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TECHNICAL REPORT

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U.S. ARMY SIGNAL CENTER COMBAT DEVELOPMENT SUPPORT FACILITY

EXECUTIVE SUMMARY FOR THE NETWORK ASSESSMENT MODEL

NOVEMBER 30, 1989

TELEDYNE
BROWN ENGINEERING
Cummings Research Park • Huntsville, Alabama 35807

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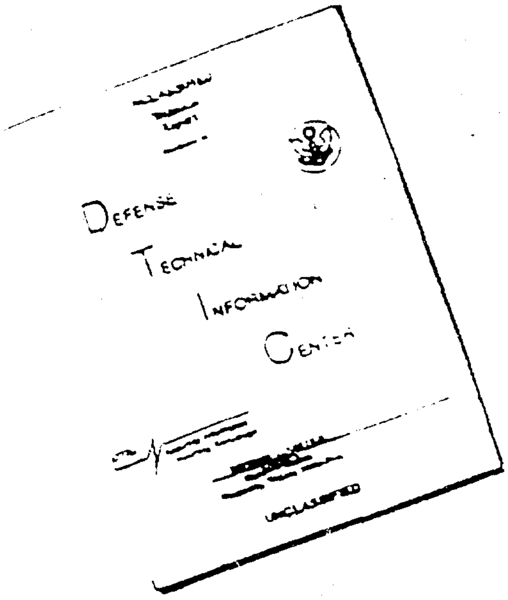

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report provides a summary of the Network Assessment Model (NAM). The NAM is a communications performance assessment simulation under development by the U.S. Army Signal Center. The NAM represents the capability to model a specific architecture against a specifi scenario. The model simulates each discrete event in the architecture being modeled and records the results, compiles summary statistics, and displays summary graphics representing the performance of the architecture.

Mobile Subscriber Equipment

Current capabilities of NAM version 3.4 (NAM3.4) include: area communications (MSE and EAC-CIP). Combat Net Radio (SINCGARS and IHFR), Army Data Distribution System (JTIDS and EPLRS), Battlefield Automated Systems (BAS), post simulation analysis, force movement, line-of-sight radio wave loss propagation, network engineering, and threat. Capabilities currently under development: Coding of a Packet Switching overlay for MSE and EAC-CIP is scheduled to be completed by Aug 90.

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cont to Blk 19, Terms

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EXECUTIVE SUMMARY FOR THE NETWORK ASSESSMENT MODEL

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Prepared by

TELEDYNE BROWN ENGINEERING
COMPUTER SYSTEMS ENGINEERING DEPARTMENT
HUNTSVILLE, ALABAMA

ABSTRACT

The Network Assessment Model (NAM) is a communications architecture model developed by Teledyne Brown Engineering for the U.S. Army Signal Center and Fort Gordon, Georgia. The NAM allows the building and execution of scenarios, consisting of friendly (blue) force laydown and activity and threat (red) force laydown and activity; traffic profiles for each element of the force laydown; and one or more communications networks to support the force. This executive summary provides the reader with an overview of the model's capabilities and resource implications. This document is not intended to provide detailed technical information about the model. More detailed information about the NAM can be found in the references listed in Appendix B.

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APPROVED:

James R. Malcolm, Manager
Communications System Development Branch

Robert L. Bishop
Program Manager

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GENERAL

SECTION 1. GENERAL

1. GENERAL

1.1 SCOPE

This Executive Summary is an overview of the Network Assessment Model (NAM). It provides a summary of the model's inputs, processes and outputs, as well as a description of the five major functions within the model. This document does not provide in-depth, detailed information about the model. More detailed information about the model can be obtained from the documents listed in Appendix B.

1.2 PURPOSE

This purpose of this document is to provide the reader with a brief description of the capabilities of the NAM. This summary will help determine the suitability of the NAM as a tool for a particular application.

1.3 BACKGROUND

The Network Assessment Model is an element of the Signal Center's Modeling program. The basic requirement is for an analytical capability to model a deployed force with its associated communications requirements and communications networks. The output of this capability thus allows the Signal Center to judge the effectiveness of proposed communications architectures to support the force. The modeling capability inherently supports the Combat Development process by allowing analysis of communications doctrinal, organizational, and technical equipment changes in terms of communications performance. Other combat development models can then be used to evaluate the overall performance of a force based upon the modeled communications performance.

The Signal Center's execution plan to satisfy this requirement produced the three elements shown in Figure 1-1. The OPFAC Data Base provides the force structure components needed to define the personnel which use communications. The Communications Data Base provides a quantification of traffic demands placed upon communications networks. The Network Assessment Model provides the communications architectures, networks and pertinent environmental aspects which simulate reality.

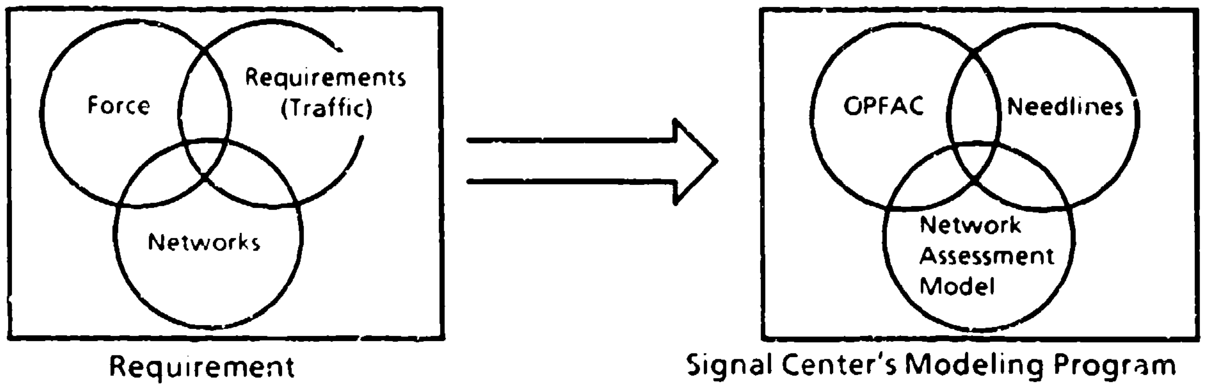

FIGURE 1-1 The Network Assessment Model, when loaded with needlines from the communications database, and OPFACs from the OPFAC Database, satisfies this requirement.

1.3.1 OPFAC Data Base

The OPFAC concept defines force structures in terms of operational components representing the actual deployed structure of a force. The force structure chemistry combines the more basic components into more complex elements as shown in Figure 1-2. The most fundamental component is the operational element (OE) which represents a small team. These teams are then combined within units to form complex OPFACs such as unit staffs. Components from several units are combined to form compound OPFACs, e.g., a brigade command post. At each level there is an associated mission, equipment and specific personnel, thus allowing the OPFACs to be defined in terms of SRC, paragraph and line number for personnel, and Line Item Numbers (LINs) for equipment.

The OPFAC concept is key to communications analysis. The OPFAC structure coupled with doctrine provides the communications analyst with a tool to depict the force as it would be deployed, equipped and organized. This allows an analyst to capture impacts of geographical separation upon units. The requirement for communications over ever increasing areas of operations has driven communications developments since the dawn of time. Another major factor driving communications development is the ever increasing amount of information to be moved. This is the purpose of the Communications Data Base.

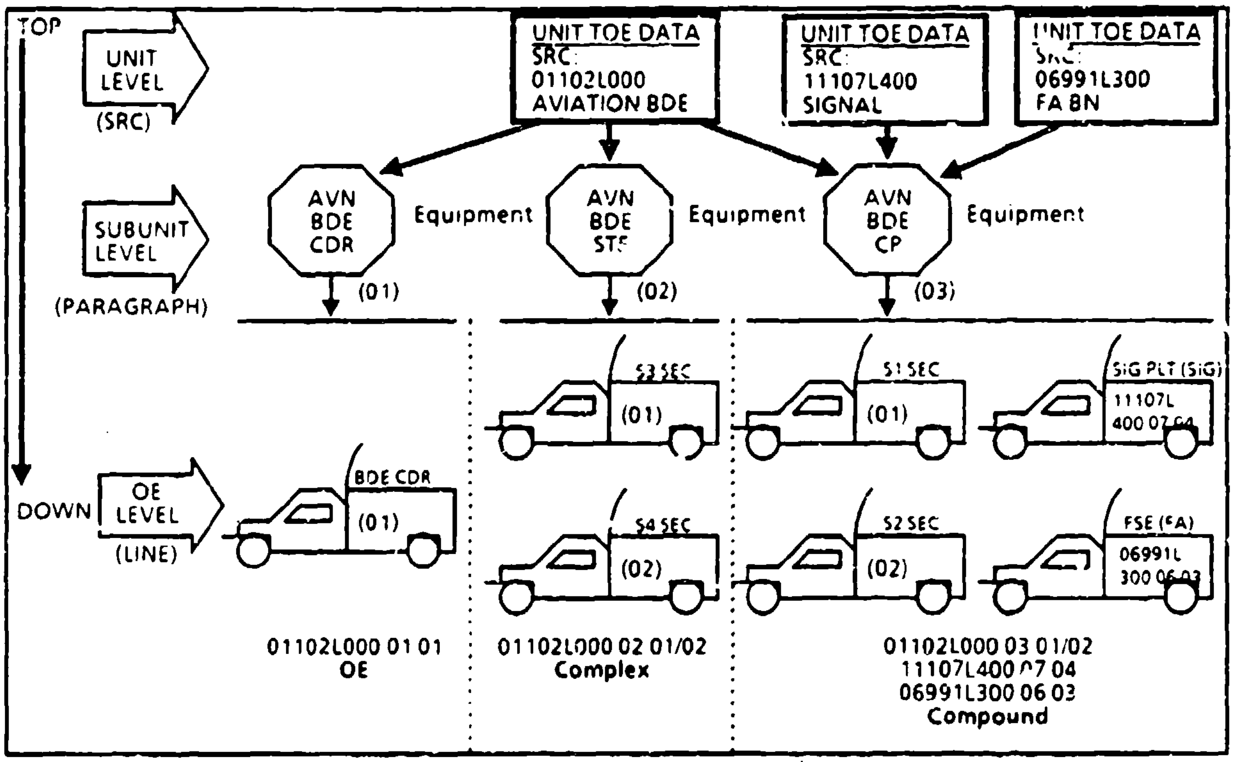

FIGURE 1-2. The OPFAC reflects a specific type of tactical unit in terms of operational ability to include authorization document (TOE, paragraph, and line number), equipment, and unit Operational Element (OE) Level (single, complex, compound OPFAC). Unit proponency and organizational relationship round out the OPFAC model.

