is ready to perform network simulations.

3.4 Menu Descriptions

All pull-down menus are viewed by placing the mouse pointer in the desired menu title box, as shown in Figure 1. All menu choices are selected by pressing the left mouse button when the mouse pointer is in the desired choice's title box.

3.4.1 Main Screen

3.4.1.1 Options Menu

Figure 1 - Main Screen/Options Menu

New

The Options menu choice New allows the user to generate a new network configuration. The user is prompted for the name of the new network and the network name will be displayed in the upper right hand corner message box. All other software functions, including parameter entries, will now pertain to this new network.

Load

The Options menu choice Load allows the user to load a previously defined network configuration file (*.net) from disk. All other software functions will now pertain to the loaded network configuration.

Quit

The Options menu choice Quit allows the user to exit the simulator and return to the DOS environment. The user will be prompted whether to save the current network configuration in a *.net file. SAVING THE FILE IS RECOMMENDED as without the network configuration file simulation results will not be available for viewing while running INS. All simulation results are automatically saved during simulation.

3.4.1.2 Parameter Menu

The Parameter menu, as shown in Figure 2, is not available until a new or loaded network configuration has been specified through the Options menu.
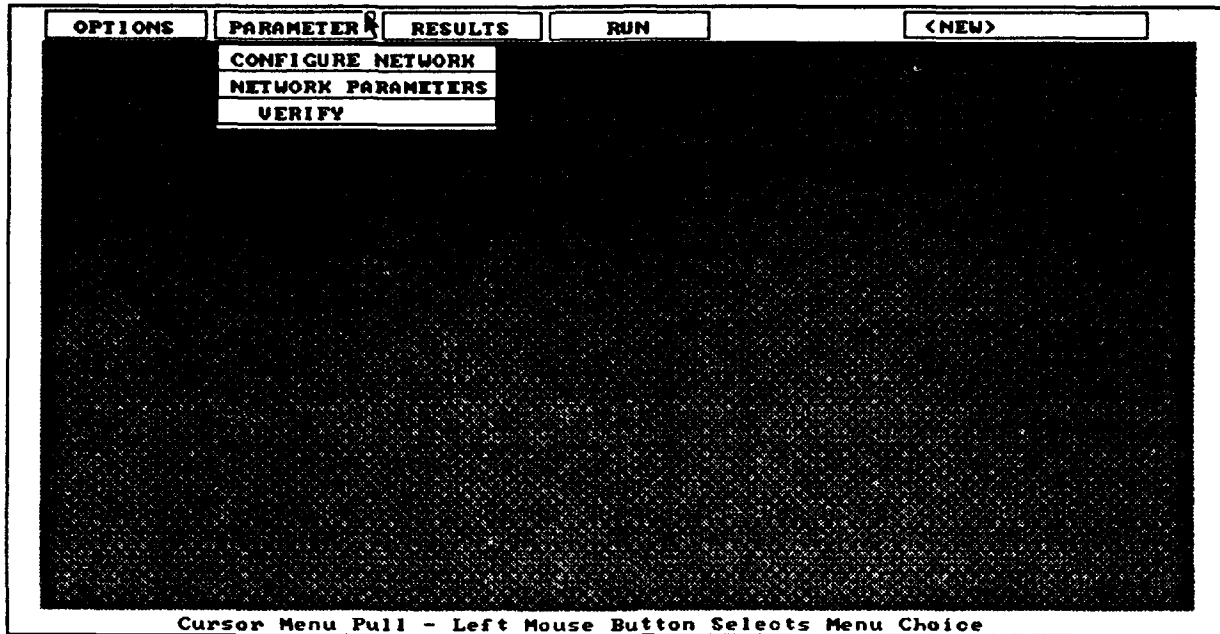
Figure 2 - Main Screen/Parameter Menu

Configure Parameters

The Parameter menu choice Configure Parameters allows the user to enter, view, and edit nodal parameters. These parameters are discussed in detail in the section Specifying Parameters.

Network Parameters

The Parameter menu choice Network Parameters allows the user to enter, view, and edit the global network parameters. These parameters are discussed in detail in the section titled Specifying Parameters.

Verify

The Parameter menu choice Verify checks the current network configuration to insure that the parameters necessary for simulation have been specified. Error messages are displayed indicating the missing parameters. The Verify choice does not check the global network parameters as default values are provided. The Verify choice does check the nodal parameters as default values are not provided for all necessary parameters. Additional parameter information is provided in the section titled Specifying Parameters.

3.4.1.3 Results Menu

The Results menu, as shown in Figure 3, is not available until a new or loaded network configuration has been specified through the Options menu.
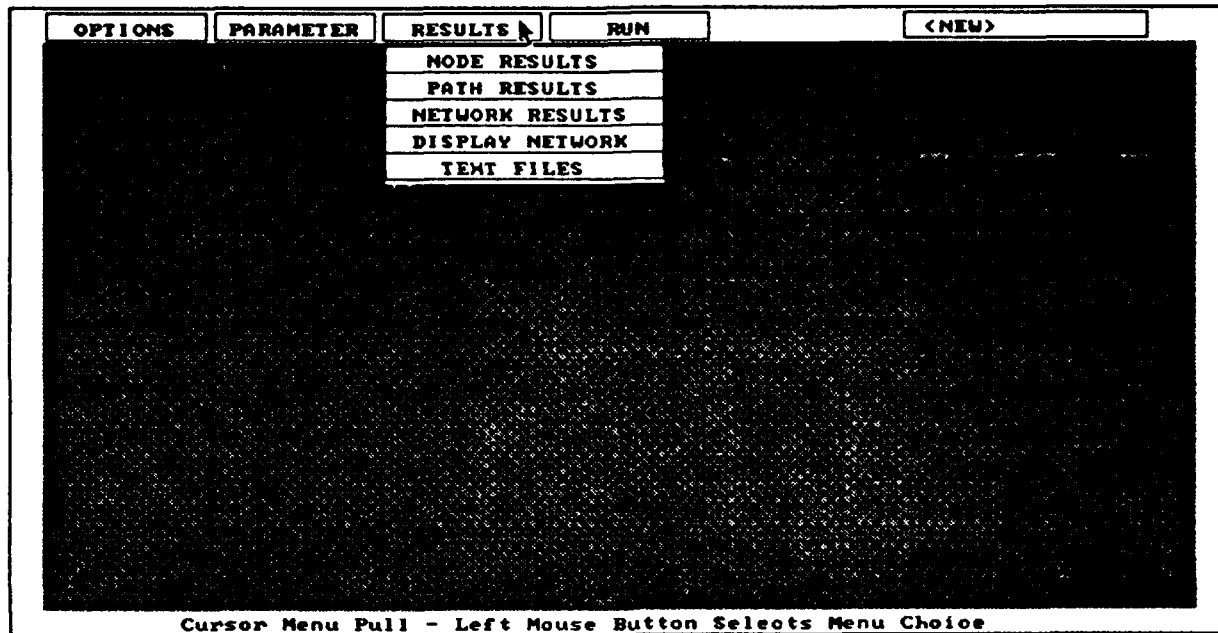
Figure 3 - Main Screen/Results Menu

Node Results

The Results menu choice Node Results displays the node results for a simulation of the current network. The user is prompted for the time interval (2..24 in 2 hour increments) to be displayed. A list of the network's nodes is provided and the user may select a node by placing the mouse pointer on the desired node and pressing the left mouse button.