1.3.2 Communications Data Base

The Communications Data Base (CDB) is a data base which the U. S. Army Signal Center developed for use as an analytical tool primarily, though not exclusively, in conjunction with the Operational Facility (OPFAC) Data Base and the NAM. The cooperative use of these three assets allows the Signal Center, or user, to assess the capability of various communications architectures to support battlefield information exchange requirements for many different force structure arrays, for standard and non-standard deployment schemes, and for a range of geographic deployment locations. The CDB represents communications requirements of selected, tactical TOE-type divisional, corps and echelons above corps (EAC) organizations. These organizations are represented and identified by Standard Requirements Code (SRC) number -- for cases where SRC data is available for units -- and by pseudo-SRCs in cases where SRC data does not exist (NATO, Joint Services, etc., type units) to allow for the description of communications requirements to and from these units. In all cases, SRCs selected for CDB use represented the currently approved version (series) available at the time SRCs were chosen.

Communications requirements within the CDB are depicted in terms of NEEDLINES. A needline, as shown in Figure 1-3, is a series of related data elements which describe a requirement to communicate information between two or more battlefield communicators. A needline describes the originator and receiver of the communications (the communicators -- identified by SRC, Paragraph and Line Number), the reason for the requirement (Purpose and Function), the subject of the call or message, the length of the message, the number of times per day the message is sent, its mode (voice, data, page, facsimile, or courier), the importance and perishability of the information, and several other elements which help to describe the requirement. The NAM uses a subset of the data elements available in the CDB. Those items critical to the NAM's use can be identified in other documentation for the system.

ID	FIELD NAME	TYPE	LENGTH w/decimal	ID	FIELD NAME	TYPE	LENGTH w/decimal
A	NDLN_CLASS	C	1	R	ORG_MOBIL	C	1
B	NDLN_SEQ	N	7 0	S	RCVR_MOBIL	C	1
C	BROAD_GRP	N	4 0	T	MODE	C	1
D	STAMIS_SWA	[illegible]	4	U	PRIME_EQ	C	2
E	ORG_SRC	C	9	V	SEC_EQ	C	2
F	ORG_PARA	C	2	W	ORG_D_DEV	C	3
G	ORG_LINE	C	2	X	RCVR_D_DEV	C	3
H	RCVR_SRC	C	9	Y	FREQ_XMIT	N	9.2
I	RCVR_PARA	C	2	Z	MSG_LENGTH	N	7.0
J	RCVR_LINE	C	2	a	PERISH	C	1
K	URC	C	2	b	COF	C	1
L	SUBSET_RAT	C	4	c	INTENSITY	C	1
M	NOM_DIST	N	3.0	d	MSG_CLASS	C	1
N	PURPOSE	C	1	e	INTEROP	C	1
O	FUNCTION	C	2	f	NDLN_STAT	C	1
P	MSG_CODE	C	6	g	STAT_DATE	D	8
Q	ACTIVITY	C	1				

FIGURE 1-3. The needlines found in the CDB are made up of 33 different fields. These fields provide a complete description of required communications.

1.3.3 Network Assessment Model

The NAM, previously known as the Communications Simulation System (COMSIM), is a simulation system designed to simulate certain Army communications systems for analytical purposes. It is used by the U. S. Army Signal Center to measure communications network stress caused by traffic and several other battlefield environmental factors. It is useful for system engineering functions, such as network sizing and configuration, as well as operational planning. It can also be used to support interoperability analysis, threat analysis, test and evaluation planning, and any application where a communications network ability to move traffic under various battlefield conditions is a consideration. Figure 1-4 is a simplified depiction of the typical communications network model.

NAM is built to evaluate communications network and architectural performance under a variety a stresses, as shown in Figure 1-5. These stresses are physical environmental factors to include electromagnetic effects and terrain; threat to include electronic warfare and attrition; battlefield activities to include movement; traffic; and Reliability, Availability, and Maintainability (RAM) of friendly forces. These stresses are measured in terms of communications connectivity, capacity, and Continuity of Operations (CONOPS). The majority of these stresses are best captured as traffic performance.

The model design is based on the premise that the major mission of a communications network is its design capability to move traffic. Actual performance is a function of numerous battlefield environmental factors that affect network throughput. From a more practical perspective, the model represents a communication path between two points with a design traffic capacity that is modified by battlefield conditions

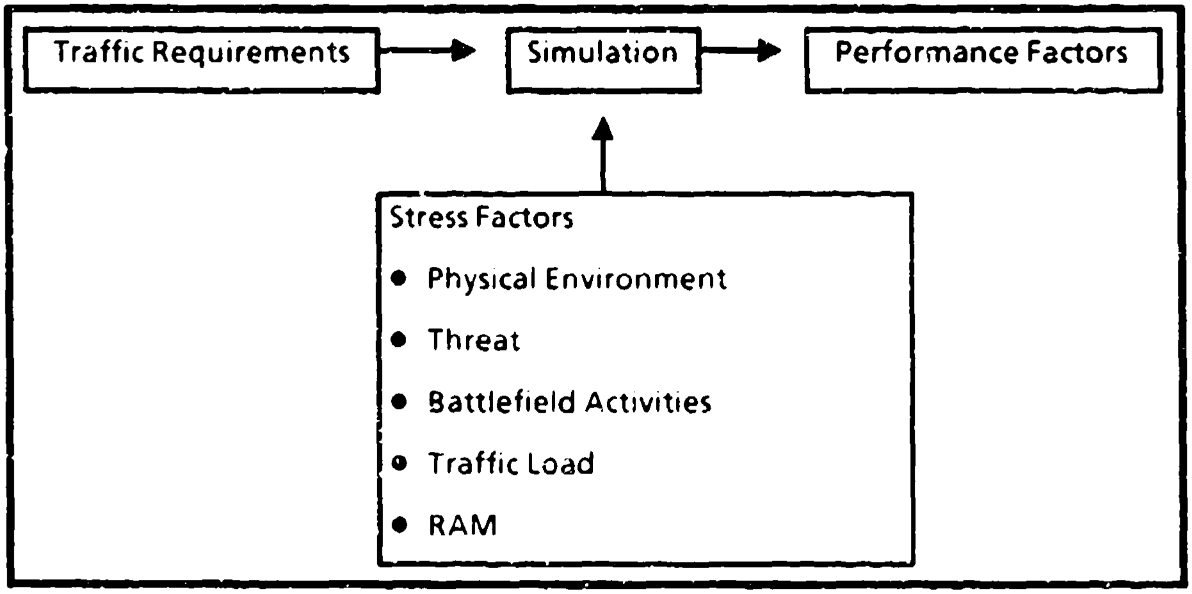

Figure 1-4. The Simplified Network Model shows the stress factors that affect each model's performance, and must be considered in order to make the model's performance factors as realistic as possible.

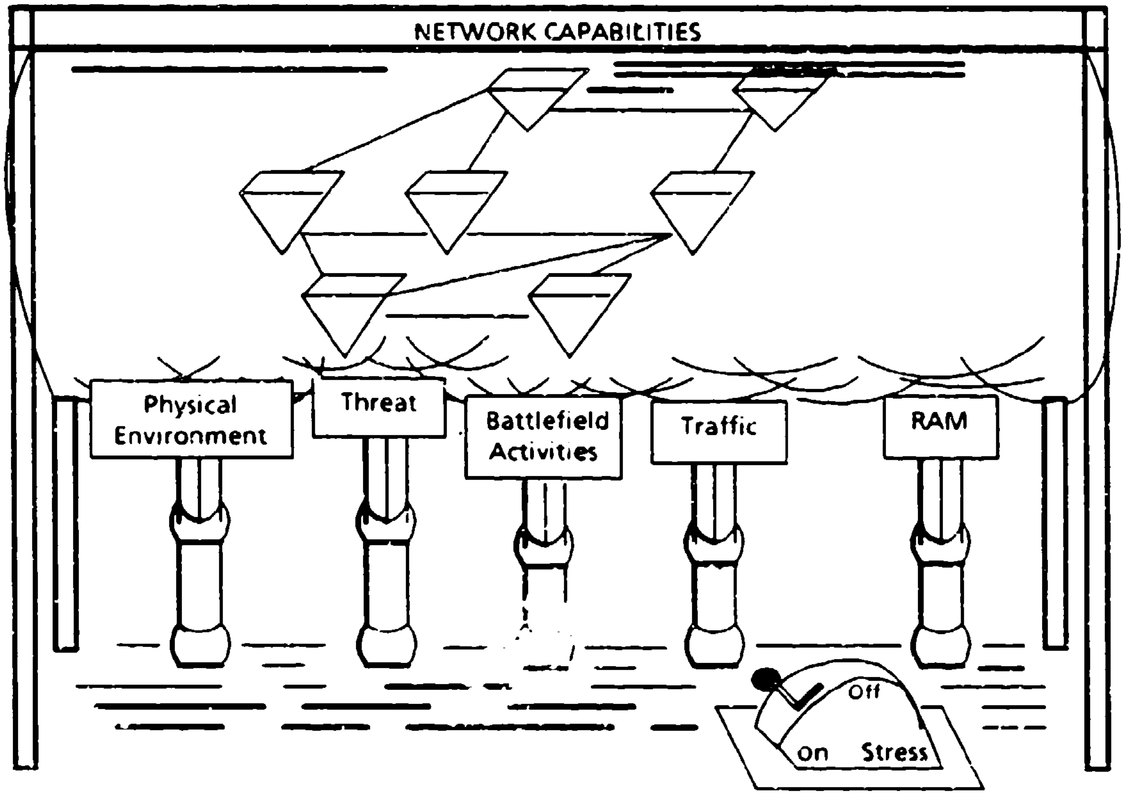

Figure 1-5. Various stresses occur on the network to affect net performance. Environmental factors, threat activities, battlefield activities, traffic, and RAM all affect communications performance against the ceiling of network capabilities.

The NAM, as shown in Figure 1-6, supports three principal activities:

- Building models and simulation programs
- Running and controlling the simulations
- Outputting communications network performance results to the analyst.

Building Models and Simulation Programs. The Maintenance function (MAINT) and Simulation Build function (SIMBUILD) provide a means for the user or analyst to build models and to establish simulation initialization values (sometimes referred to as programming the simulation). Menu driven procedures and interactive graphics are used for:

- Creating the individual simulation element models
- Setting up the force and threat models and the communication network architecture for traffic loading
- Configuring the scenario events for specific analysis requirements.

Running and Controlling Simulations. The Simulation Run (SIMRUN) function provides execution control and information management during the actual simulation operation. Essentially, it executes the simulation that was set up by the analyst in the previous activity. The major output is performance data, which is saved for analysis in the following activity.

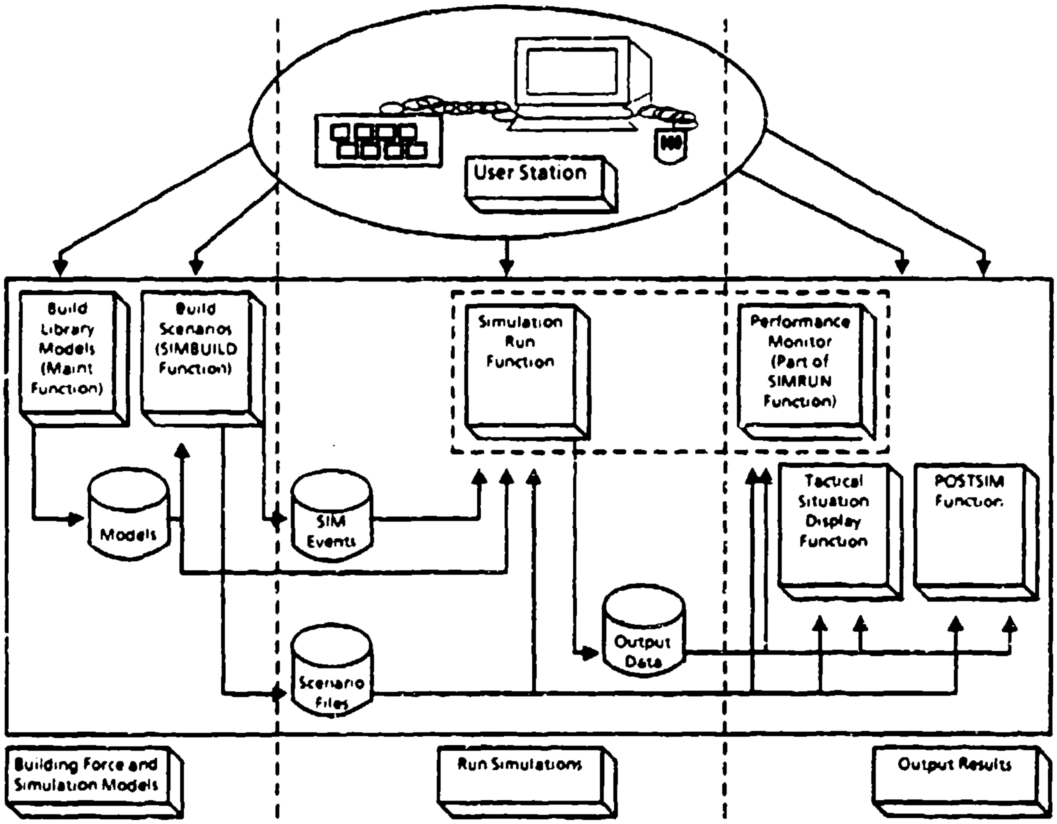

FIGURE 1-6. The Network Assessment Model has five major functions: Maintenance, SIMBUILD, SIMRUN, Tactical Situation Display, and POSTSIM. These functions feed each other in order to develop, run, and analyze any simulation.

<u>Outputting Results.</u> The Performance Monitor (PMONITOR) and Post Simulation Analysis (POSTSIM) functions both extract data from the output data files and reduce/format them for presentation to the analyst. The PMONITOR function provides a limited ability to observe simulation progress and performance during the simulation run. It is limited in the sense that not all data are meaningful during the run. The POSTSIM function operates after the run and provides a broad range of data reduction/analysis capabilities that can be presented in both graphic and tabular forms. Another output of the NAM is the Tactical Situation Display (TSD), which gives a playback of the simulation that was executed.

1.4 HARDWARE REQUIREMENTS

The NAM executes on Silicon Graphics 3000 and 4D series IRIS workstations. The model currently requires a minimum of 8 Mbytes of main memory, 24 bitplanes, and 170 Mbytes of disk storage. Scenarios, input data bases, and output files require additional storage. The amount of storage required for a particular application is not immediately obvious; however, a minimum of 25 to 30 Mbytes is required to work with relatively small, division-level scenarios. The NAM can be ported to other hardware configurations that support a standard UNIX environment.

1.5 MANPOWER REQUIREMENTS

The NAM can be operated by any person who is knowledgeable in communications functions and practices. The NAM is user-friendly with pull-down menus that prompt the user to make selections.

SECTION 2.

MODEL PROCESSES

SECTION 2. MODEL PROCESSES

2. MODEL PROCESSES

2.1 MODEL INPUTS

Data input requirements may be in the form of an operations plan/order, a troop list, equipment change list, or other hardcopy documents. Military and/or communications experience and knowledge of the combat mission dictates the need for detailed data input documents. The use of the results for planning functions may require the building of "what if" items to simulate a proposed change to current practice or equipment.

The NAM interfaces with external files to create various databases for use in the NAM. NAM uses Defense Mapping Agency (DMA) map data to create maps for use in the NAM. The Communications Data Base (CDB) is used for the NAMs creation of needlines. The OPFAC Data Base (ODB) is used to create the OPFAC Configuration Model (OCM) Library. The NAM may also receive manual inputs from TOEs and BOIPs for the OCM library. The Threat Model (TM) library is built manually in the NAM using all available threat data. Figure 2-1 depicts external inputs to the NAM.

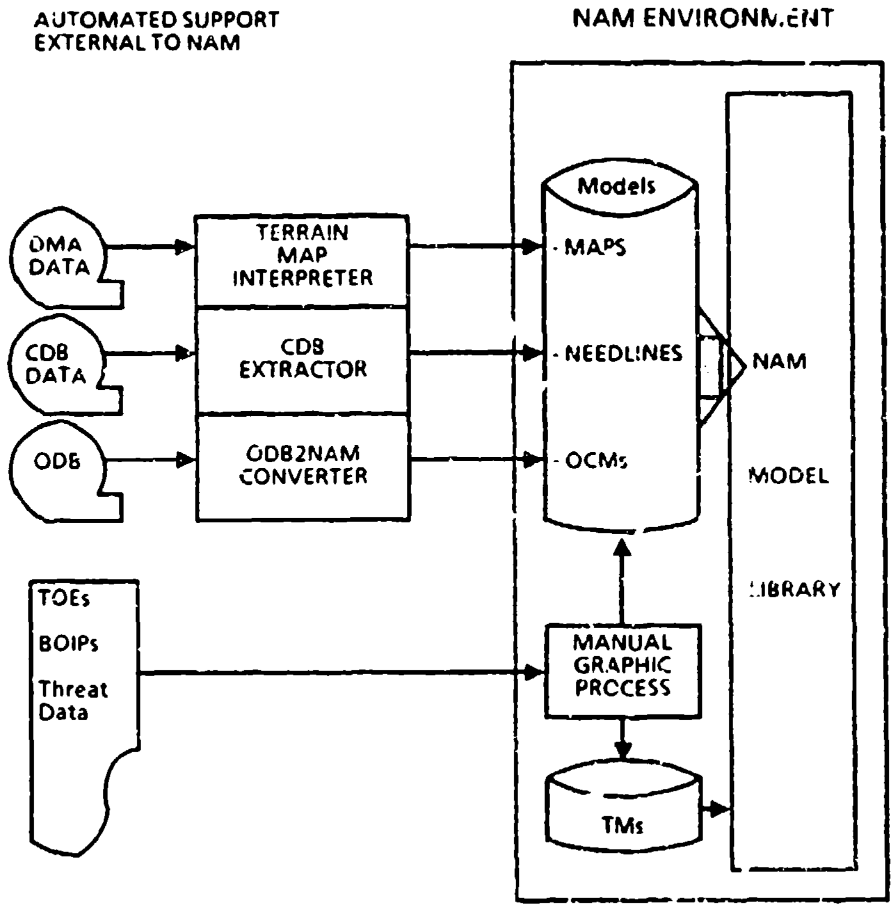

FIGURE 2-1. The NAM Model Library is built from inputs from external databases and manual inputs. The Library uses DMA data, CDB, ODB, and manual inputs from TOEs, BOIPs and Threat data.

2.1.1 MAPS

The terrain modeling uses Defense Mapping Agency (DMA) data that provides terrain elevation and terrain feature data. Colors represent sequential elevation contours and may be supplemented by displayed altitudes in meters.

The maps used in the NAM vary in size and location from as little as a small town to as big as Europe. The detail on the map is based on available DMA Digital Features Analysis Data (DFAD) The elevation and position in Latitude/Longitude, Universal Transverse Mercator, or Military Grid Reference System (MGRS) is based on DMA Digital Terrain Elevation Data (DTED). Figure 2-2 depicts an Eglin area map on the NAM. This map is displaying both DFAD and DTED data. Elevations are depicted as bands of colors as shown on the chart on the left hand side. Primary roads are shown in magenta. Built-up areas are outlined in white. Hydrological features are shown in blue and include river, streams and swamps. Power lines and cleared areas are shown in black. Railroads are shown as white lines.