Path Results

The Results menu choice Path Results displays the path results for a simulation of the current network. The user is prompted for the time interval (2..24 in 2 hour increments) to be displayed. A list of the network's source/destination pairs is provided and the user may select a pair by placing the mouse pointer on the desired pair and pressing the left mouse button.

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Network Results

The Res lts menu choice Network Results displays the network results for a simulation of the cui nt network. The user is prompted for the time interval (2..24 in 2 hour increments) to be displayed.

Display Network

The Results menu choice Display Network draws the world map, draws lines connecting all of the nodes that have message flows between them, and displays the node names. The node names are yellow when no message loss is occurring at the node and are red when message loss is occurring at the node.

Text files

The Results menu choice Text Files changes results data files into ASCII text files. This allows the results to be viewed by the user using the DOS Type command or through other text editors. The user is prompted for the time interval (2..24 in 2 hour increments) to be converted.

3.4.1.4 Run

The Run title box begins simulation. There is no menu associated with the Run title box.

3.4.2 Node Edit Screen

The Node Edit Screen is entered by selecting the Parameter menu choice Configure Parameters from the Main Screen. Once selected, the world map will be displayed, as shown in Figure 4, in addition to the Node and Save menu title boxes.
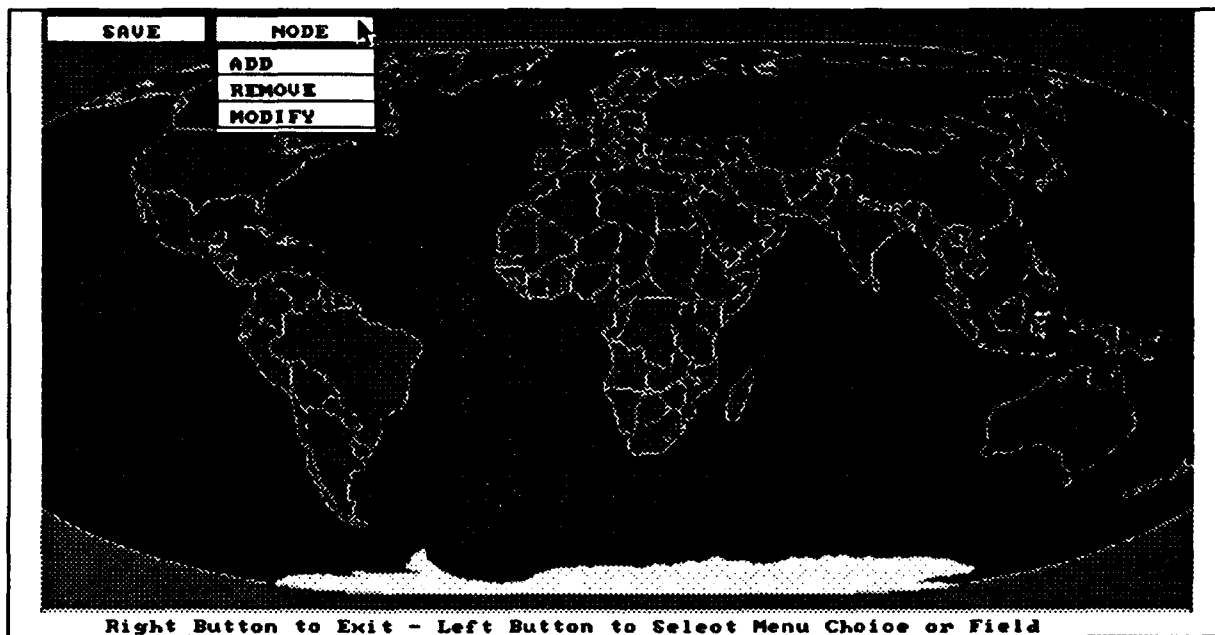
Figure 4 - Node Edit Screen/Node Menu

3.4.2.1 Node Menu

Add

The Node menu choice Add allows the user to add nodes to the network configuration. The user is prompted for the name of the new node. Having entered the new node's name, the node's default parameters are displayed for the user to edit. Node parameters are discussed in detail in the section titled Specifying Parameters.

Remove

The Node menu choice Remove is used to delete previously specified nodes. If the node is a destination for messages from a source node, that source node must be modified so that it no longer sends messages to the node being removed. Until that modification occurs, the removal of the desired node is prevented.

Modify

The Node menu choice Modify allows the user to modify the parameters of a previously specified node. The user is prompted for the name of the node to be modified. Having entered the node's name, the node's parameters are displayed for editing.

3.4.2.2 Save

The Save title box prompts the user for a save file name and saves the current network configuration in a *.net file. When entering large network configurations, periodic saves are recommended to prevent the loss of the complete network configuration due to conditions such as power loss.

3.5 Specifying Parameters

3.5.1 Parameter Descriptions

3.5.1.1 Network Parameter Descriptions *

Parameter	Description
Total Number of Nodes	Number of nodes allowed in the network. Range: 2 - 100
Sun Spot Number	Sun spot number to be used when finding a link SNR in the IONCAP table.
Month	Month to be used when finding a link SNR in the IONCAP table.
Channel Type	Channel type Good, Moderate, or Poor as defined for Fading-Multipath. Used when finding BER from Modem BER table.
Channel Rank	Determines whether the 1st(best), 2nd(2nd best), or 3rd(3rd best) SNR is used from the IONCAP table.
LQA Knowledge	Not currently used.
LQA Uncertainty	Not currently used.
Global Arrival Rate	Not currently used.
Traffic Length	The number of bits per message. Range: 1 - 10,000
Acknowledgement Length	The number of bits per acknowledgement. Range: 1 - 10,000
Transmit Power Level Reduction	Network transmit power level reduction in dB, with 0 = 1KW. Range: 0 - 30

Noise Power Level Increase	Network receive noise level increase in dB. Range: 0 - 30
Quality of Service	Priority in selecting paths and determining network performance (1 - low delay, 2 - high reliability, 3 - LPD/LPE, 4 - high throughput).
Max Net Number	The maximum net number, starting from 1, to which a node may be assigned. Range: 1 - 10
Inter-net Linking Delay	The expected linking delay, in seconds, for a node to link with another node which is in a different net. Range: 0 - 32,000
Intra-net Linking Delay	The expected linking delay, in seconds, for a node to link with another node which is in the same net.Range: 0 - 32,000

* Applies to every node in the network.