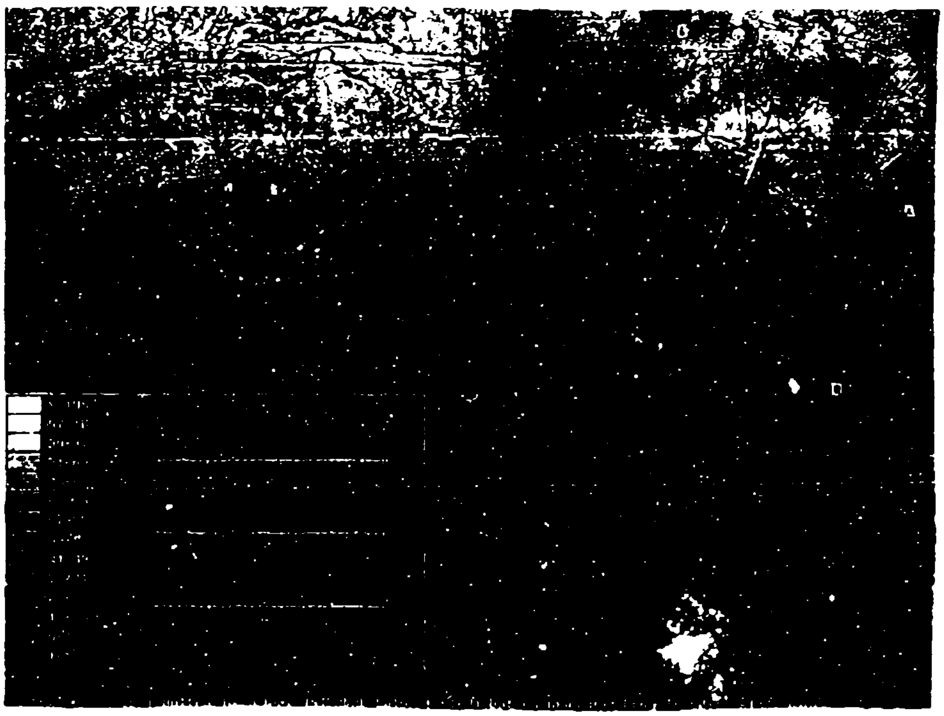

FIGURE 2-2. The NAM uses DMA level 1 and 2 data to create maps. This Eglin area map has both the elevation and the Digital Features Analysis Data (DFAD) displayed. The user can change the colors of map elevation by using the color editor in the utilities menu.

2.1.2 CDB

The CDB is a communications need description based on inputs submitted by the Proponent Service Schools. Needlines used in the NAM are created from the CDB. They describe who send and receives the call, its importance, the cost of failure, the command structure, equipment used, length, priority, activity, frequency, classification, and purpose as determined by the proponent service school. The service school updates the CDB periodically to reflect current doctrine. The needline is a tool that the NAM uses to ensure that only properly equipped and doctrinally correct OPFACs communicate. Figure 2-3 shows how the OPFAC Needline Table (ONLT) is created. The ONLT is built by an automatic process which compares the SPLs found in the OCM Library with the SPLs in the CDB to produce a table of sending and receiving OCM which match needlines found in the CDB. The errors listed describe the types of errors encountered when the ONLT is produced. Figure 2-4 displays in a "pinwheel" the ONLT. The red circle in the middle is the sender and the blue circles on the outside are the receivers. The number on the spokes are the quantity of needlines between each sender and receiver. The number on the circles represent the OCM sequence number of when they were entered in the OCM Library.

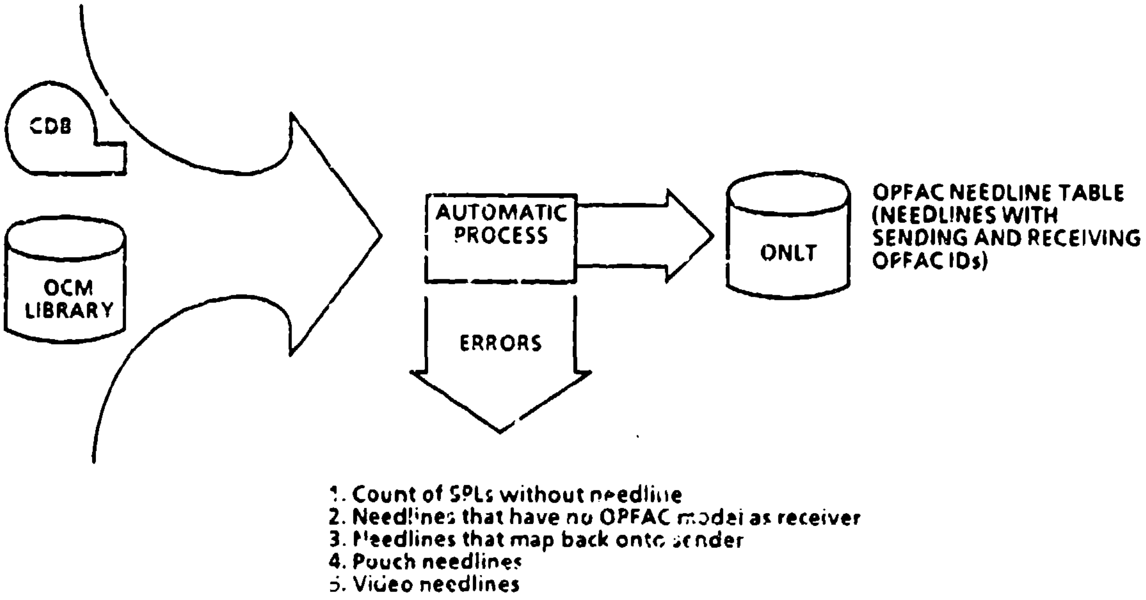

FIGURE 2-3. Build Needline Tables is a process whereby SPLs found in the OCM Library are matched to SPLs in needlines in the CDB to produce an OPFAC Needline Table (ONLT). The ONLT is a list of OCMs with needlines that match other OCMs in the Library based on CDB needlines.

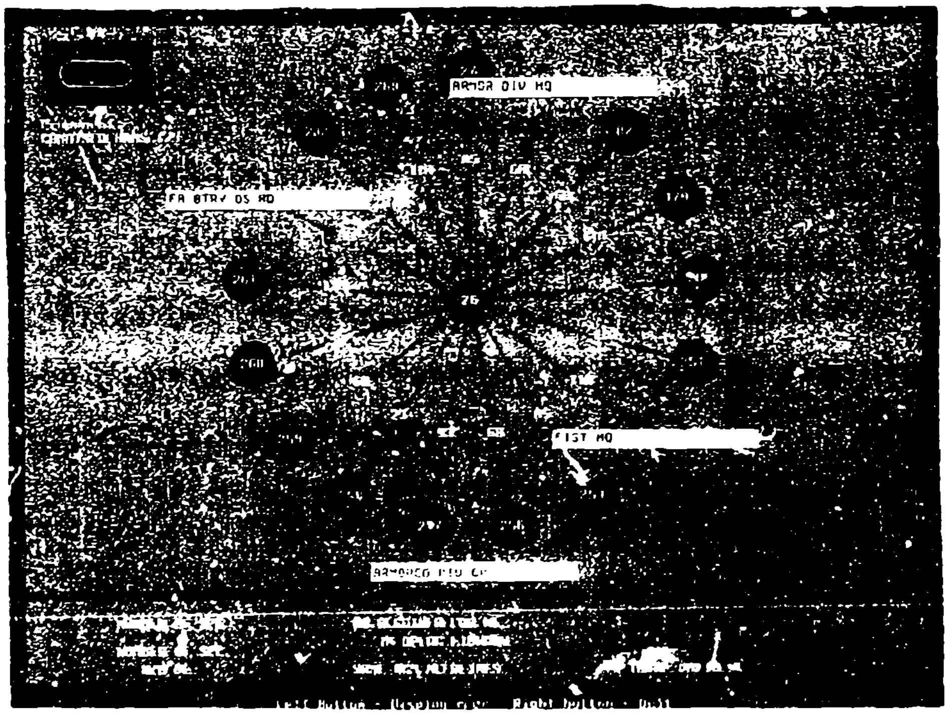

FIGURE 2-4. Viewing existing needlines will graphically picture the needline table for you. It will bring up the build needline frame and display the OCM and associated needline information for you. You may step through each OCM viewing the needlines with the associated receivers

2.1.3 OCM Library

The OCM Library is created by running the ODB through the ODB2NAM converter or by manually creating the OPFACs using the NAMs menus. The OPFACs consist of symbols, equipment, title structure, and mission derived from Army Tables of Organization and Equipment (TOE), Standard Requirements Code (SRC), Basis of Issue Plans (BOIP), and intelligence documents. Figure 2-5 depicts the process to build OPFAC configuration models. As the figure shows, the user can create the OPFACs manually by using the menus found in OCM Library Maintenance. Figure 2-6 depicts an OCM template. The fields on the lower left of the template that are red must be filled in; the white ones are optional. The symbols and echelons are standard ones found in FM 101-5-1. Some additional symbols depict Air Force units which are not found in the FM.

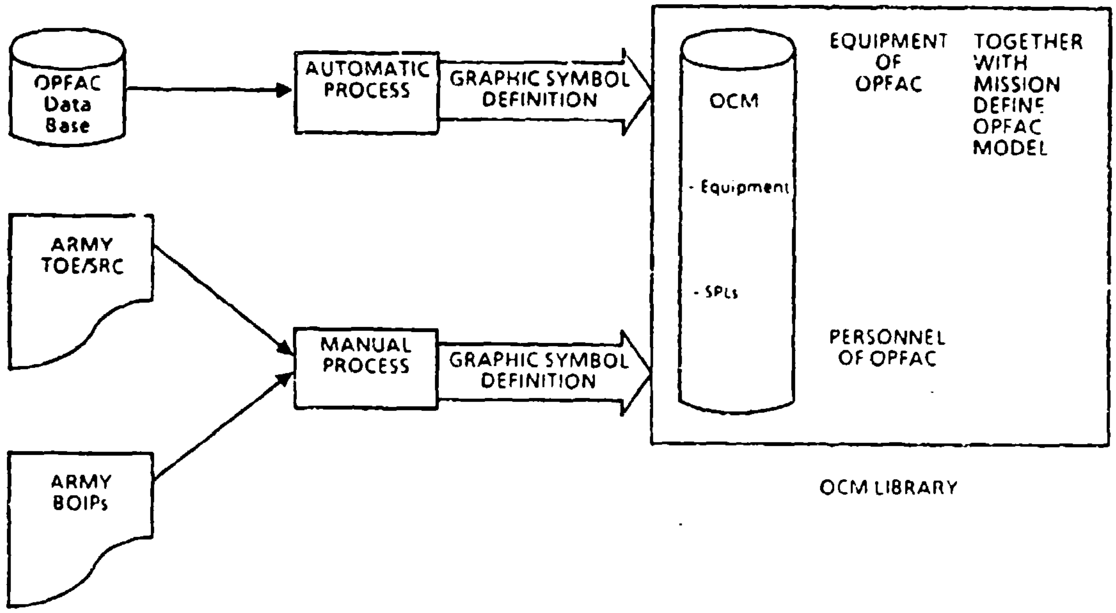

FIGURE 2-5. The Build OPFAC Configu.ation Model allows the user to build the OCM Library by matching the unit's mission with the equipment and personnel authorized for that unit.