3.5.1.2 Nodal Parameter Descriptions

Parameter	Description
Latitude	Latitude in degrees. Range: 0 - 90
Longitude	Longitude in degrees. Range: 0 - 180
Net Number	The number of the net the node is assigned to. Range: 1 - 10
Message Generation Rate	Not currently used.
Traffic Bit Rate	The maximum rate, in bits per second, at which the modem can operate. Valid Entries: 75, 150, 300, 600, 1200, 2400
Transmit Power Level Reduction	The transmit power level reduction at each node, in dB. This reduction is in addition to any that was specified for the network parameters. Range: 0 - 30
Receive Noise Level Increase	The receive noise level increase at each node, in dB. This is an additional increase to that specified for the network parameters. Range: 0 - 30
Number of Destinations	Total number of nodes that messages are being sent to. Range: 0 - 99
Destination Node Name	Name of a node that messages are being sent to. (1 - 3 characters)
%Msg for this Destination	Percent of Message Generation Rate being sent to a given destination node. Range: 1 - 100

3.5.2 Entering Parameters

Before entering any network or nodal parameters, the network being worked on must be specified. That network may be a new network or a network that was saved to disk from a previous session. To specify a network to be developed or edited, the Options menu choices New or Load are used. The user will be prompted for a network name for New or will be given a list of the first 15 *.net files found on disk in the current directory. Once a network has been chosen, the network's parameters may be edited.

3.5.2.1 Network Parameter Entry

The Parameter menu choice Network Parameters allows the user to view and edit the global network parameters. Place the mouse pointer on the Parameter menu title box to view the menu's choices. Select the choice Network Parameters by placing the mouse pointer in the Network Parameters choice title box and pressing the left mouse button.

Figure 5 - Network Parameter Entry Screen

The Network Parameters window is now displayed, as shown in Figure 5, allowing editing of the global network parameters. To select a parameter to be edited, place the mouse pointer over the current parameter value and press the left mouse button. Enter the value desired and press the ENTER key. If the value is out of range, an error message will be displayed indicating acceptable values and the input will be discarded.

To exit global network parameter entry, hit the right mouse button.

3.5.2.2 Nodal Parameter Entry

The Parameter menu choice Configure Network allows the user to enter, view, and edit nodal parameters. Place the mouse pointer on the Parameter menu title box to view the menu's choices. Select the choice Configure Network by placing the mouse pointer in the Configure Network choice title box and pressing the left mouse button.

The Node Edit Screen is now displayed. The world map is shown along with previously specified nodes. Place the mouse pointer over the Node menu title box to view the menu choices.
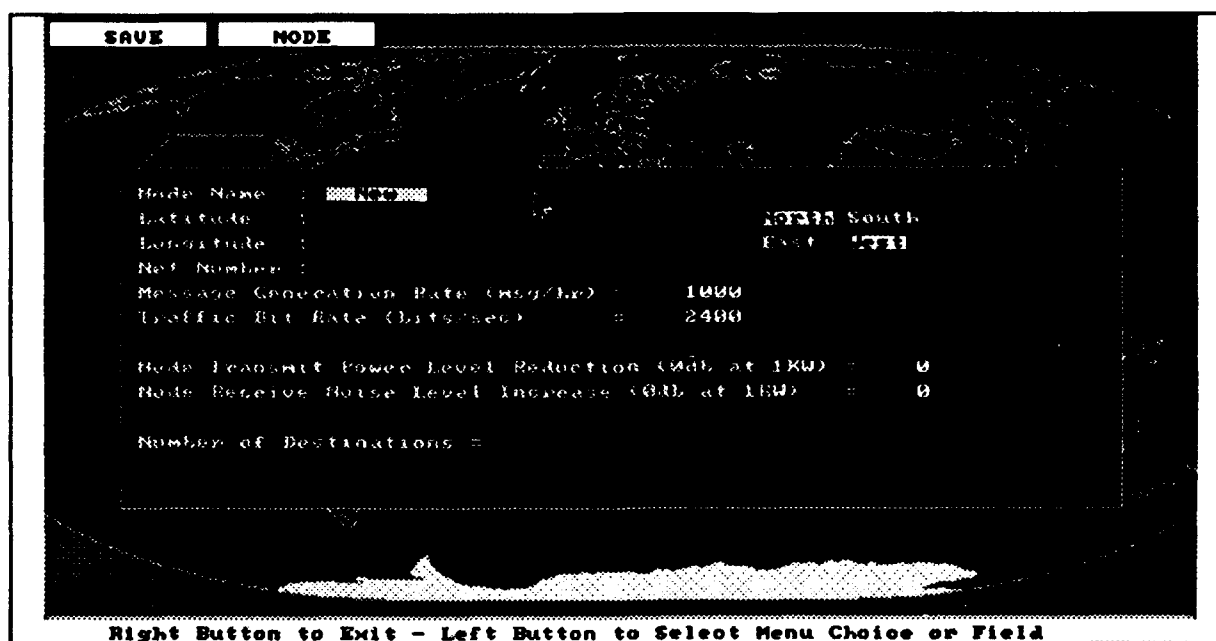
Figure 6 - Node Parameter Entry Screen

Add

To add a node, select the choice Add by placing the mouse pointer in the Add choice title box and pressing the left mouse button. A prompt will appear requesting the name of the new node. The node name can be between 1 and 3 characters (names are case sensitive). Once the name has been entered, press the ENTER key. The node's default parameters are now displayed, as shown in Figure 6, for viewing and editing. To select a parameter to be edited, place the mouse pointer over the parameter value and press the left mouse button. Enter the value desired and press the ENTER key. If the value is out of range, an error message will be displayed indicating acceptable values and the input will be discarded.

When editing the Number of Destinations parameter, the destination entry screen, as shown in Figure 7, is displayed. The value of the Number of Destinations parameter is calculated automatically after the destination screen is edited.

Figure 7 - Node Parameter Entry/Destination Entry Screen

To enter destinations, select the Number of Destinations parameter by placing the mouse pointer on the Number of Destinations value location and pressing the left mouse button. The destination entry screen will now be displayed. The mouse pointer is no longer displayed but rather asterisks are used to show cursor location. First, the destination to be added, modified, or removed is selected by entering the destination's name and pressing the ENTER key. The cursor is now at %Msg for this Destination parameter. The user enters the percent of the Message Generation rate to be sent to this destination. The user may now choose to add the destination (add and modify are treated as an add), or remove the destination. Prior to executing the destination change, the user is prompted as to whether viewing the destination list is desired. All default responses are listed in parenthesis.

When viewing destinations, the user can press the right mouse button to view more (only when the number of destinations is greater than 10), the ENTER key to return to the start of the list, or the left mouse button to view the current page while returning to the destination entry window.

As with previous parameter editing, the current parameter entry screen may be exited by pressing the right mouse button.

Remove

To remove a node, select the Node menu Remove choice as was described for adding a node. The user will be prompted for the name of the node to be removed. If the node is specified as a destination for a source node, an error message will appear indicating the source node, and the removal of the node will not be allowed until it is no longer a destination.

Modify

To modify a node, select the Node menu Modify choice as was described for adding a node. All parameters may now be edited as described for the Add node choice.

Exit

Press the right mouse button to leave the Node Edit Screen and return to the main menu.

3.6 Simulation

Once the network configuration has been developed, the network can be simulated. To simulate the network, select the Run title box from the Main Screen by placing the mouse pointer in the title box and pressing the left mouse button.

The user will be prompted to choose a number between 1 and 32,767. This number is a factor in determining the selection of nodes visited for paths greater than one hop. The actual selection depends on many factors, such as the number of nets, but choosing the same number with a given configuration will always produce the same results. For those familiar with random number generators, this number is a random number generator seed. Enter the number by typing the value followed by the ENTER key.

Next, the network will be reviewed to confirm that all necessary parameters have been entered. This check is identical to the Parameter menu Verify choice. Some of the error messages are warnings in that they will not prevent simulation, others will prevent simulation. For further discussions of error messages see section 4.
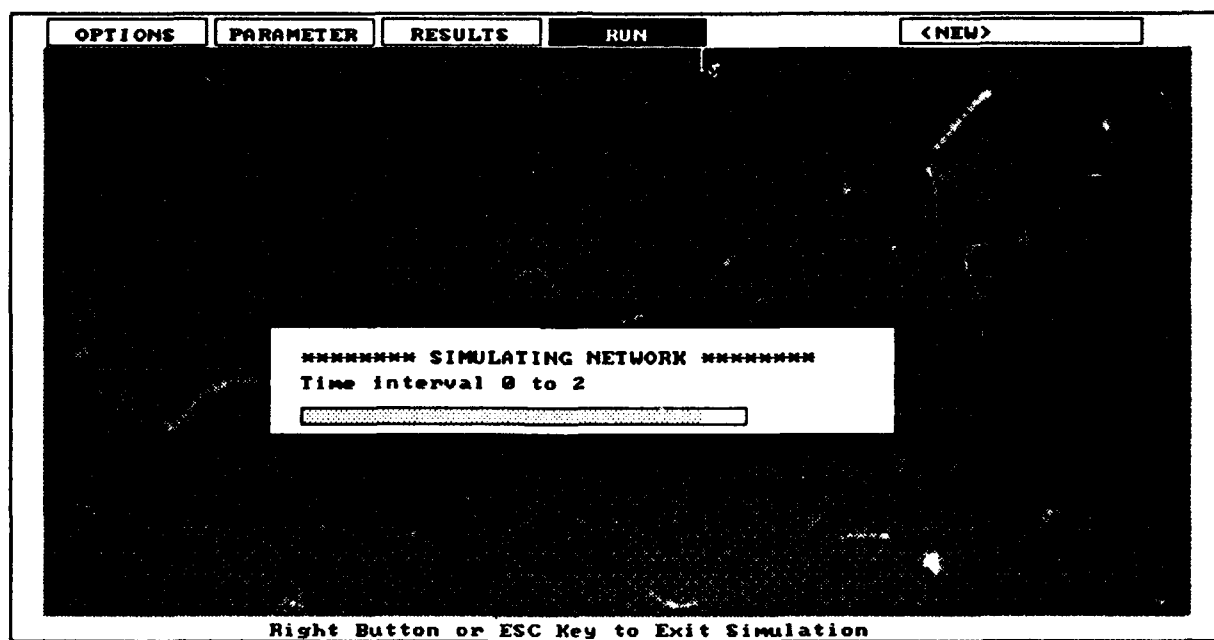
Figure 8 - Simulation "barometer"

Once Verify is complete, the test paths are generated and the simulation begins. A "barometer", as shown in Figure 8, is given to indicate the progress of the simulator. The barometer represents the time required to simulate the network for a 2 hour interval. By pressing the right mouse button or the escape key, the simulation may be terminated following the completion of the current 2 hour simulation. If allowed to continue, the simulator will simulate all twelve 2 hour intervals for a total of 24 hours.

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3.7 Simulation Results

3.7.1 Results Descriptions

3.7.1.1 Node Results Descriptions

Result	Description
Inflow rate	Rate of data flow into the node. Units: Bits/Sec
Outflow rate	Rate of data flow from the node to other nodes. Units: Bits/Sec
Inter net outflow rate	Outflow rate from the node to nodes in a different net. Units: Bits/Sec
Intra net outflow rate	Outflow rate from the node to nodes within the same net. Units: Bits/Sec
Source rate	Rate at which data originates at the node. Units: Bits/Sec
Termination rate	Rate at which data terminates at the node. Units: Bits/Sec
Throughput	Rate at which data flows through the node. Units: Bits/Sec
Composite Bit Rate	Mean rate at which data is transmitted Units: Bits/Sec
Error rate	The error rate from the node to all other nodes. Units: Probability of a Bit Error
Missed message ratio	Expected number of times a message must be sent. Units: None
Adjusted length	The effective message length. Units: Bits/Message

Service demand	Total data attempting to flow from the node. Units: Bits/Sec
Intensity	Fraction of the Modem's bit rate capacity being used. Units: Percent
Linking delay	Average time for the node to link with another node. Units: Seconds/Message
Delay	Time between receiving and sending a message for a node. Units: Seconds/Message
TX data loss	Aggregate rate of data loss at the node. Units: Bits/Sec

3.7.1.2 Path Results Descriptions

Result	Description
Delay	Average time spent sending a message from the source node to the destination node. Units: Seconds/Message
TX data loss	Average rate of data loss from the source node to the destination node. Units: Bits/Sec
Remaining TX Capacity	Additional transmit capacity available from the source node to the destination node. Units: Bits/Sec
LPE/LPD	Average SNR from the source node to the destination node. Units: dB

3.7.1.3 Network Results Descriptions

<u>Result</u>	<u>Description</u>
Path combination	The 5 best paths are saved when creating paths and 3 of those 5 are chosen to send messages through. Each number in the result represents one of the 3 paths (eg - 123 means paths 1, 2, and 3 were chosen).

Allocation method	A - Messages are allocated equally to each of 3 paths.
	B - 50% of messages are allocated to path 1.
	   30% of messages are allocated to path 2.
	   20% of messages are allocated to path 3.
	C - All messages are allocated to the best path of 3.

Source rate	Rate at which data originates for the entire network. Units: Bits/Sec
Termination rate	Rate at which data terminates for the entire network. Units: Bits/Sec
Reliability	Source rate divided by termination rate for entire network. Units: None
Average delay	Average message delay for the network. Units: Seconds/Message
Remaining TX Capacity	Additional transmit capacity available for the network. Units: Bits/Sec
LPE/LPD	Average SNR for the network. Units: dB

3.7.2 Viewing Results

From the Main Screen, place the mouse pointer over the Results menu title box to view the menu's choices.