FIGURE 2-6. The OCM Library is built using standard Army symbols and equipment based on TOE. The analyst can build OCMs for most units found in the Army.

2.1.4 TM Library

The TM Library is created manually in the NAM. The analyst builds the TMs using the menus in TM Library maintenance. The TMs are communications jammers found in Band I, Band III, MSRT, JTIDS, EPLRS and Generic bands. The user will enter the TMs title, max power, beam width, antenna gain, max vertical angle, antenna height and the jamming band. The jammers are stored in the Library by jamming band. The TMs, like the OCMs, can be ground or airborne types. Figure 2-7 depicts a built TM for the MSRT jamming band.

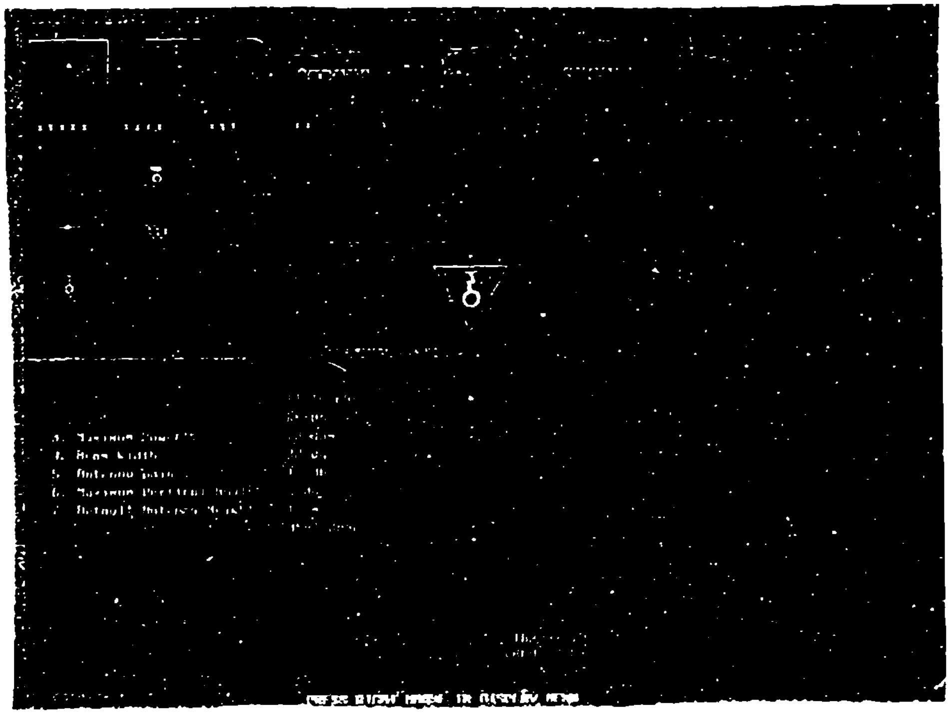

FIGURE 2-7. The TM Library is built using threat parameters found in intelligence documents so that TMs are built to operate as realistically as possible. The analyst will enter the jamming band, power, beamwidth, antenna gain, vertical angle, height, and title.

2.2 MODEL PROCESSES

The stresses of Section 1 are produced by the Model Processes of terrain, threat, battlefield movement, traffic and RAM. These processes provide the realism of the battlefield by influencing modeled communications. Threat, battlefield movement and traffic are defined by the user building the scenario.

2.2.1 Terrain and Electromagnetic Environment

The process of stressing a network in terms of terrain uses the Defense Mapping Agency (DMA) Digital Terrain Elevation Data (DTED) to provide terrain elevations and contours. Section 2.1 explained the loading of DMA data into the NAM, and gave an example of a terrain map. These maps are provided to assist the user in programming the model The primary use of elevation data within the NAM is within the propagation modeling which models the electromagnetic environment.

The electromagnetic environment is an extremely complex environment as shown in Figure 2-8. NAM models this as a function of power levels based upon the transmitted power and the associated power losses through the environment. NAM uses the Terrain Integrated Rough Earth Model (TIREM) to compute the losses encountered by a signal as it goes from transmitter to receiver. The TIREM accepts the location of the transmitter and receiver on a digitized DMA map, the transmitter's frequency, and the antenna height for both transmitter and receiver. TIREM will then return a dB loss based upon these inputs. The NAM then computes the power received by adding the antenna gains of the transmitter and receiver to the transmitter's power and subtracting the path loss returned by TIREM. If the receive power is less than the receiver's Minimum Discernible Signal (MDS) level, the transmission will not succeed and the connectivity routine will be updated for no connectivity. If the receive power is greater than the MDS, the NAM will determine the jammer impact upon the receiver. The cumulative jammer power received will be decremented from the receive power level. If this value is greater than the Minimum Signal-to-Noise Threshold, then the connectivity routine will be updated for connectivity, otherwise, it will be set with no connectivity.

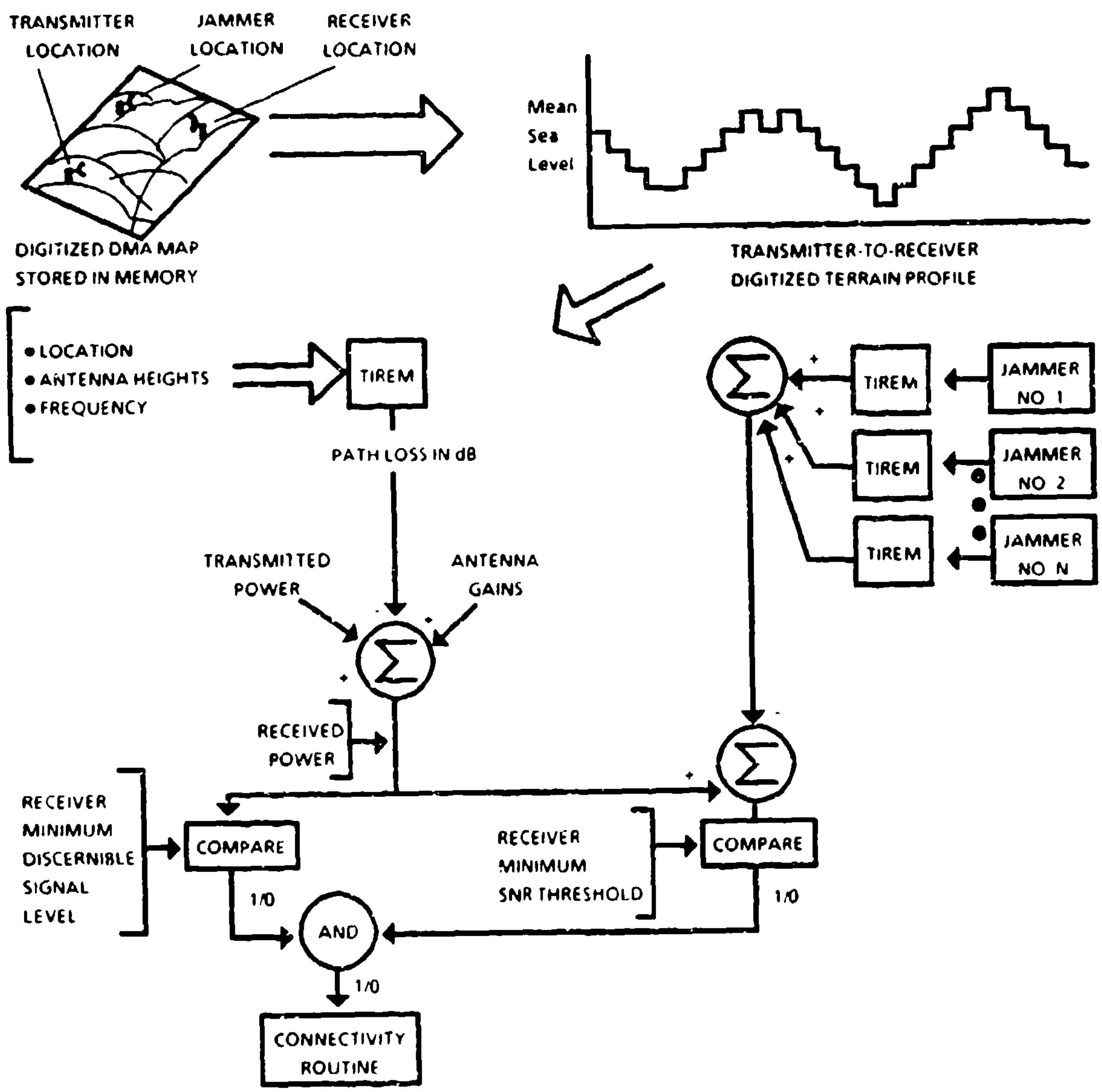

FIGURE 2-8. The TIREM propagation model uses terrain profile, antenna heights, frequency, and location to derive friendly communications received power and enemy jammer power. The friendly received power is compared with enemy jammer power to produce the connectivity routine that is used in the communications model.

2.2.2 Threat

Threat jammers power is also applied to TIREM. The resultant OPFAC power is then compared to the resultant THREAT power. The result is the Receiver Minimum Signal to Noise Ratio (SNR) threshold. The connectivity routine then determines call completion by comparing the minimum Signal-to-Noise Ratio (SNR) with the equipment minimum discernible signal level. The threat (jamming) effects the communications as it does in reality; the user building the scenario selects the threat jammer parameters so to influence the communication directly. Early viewing of the jammer's effective range can be viewed in the menu item 'Jamming Template' as shown in Figure 2-9. In this figure, colors depict the three levels of jamming effects: in the white area, probable communication; in the magenta area, questionable communication; and in the black area, no communication.