3.7.2.1 Node Results
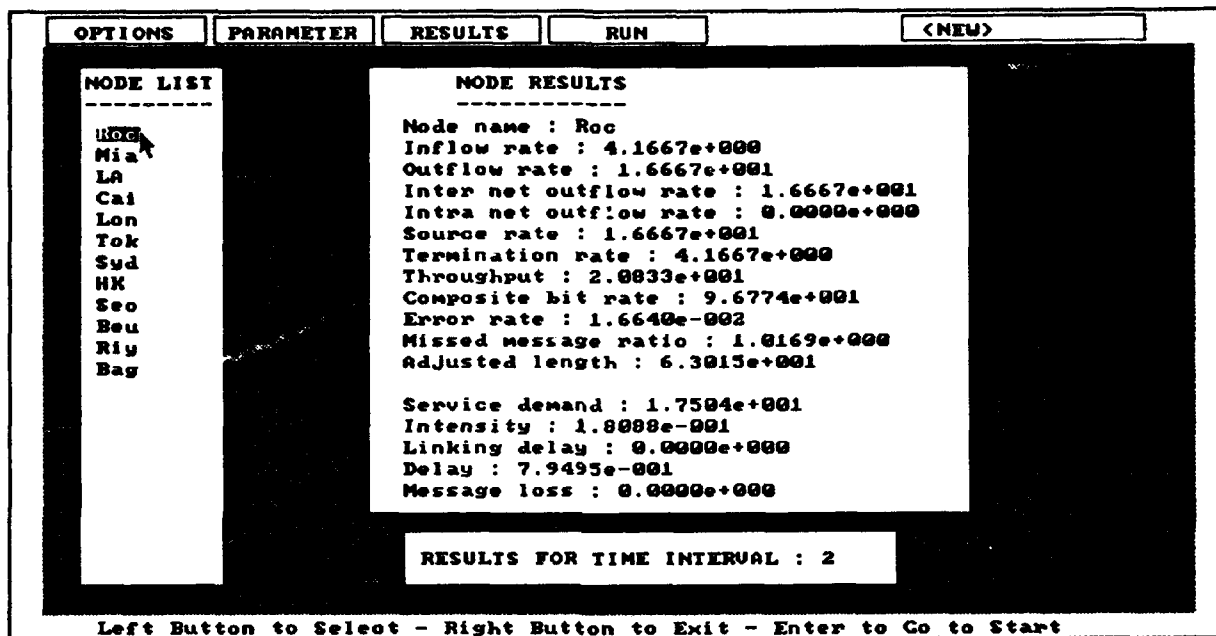
Figure 9 - Node Results Screen

The Results menu choice Node Results displays the node results for a simulation of the current network, as is shown in Figure 9. The user is prompted for the time interval (2..24 in 2 hour increments) to be displayed. A listing of all the nodes is listed to the left of the screen. To view the results for a given node, place the mouse pointer over the name of the node and press the left mouse button. If the list of nodes is greater than twenty, press the right mouse button to view the next page of nodes and the ENTER key to return to the start of the list.

To exit the Node Results display, continue to press the right mouse button. The number of times the right mouse button must be pressed is dependent on the number of nodes. The Node Results display cannot be exited until all of the nodes have been listed.

3.7.2.2 Path Results

The Results menu choice Path Results displays the source/destination pair results for a simulation of the current network. The user is prompted for the time interval (2..24 in 2 hour increments) to be displayed. A listing of all the source/destination pairs in the network configuration are listed to the left of the screen, as is shown in Figure 10.
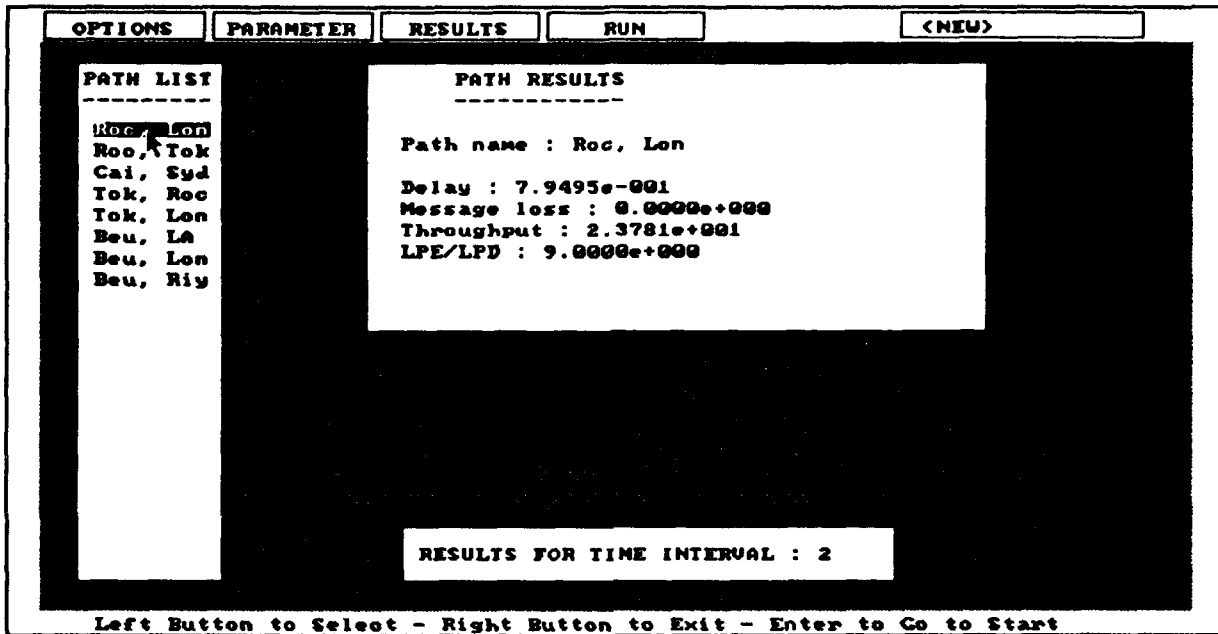
Figure 10 - Path Results Screen

To review the results for a given source/destination pair, place the mouse pointer over the name of the source/destination pair and press the left mouse button. If the list of source/destination pairs is greater than twenty, press the right mouse button to view the next page of pairs and the ENTER key to return to the start of the list.

To exit the Path Results display, continue to press the right mouse button. The display will be exited once all of the source/destination pairs have been displayed.

3.7.2.3 Network Results
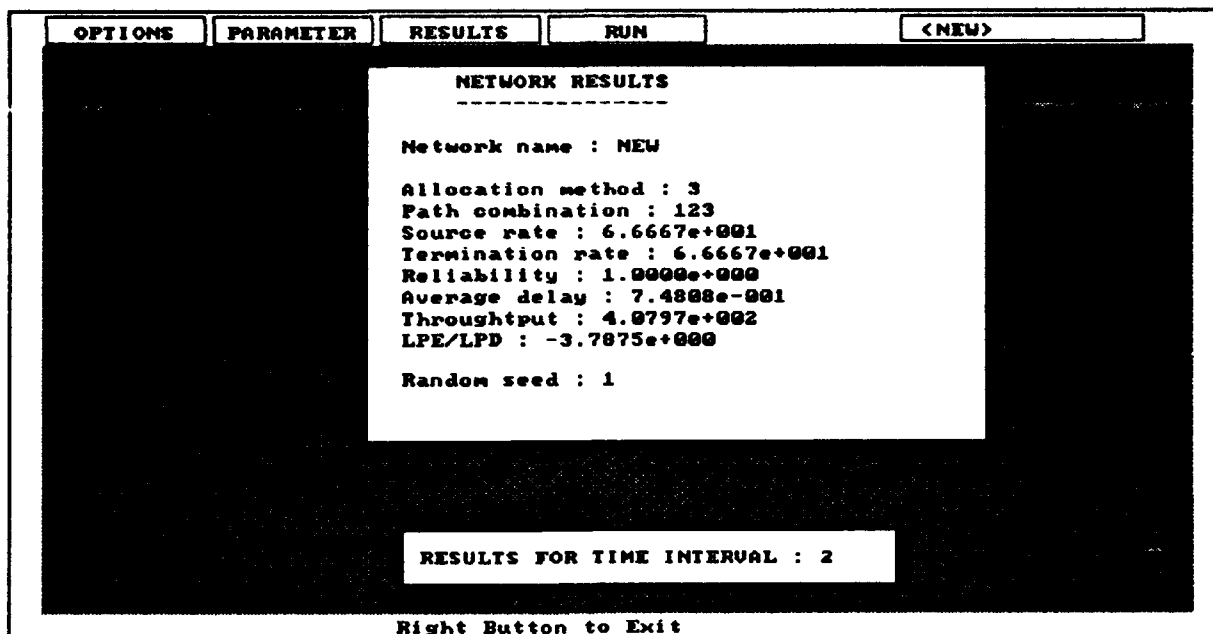
Figure 11 - Network Results Screen

As is shown in Figure 11, the Results menu choice Network Results displays the current network's composite results. The user is prompted for the time interval to be displayed and presses the right mouse button to exit.

3.7.2.4 Display Network
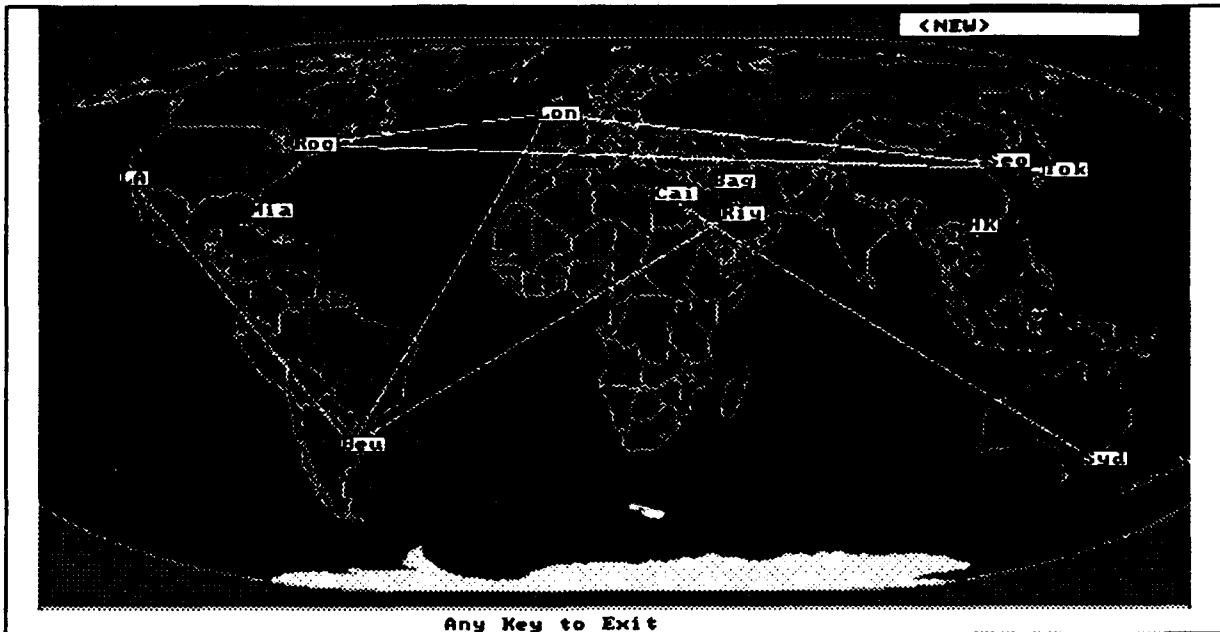
Figure 12 - "Display Network" Results Screen

The Results menu choice Display Network draws the world map, draws lines connecting all of the nodes that have message flows between them, and displays the node names. Figure 12 shows an example of the Display Network choice with a sample network. The node names are yellow when no message loss is occurring at the node. The node names are red when message loss is occurring at the node.

3.7.2.5 Text Files

The Results menu choice Text Files changes results data files into ASCII text files. The ASCII text files may be viewed by the user exiting the INS and using the DOS type command or through other text editors. The user is prompted for the time interval (2..24 in 2 hour increments) to be converted.

NET_?.TXT

The Net_?.txt file (where the ? would be the time interval) is available for viewing only if the Text Files choice has been executed. The file is an ASCII text file with the same network results as those displayed by the user's interface.

NODE.TXT

The Node.txt file is available for viewing only if the Text Files choice has been executed. The file is an ASCII text file which lists all possible node combinations and the time independent characteristics of each node combination. The distance between each node is given with the sign of the distance representing the general direction between the nodes. A positive distance indicates the general direction between the nodes is East-West. A negative distance indicates North-South. The messages per hour flowing from the first node to the second node of the combination list is also given. This value represents source/destination pair message flows, not actual node-to-node link message flows.

NODE_?.TXT

The Node_?.txt file (where the ? would be the time interval) is available for viewing only if the Text Files choice has been executed. The file is an ASCII text file with the same node results as those displayed by the user's interface.

PATH_?.TXT

The Path_?.txt file (where the ? would be the time interval) is available for viewing only if the Text Files choice has been executed. The file is an ASCII text file with the same path results as those displayed by the user's interface.

PATHS_?.TXT

The Paths_?.txt file (where the ? would be the time interval) is available for viewing whether or not the Text Files choice has been executed. The file is an ASCII text file which lists all source/destination pairs and the 5 best paths with the best path listed first. The message flow assigned to each path is shown. This is based upon the relative cost of each path determined by the INS.