Attrition is modeled by capturing the impact of an instantaneous death of an element. Depending upon the element, the consequences can be severe or very minor, i.e., a communication node's attrition would cause many call failures. The user discretely programs the time for attrition to occur.

FIGURE 2-9. This Jamming Template depicts the jamming power of the JTIDS jammer in the shaded areas. The area not shaded shows the effect of terrain masking.

2.2.3 Battlefield Activities

The battlefield activities modeling process stress communications networks by inducing movement and activities which change traffic loading. All of these are user programmable for each element in a scenario. Movement is modeled as a change in the horizontal position for all but airborne OPFACs which can also change vertical positioning. Activities which affect traffic loading include the intensity code and activity code. The former is a modeling of how hard a unit is working from reserve to heavy combat while the latter models specific activities such as river crossings.

2.2.4 Traffic

The traffic process stresses the model by applying the traffic selected by the user to the user designed networks. The user activates needlines to specific OPFACs for the NAM to model traffic. As system load approaches capacity, the probability of success, and net efficiency decreases. Figure 2-10 depicts the flow of traffic in the NAM. OPFAC Configuration Models (OCMs) are built and deployed in scenarios, and once connected to communication nets they become Communication User Models (CUMs). Needlines for the OCM are developed based on SRC paragraph and line numbers matching CDB data, creating the OPFAC Needline Table (ONLT). The deployed CUMs are assigned activity and intensity levels for the scenario to depict battlefield action. The traffic generator activated in SIMRUN creates the requirement to satisfy a needline by scheduling traffic over the needline's primary network or secondary if the primary fails. Offered traffic is routed by way of a Communications Resource Model (CRM) over the networks path by way of a specific network's equipment and protocols to another CRM. Based upon which net is used, obstacles such as jamming and attrition, etc. can cause failure of the communications connection. Traffic passing all of the obstacles will be successfully routed to the receiving CUM. Failed traffic will either be retried or logged as failed.

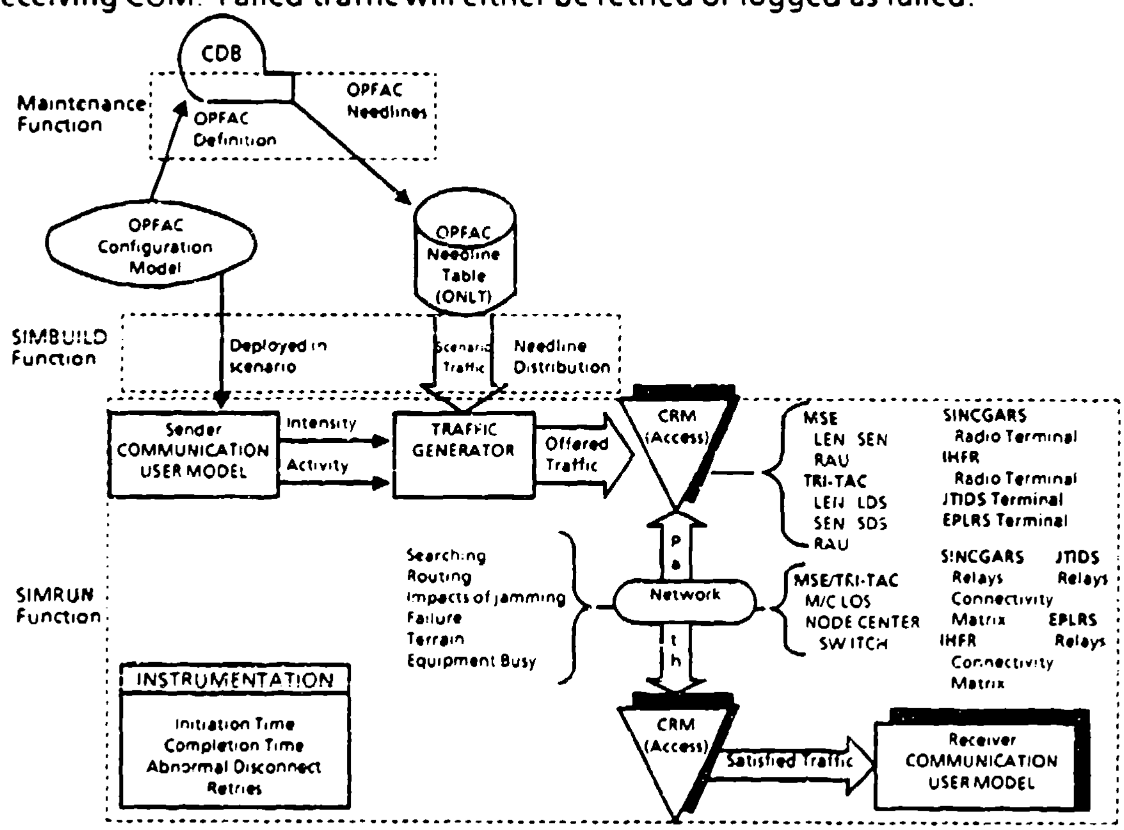

FIGURE 2-10. Traffic is based on deployed OCMs with valid needlines. Once traffic is offered to a net, then various events can happen, such as jamming, failures, etc.

2.2.5 RAM

Modeling of RAM captures the impact of critical component failures thus causing a communications shutdown. The failure is absolute and is considered catastrophic. The modeling takes into account partial failures and redundant equipment by allowing modification of failure time. Thus a switchboard with a redundant processor, would not fail if one processor failed but only if the second failed before the first was restored to major service. The user programs the failures prior to the execution of a scenario.

2.3 MODEL OUTPUTS

The NAM provides three types of output: runtime data during the simulation run, graphical playback data after the simulation run, and post simulation graphical and tabular statistics. These three types of output are all obtained from log files which were produced during the simulation execution. The eight log files and the type of information they contain are shown in Figure 2-11.

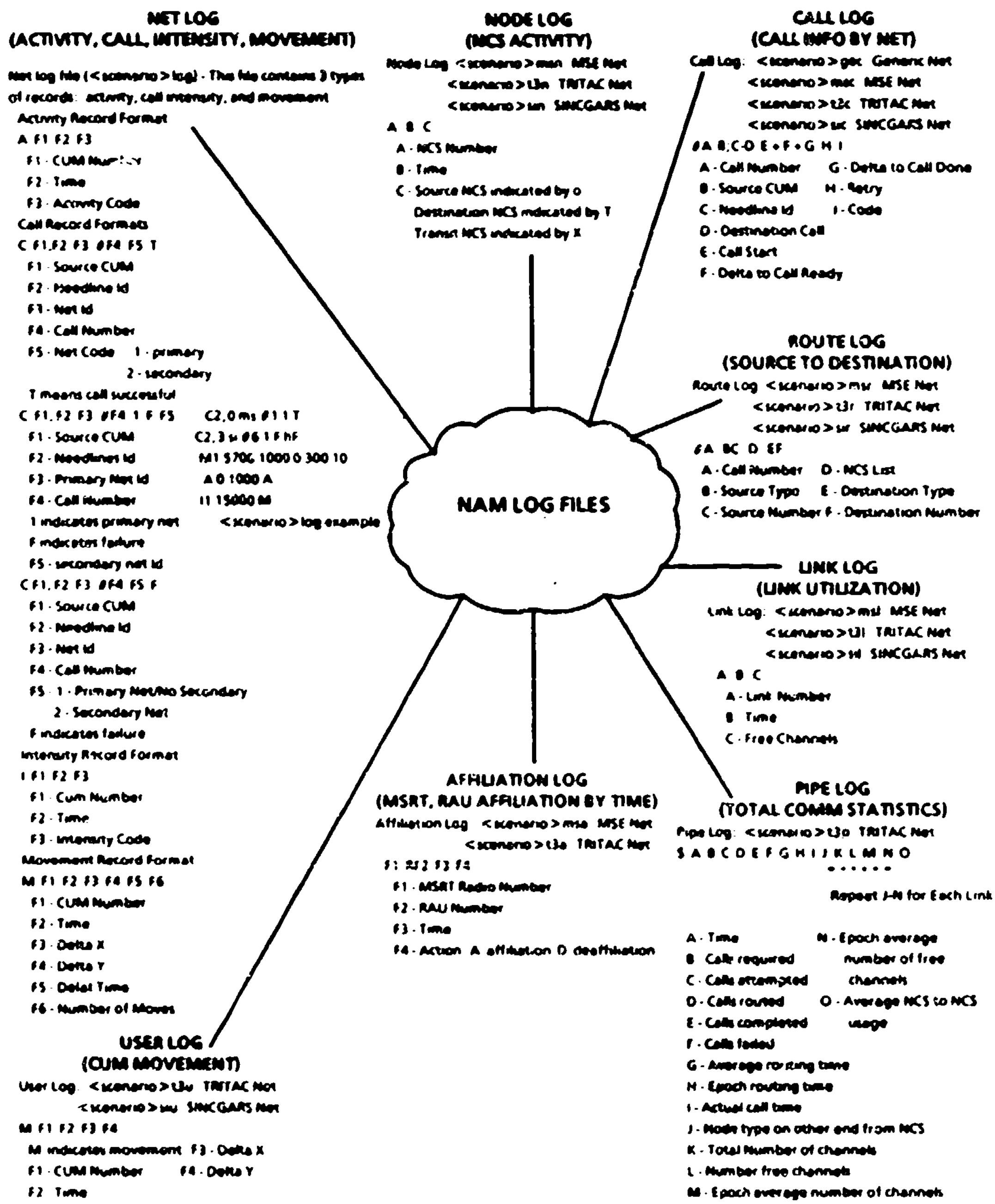

FIGURE 2-11 The net log file is created at the start of the simulation run. All other log files are created during the simulation run. These files will allow the analyst to conduct a detailed study of communications performance.