TIME_?.TXT

The Time_?.txt file (where the ? would be the time interval) is available for viewing only if the Text Files choice has been executed. The file is an ASCII text file which lists all possible node combinations and the time dependent link characteristics of that node combination. The bit rate, signal-to-noise ratio, and message error rate are given for each link. Again, these results are node-to-node link results and represent actual point-to-point transmission characteristics.

TRAF_?.TXT

The Traf_?.txt file (where the ? would be the time interval) is available for viewing only if the Text Files choice has been executed. The file is an ASCII text file which lists all possible node combinations and the message flows between each node combination due to routing. The message flow represents the actual messages per hour flowing for a given node-to-node link.

4 Error Messages

The following section defines all error messages which may be produced by the INS software package. These error messages will be displayed and will continue to be displayed until the operator presses a key.

4.1 Network Configuration Errors

Acknowledgement length must be between 1 and 10,000 bits:
Acknowledgement Length is the length of every acknowledgement sent as a result of an incoming message and must be a value between 1 and 10,000 bits. Re-enter the Acknowledgement Length.

Inter_link_delay must be between 0 and 32,000 sec/msg:
The linking delay for an inter-net node-to-node link must be a value between 0 and 32,000 seconds/message. Re-enter Inter-net Linking Delay.

Intra_link_delay must be between 0 and 32,000 sec/msg:
The linking delay for an intra-net node to node link must be a value between 0 and 32,000 seconds/message. Re-enter Intra-net Linking Delay.

LQA uncertainty must be between 0 and 100 percent:
LQA Uncertainty must be between 0 and 100 percent. The LQA Uncertainty parameter is not currently used by INS.

Nodes assigned to nets > xx:
Nets above the maximum number of nets chosen have nodes assigned to them. The nodes assigned to those nets must be deleted or assigned to different nets to allow entry of the new Maximum Net Number.

Noise increase must be between 0 and 30:
Noise Increase must be between 0 and 30 DB. Re-enter Noise Increase.

Number of nets from 1 to xx:
The maximum net number allowed is 10. There must be at least 1 net as all nodes must reside in a net. Re-enter Maximum Net Number.

Number of nodes error:
> The maximum number of nodes allowed, 100, have already been specified.

Traffic length must be between 1 and 10,000 bits/msg:
> Traffic Length is the length of each message in the system and must be a value between 1 and 10,000 bits/msg. Re-enter Traffic Length.

TX reduction must be between 0 and 30:
> TX Reduction must be between 0 and 30 DB. Re-enter TX Reduction.

4.2 Node Configuration Errors

All nets are full, Current number of nets = xx:
> Additional nodes cannot be added as all nodes must be assigned to a net. Each net can have a maximum of 10 nodes and there are a maximum of 10 nets allowed. The Maximum Net Number may be increased if it is less than 10. Return to the main screen and select Parameter menu choice Network Configuration to change the value of the parameter Maximum Net Number.

Bit_Rate must be 75, 150, 300, 600, 1200, 2400:
> The node bit rate must be one of the values shown above as those are the bit rates supported by the transmitting modem. Re-enter the Bit Rate.

Destination percentage must be 1 to 100:
> The percentage for each destination must be between 1 and 100. Re-enter the desired destination name and percentage.

Generation rate must be between 0 and 32000:
> The node generation rate can only be between 0 and 32,000 messages per hour. Re-enter the Generation Rate.

Latitude must be between 0 and 90:
> The latitude value entered is invalid. Re-enter the Latitude.

Longitude must be between 0 and 180:
> The longitude value entered is invalid. Re-enter the Longitude.

Max nodes per net = 10, Net number xx is full:
The net chosen is full. The node must be assigned to another net or a node must be removed from the desired net to allow the new node to be added.

Max nodes per network currently specified at xxx:
The network configuration parameter Number of Nodes must be increased if additional nodes are to be specified. Return to the main screen and select the Parameter menu choice Network Configuration.

Max_Source Nodes = 10, 10 source node(s) already specified:
The maximum number of nodes allowed to source messages is 10. The destinations must be deleted from a current source node to allow additional source nodes.

Net number must be between 1 and xx:
The node can only be in one of net numbers 1 through the Maximum Net Number. Re-enter Net Number.

Node name not found:
No nodes with the node name specified exist.

Node xxx already specified:
The name chosen for a node has already been used and may not be used to reference a new node.

Node xxx is the source node:
The destination chosen is the name of the source node. A node cannot send messages to itself.

Node xxx lists this node as a destination:
The node chosen cannot be deleted as it is a destination for the node shown. Remove the node to be deleted from the destination list of the source node shown prior to attempting deletion again.

Noise increase must be between 0 and 30:

Noise Increase must be between 0 and 30 dB. Re-enter Noise Increase.

Total destination percentage must be 100:

The percentage of messages transmitted to all of the destinations for a given node must total 100. The user will not be allowed to leave the destination entry screen until the total percentage equals 100.

TX reduction must be between 0 and 30:

TX Reduction must be between 0 and 30 dB. Re-enter TX Reduction.

!! WARNING !! Insufficient disk space to store network, Estimated file size: xxxKB:

The estimated file size is an overestimation for safety purposes. If the network is a new network, the user will be prevented from adding additional nodes to the network. There should be sufficient room on the disk to store the network configuration that has been developed. The user should then terminate INS and delete unnecessary files from the disk.

WARNING - If the network was loaded from disk, modified, and the intention was to save the network configuration under a different name, the complete file will not be saved and the *.net file will not be usable. If the user saves the file with the same name as the file loaded, the *.net file should be valid but will overwrite the old *.net file.

4.3 Verify Errors

Max network circular radius of 4000 miles:

The maximum network circular radius allowed is 4,000 miles. The user is warned when a node-to-node distance exceeds 8,000 miles. This is only a warning and does not prevent simulation of the specified network.

Necessary parameters not specified for node named:

The node indicated does not have all of it's parameters specified. Simulation of the network will not be allowed until the necessary parameters for all nodes in the network have been specified.

No messages are being generated, Simulation canceled:

All of the specified source nodes have a generation rate of 0. There is no need to simulate the network and therefore simulation is prevented.

No source/destination pairs! Simulation not required:

No nodes are currently specified as source nodes. Simulation will not be allowed until source/destination pairs have been specified as there is no need.

!! WARNING !! Insufficient disk space to store results from a 2 hour simulation:
>There is not sufficient disk space available to store the *.dat results files from a 2 hour simulation. Terminate INS and review disk usage, deleting any unnecessary files.