2.3.1 Runtime Data Output

Runtime Data Output is the output viewed during the run of the simulation. As the simulation runs, this data is read from the output log files and, updates to the graphics occur at each user defined epoch. Figure 2-12 provides a sample of the runtime data output. For the area networks, SINCGARS and High Frequency the display shows the amount of calls required, attempted, routed, completed, and failed. For JTIDs, EPLRS and Generic, the active dedicated paths will be displayed along with total call statistics for the primary and secondary nets and the calls still in progress for both.

FIGURE 2-12. The Runtime Data program reads the simulation interface and control files and sets up the graphics. It then begins reading the simulation run output, maintaining records and statistics. It also updates the graphical performance display each user-defined epoch until simulation execution terminates, as well as provides statistics by net giving call activity, circuit status, and total call success.

2.3.2 Graphical Playback Data

Graphical playback data of the user selected net performance is shown after the simulation has ended. Playback displays traffic on TRI-TAC, MSE, SINCGARS and HF. It also shows RAU affiliation for TRI-TAC and MSE and circuit connectivity for EPLRS and JTIDs. Playback visually portray changes in communications due to the stresses as the scenario is played back. An example of a playback display is shown in Figure 2-13. This playback displays movement and call activity transitting the net. TRITAC playback also displays the amount of calls on each link and the link threshold. Link threshold in red is greater than or equal to 90%, white is greater than or equal to 50%, but less then 90%, and blue is less than 50%.

2.3.3 Post Simulation Statistics

The Post Simulation function allows the user to view graphically or print the statistics generated from the eight log files that can be used to evaluate communications performance. This data provides three types of statistics, traffic, node/switch, and link performance for a selected epoch or the total simulation. Output can be shown as pie/bar charts or as a table of statistics. The table provides the most detailed information. The net log file provides data on activity, call, intensity, and movement. The other log files (i.e., call, route, link, user, affiliation node, and pipe logs) provide detailed information on communications performance. Figure 2-14 is a sample of a Post Simulation statistics display.

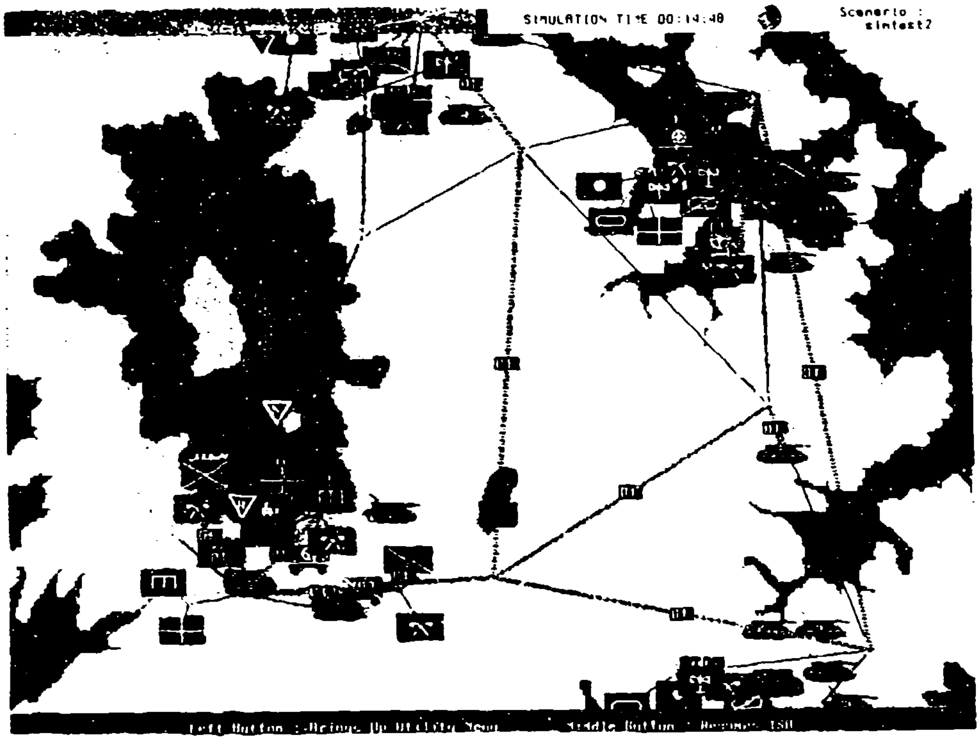

FIGURE 2-13. TRI-TAC Graphical Playback allows the analyst to view a playback of net activities during the scenario.

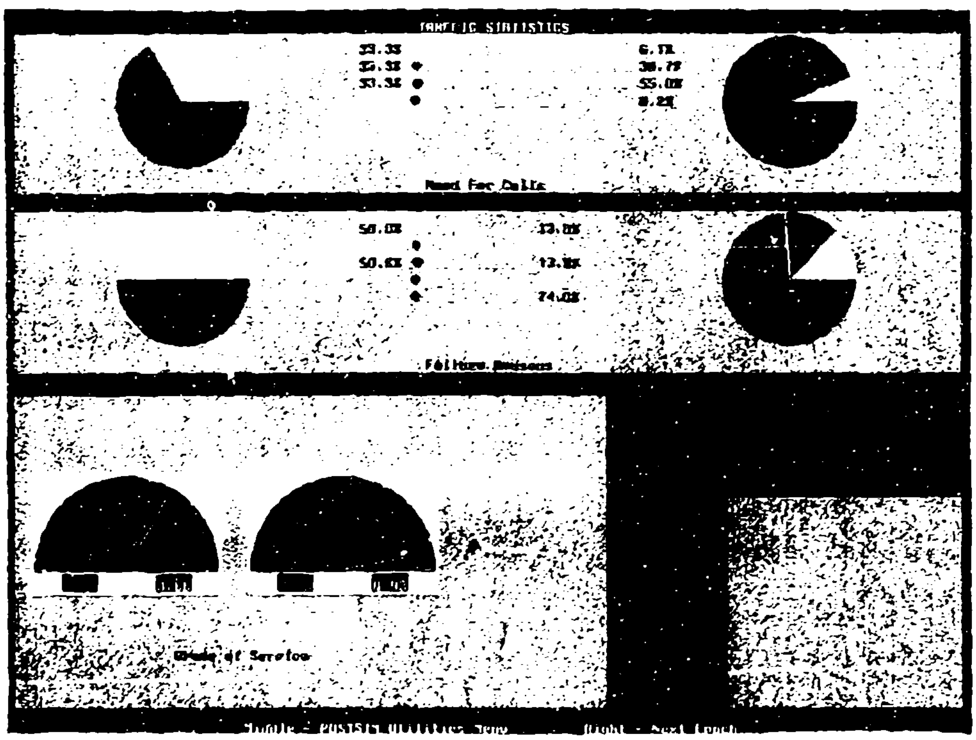

FIGURE 2-14. Post Simulation data for traffic performance can be shown in pie charts.

SECTION 3.

MODEL FUNCTIONS

SECTION 3. MODEL FUNCTIONS

3. MODEL FUNCTIONS

The NAM consists of a number of menu-driven programs that allow the user to build simulation element models, define a simulation scenario, execute a scenario, play back the simulation, and display simulation data in graphical or tabular form for analysis. Thus, the five major functions of the NAM are Maintenance, SIMBUILD, SIMRUN, Tactical Situation Display (TSD), and POSTSIM.

3.1 MAINTENANCE

Use of the NAM begins with the Maintenance subfunctions of OCM and Threat Maintenance, along with Needline Table Maintenance. The user should have a good background in tactical Army organizations in order to use or revise the Force in the OCM Library and a good background in enemy electronic warfare to use or revise the Threat Library.

3.1.1 OCM Library

The OCM represents the communications equipment, data devices, and people by SRC paragraph and line number incorporated in the OCM. The user can use the OCMs as they exist or can modify or create new OCMs. Development of the OCM Library was discussed in Section 2.1.3.

3.1.2 TM Library

The TM Library is created manually by the user selecting and inputting menu driven choices. The user selects the band of the communications jammer along with other information such as power, beamwidth, azimuth, and title. Development of the TM Library was discussed in Section 2.1.4.

3.1 3 Needline Table Maintenance

Needlines represent a mission essential requirement to pass battlefield information between two communications users in the same or different tactical TOE units. The user can choose to create or view needlines in the Needline Table Maintenance process. Section 2.1.2 provided more information on Needlines.

3.2 SIMBUILD

SIMBUILD is the process that the user follows to build or modify a scenario. The user begins by either selecting a pre-existing scenario or defining a new scenario. When a scenario is being built, the force, threat, and communications networks are being deployed geographically. In addition, certain needline relationships are being established.

3.2.1 Force and Threat Laydown

The first event that must be done when creating a new scenario is to choose the map to be displayed. The user will also choose the color file that will define the map's elevations. By selecting a certain map, the user is defining the geographic setting for his scenario.

The next two steps in building a scenario are the deployment of the force and threat. These are both deployed geographically, and tactically represent the combat situation to be modeled. Figure 3-1 shows a deployed force and threat. To assist the user, the NAM has various utilities available to help in the Laydown process. The user can declutter all or part of the force and threat. The map can be zoomed or dezoomed. Colors on the map can be changed to enhance elevations. A get-max elevation selection allows the user to find the highest point in a selected area. A measure distance utility allows the user to measure the distance from one point to another. The coordinates can be changed between Universal Transverse Mercador, Military Grid Reference System, and Latitude/Longitude.

FIGURE 3-1. The force and threat laydown on this map depicts the NAM's use of graphics to aid the analyst in his deployment of forces needed to conduct his communications analysis mission.

3.2.2 Network Engineering

Once the force and threat are deployed, the user is ready to deploy communications networks. The NAM models TRI-TAC Block III, MSE, SINCGARS, HIGH FREQUENCY, JTIDS and EPLRS. These networks are deployed geographically and represent the existence of that particular type of communications device in the area of deployment. These network models are built to perform as realistically as possible. TRI-TAC Block III/MSE allows the user to build, engineer, and affiliate OCMs to the area network. SINCGARS and HIGH FREQUENCY allow the user to declare nets, add OCMs to the nets, place relays, and change net parameters. JTIDS and EPLRS allow the user to develop nets and circuit relationships.

The NAM has several utilities to assist in development of the networks. Figure 3-2 depicts the networks on the left and the engineering utilities across the top. These utilities allow the user to develop the best communication networks. Figure 3-3 and 3-4 show TRI-TAC and JTIDS deployed in a scenario. The TRI-TAC area network display shows the line of sight utility in the upper right corner along with the engineered network. The JTIDS network displays the net utilization utility in the lower left corner along with net connectivity.