4.4 File Input/Output Errors

Unable to close file:
>Generally, this error message indicates that the current disk is full and there is not room to store the *.net network specification file, *.dat results files, or *.txt ASCII text results files. In the case of *.net files, the entire file has not been stored meaning that the file cannot be used for future simulations. *REMOVE THE EFFECTED *.NET FILE FROM DISK* as it's use will cause INS execution problems. The results files, *.dat and *.txt, will also be incomplete and should be removed from the disk. The current session of INS should be terminated and the user should review disk usage to remove unnecessary files. The cause of the error, although unlikely, may be DOS related and further investigation in the appropriate DOS manual is then required. Investigation for the cause in the DOS manual is recommended only as a last resort.

Unable to open file:
>Generally, this error message indicates that a results *.dat file required for the user requested action does not exist in the current directory/sub-directory. Simulation of the desired network is recommended. If all simulation results files appear to be present, the cause of the error, although unlikely, may be DOS related and further investigation in the appropriate DOS manual is then required. Investigation for the cause in the DOS manual is recommended only as a last resort.

4.5 Simulation Results Errors

Data is for network xxx:
>The results data found on disk is not for the network currently specified and named in the upper right hand corner message box. Run the simulation for the time interval and network desired or retrieve the network for which results data exists. The results cannot be viewed without the currently specified network and the results data network being the same.

Time interval xx data not found:
>No results data for the time interval specified was found in the current directory or sub-directory. Run the simulation for the time interval and network desired.

Time interval xx not accepted, Time interval must be 2,4,6,...,24:

> The time interval entered is not a valid time interval. Valid time intervals start with 2 and continue until 24 in 2 hour increments.

*.net may have been modified since last simulation:

> The current network configuration has been saved to disk since the simulation results data were generated. The user may still view the results data but should be aware that any changes made to the network may noeb reflected in the current simulation results. It is suggested that the simulation be run again with the most recent *.net file.

5 Notes

This section includes a glossary of terms and acronyms used in this manual and in the INS software.

5.1 Glossary of Terms

ASCII Text Files
>   Files consisting of ASCII characters.

Destination Node
>   Node which is the intended recipient of messages.

Global Network Parameters
>   Parameters applying to the network as a whole and that apply to each and every node. The Global Network Parameters are displayed when the Parameter menu choice Network Configuration is selected.

Link, Node-To-Node Link
>   A link refers to an actual point-to-point transmission connection between nodes. In contrast, a source/destination pair represents a source node and destination node relationship without indicating the particular path a message takes.

Menu Title Box
>   Screen location which designates where the mouse pointer must be to view a given pull-down menu.

Mouse Pointer
>   Screen pointer which moves in conjunction with mouse movements.

Node/Nodal Parameters
>   Node specific parameters. Nodal Parameters are available once the Parameter menu choice Configure Network is selected.

Path
>   The series of links required to get messages from a source to destination.

Pull-Down Menus
>   Listing of available options/choices displayed once the mouse pointer is in a Menu Title Box

Source Node

    Node which is generating messages.

Source/Destination Pair

    Two nodes where one node is a source generator of messages and the other node is the intended terminator destination for those messages.

Text Editors

    Software program allowing the user to manipulate and modify ASCII Text Files.

User's Interface

    Graphical interface provided to enter network parameters, view the specified network configurations, run a network simulation, and view simulation results.

*.net File

    ASCII text file with network configuration data.

*.Txt Files

    ASCII text files with network simulation results.

5.2 List of Acronyms

ASCII	American Standard Code for Information Interchange
BER	Bit Error Rate
dB	Decibel
DOS	Disk Operating System
EGA	Enhanced Graphics Adapter
HF	High Frequency
INS	Improved HF Data Network Simulator
IONCAP	Ionosheric Communications Analysis and Prediction Program
ms	Milliseconds
PC	Personal Computer
SUM	Software User's Manual
SNR	Signal-to-Noise Ratio
SNDR	Signal-to-Noise-Density Ratio

6   Appendixes

6.1   Appendix A - Modem BER Table

```
/******************************************************************/
/******************************************************************/
/
File Name : modember.h
*/
/******************************************************************/
/******************************************************************/


/*      POOR  = Dual Fading Paths
 **            Equal Average paoer
 **            Doppler Spread = 2Hz(Both Paths)
 **            Multipath Spread = 5ms
 **            1.25 Sec Interleaver
 **
 **      MODERATE  = Mil. Std
 **            Long Interleave
 **            Doppler Spread = 1Hz
 **            Multipath Spread = 2ms
 **
 **      GOOD  = Single Fading Path
 **            Doppler Spread = 1Hz
 **            10 Sec Interleaver
 */
```

```
float modem_ber[7][6][3] =

/*              poor   mod    good*/

/* -5db */      {{{5.0e-1, 8.0e-4, 2.5e-3},   /*bit_rate = 75  */
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       150 */
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       300 */
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       600 */
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       1200*/
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       2400*/

/* 0db */       {{{2.0e-4, 3.3e-7, 1.0e-7},   /*bit_rate = 75  */
                {2.0e-2, 2.6e-3, 1.5e-3},    /*       150 */
                {1.5e-1, 3.5e-1, 3.0e-1},    /*       300 */
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       600 */
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       1200*/
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       2400*/

/* 5db */       {{{1.0e-7, 1.0e-7, 1.0e-7},   /*bit_rate = 75  */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       150 */
                {3.5e-4, 1.0e-6, 1.2e-6},    /*       300 */
                {1.3e-2, 1.7e-3, 6.0e-3},    /*       600 */
                {1.8e-1, 3.2e-1, 1.4e-1},    /*       1200*/
                {5.0e-1, 5.0e-1, 5.0e-1},    /*       2400*/

/* 10db */      {{{1.0e-7, 1.0e-7, 1.0e-7},   /*bit_rate = 75  */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       150 */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       300 */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       600 */
                {2.0e-3, 9.0e-5, 1.1e-4},    /*       1200*/
                {5.0e-1, 1.5e-2, 5.0e-1},    /*       2400*/

/* 15db */      {{{1.0e-7, 1.0e-7, 1.0e-7},   /*bit_rate = 75  */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       150 */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       300 */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       600 */
                {1.0e-7, 1.0e-7, 1.0e-7},    /*       1200*/
                {1.5e-2, 6.0e-6, 1.3e-3},    /*       2400*/
```

```
/* 20db */    {{{1.0e-7, 1.0e-7, 1.0e-7},   /*bit_rate = 75   */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       150 */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       300 */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       600 */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       1200*/
             {2.6e-4, 1.0e-7, 1.0e-7},   /*       2400*/

/* 25db */    {{{1.0e-7, 1.0e-7, 1.0e-7},   /*bit_rate = 75   */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       150 */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       300 */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       600 */
             {1.0e-7, 1.0e-7, 1.0e-7},   /*       1200*/
             {1.0e-6, 1.0e-7, 1.0e-7},   /*       2400*/

/*******************************************************************/
/*******************End of File - MODEM_BER.H****************/
/*******************************************************************/
```

MISSION

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