NETWORK ENGINEERING UTILITIES

Network / Tool	Line of Sight Profile	Point to Point Connectivity	Net Connectivity	Area Coverage	Net Utilization Table	Review Net List	Place Relays
TRI-TAC/ MSE	X	X (1)		X RAU			
SINCGARS		X	X	X		X	X
High Frequency		X	X	X		X	X
EPLRS		X				X	X
JTIDS		X	X		X	X	X

1 Affiliation/MC Engineering

Figure 3-2. The network utilities allow the user to enhance or develop the networks so they can operate at the optimum level.

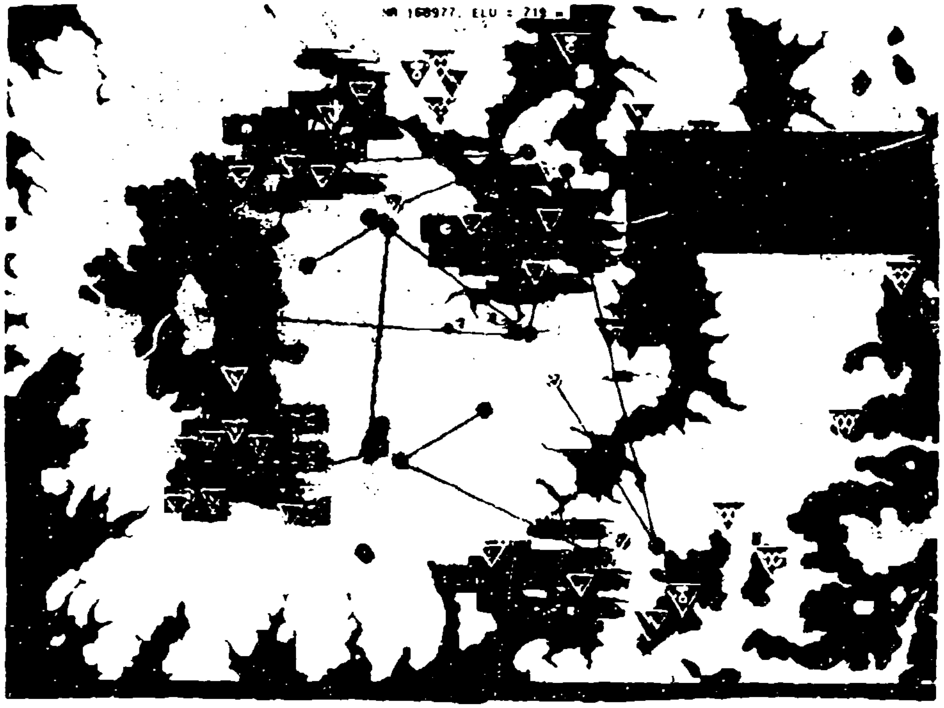

FIGURE 3-3. This net in TRI-TAC is deployed showing TRI-TAC equipment in yellow and MSE equipment in white, with the line of sight along the dotted line.

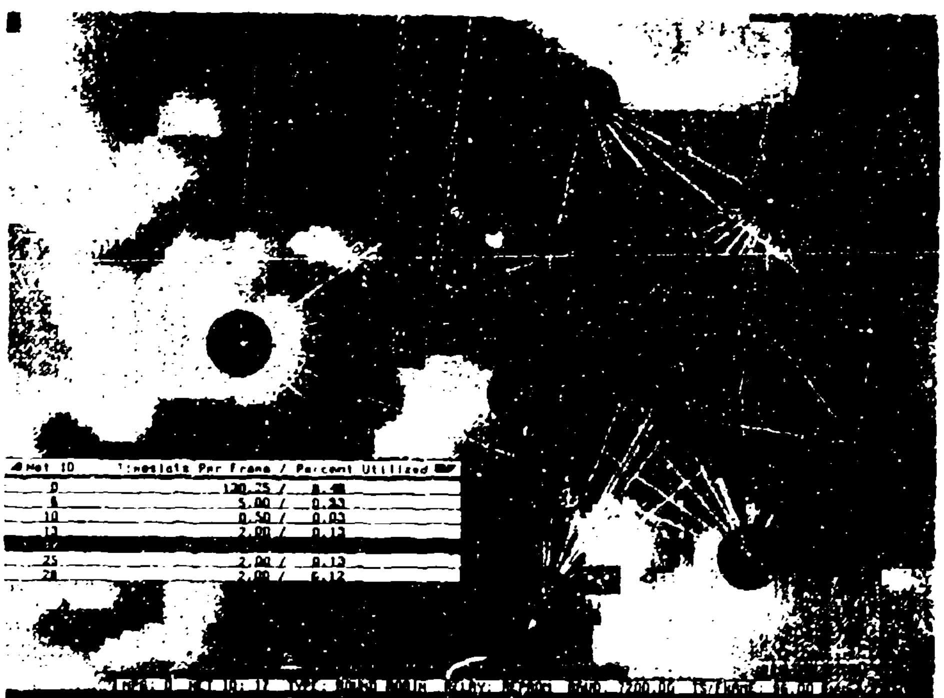

FIGURE 3-4. The JTIDS net display shows connectivity within the net, where OPFACs circled in red are receivers only; those with triangles are relays; and those with three tickmarks are transmitters.

3.2.3 Traffic

A key factor in any communications network is the load that the user places on it, frequently referred to as traffic. Once the force and communications nets have been deployed, the user can generate scenario traffic. The Traffic process allows the user to define which particular units will communicate during the simulation. The needlines identify which units or types of units need to communicate to other units. Traffic allows the user to select by title which of the units needs to communicate to other units by title. Figure 3-5 depicts the process of building traffic. In the lower right side of the chart the ONLT shows that needline one is from Division to Brigade. The scenario requires that 2nd Division talks to its units 1/2 and 2/2. Traffic allows the user to select 2nd Division as the transmitter and only 1/2 and 2/2 as receivers under needline 1. All other potential receivers would not be selected unless the mission required it. In the upper right of the chart, the needline information is displayed for the needline between the Division and Brigade.

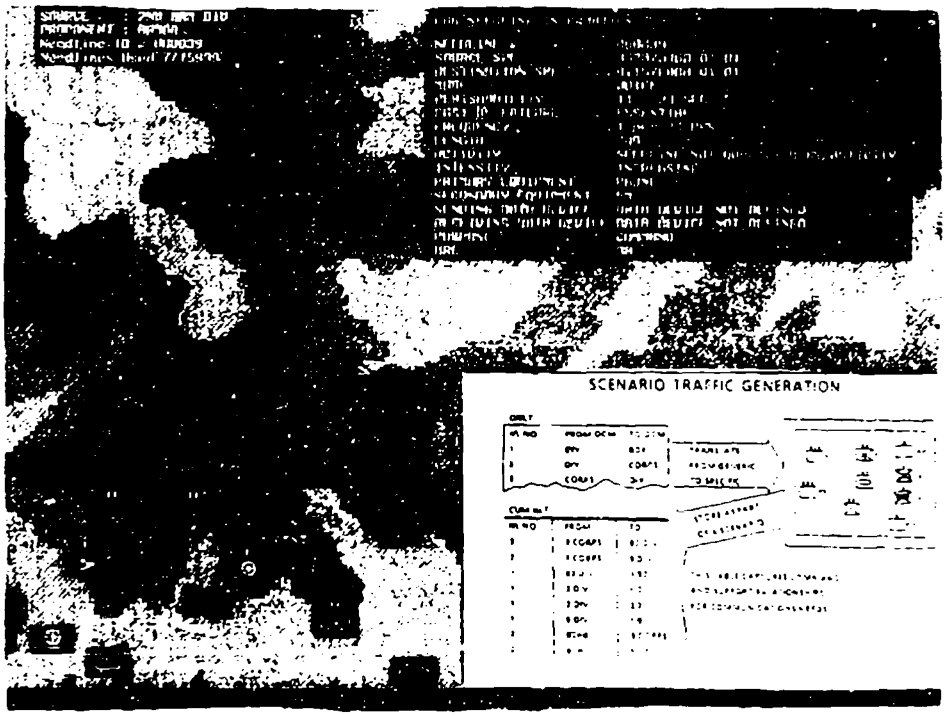

FIGURE 3-5. The analyst must select sender and receiver OCMs by title according to the needlines found in the ONLT. This process creates traffic that is stored as part of a scenario.

3.3 SIMRUN AND PMONITOR

SIMRUN is the process of applying the stresses to the deployed networks for a user defined period of time. SIMRUN allows the user to select which communications networks (TRI-TAC/MSE, SINCGARS, JTIDS, EPLRS, and HIGH FREQUENCY) will be simulated.

SIMRUN programs allow initialization of the simulation through scenario selection and the setting of control parameters and diagnostic flags. Moreover, SIMRUN programs actually perform the simulation for the currently defined scenario. Models placed in a scenario exercise the specified events over time, thus stressing the communications networks and establishing calls as either completed or not. A completed call is a communications connection that can be established and maintained long enough to transmit the information/content of the needline plus associated overhead.

SIMRUN reads the inputs files as prepared in the SIMBUILD process and executes the simulation. The user can modify the control parameters, SIMRUN parameters, or change the network parameters by modifying the affiliations and delays.

Figure 3-6 depicts SIMRUN's handling of the traffic on the nets. Needlines are scheduled and nets are assigned. Traffic is passed to the nets along with OPFAC movement status. Call status is passed back to the OPFAC modeler. If the call failed, the call will be retried or routed to a different net. If the call succeeded, it will be passed to a log file. The network modeler is stressed with Threat, RAM, Movement, and Traffic activity. Network events are also sent to a log file.

SIMRUN's outputs are the log files described in Section 2.3. These log files are used by the output processes. PMONITOR is an on-line function which provides the user with a record of network performance. Figure 3-7 is an example of a PMONITOR screen. Each network has a line chart depicting call requirements, call attempts, which are call requirements obtaining a source instrument, calls routed, calls completed, and calls failed. In addition, the lower right hand corner shows the architecture performance of calls required, completed and failed on the primary and secondary means.

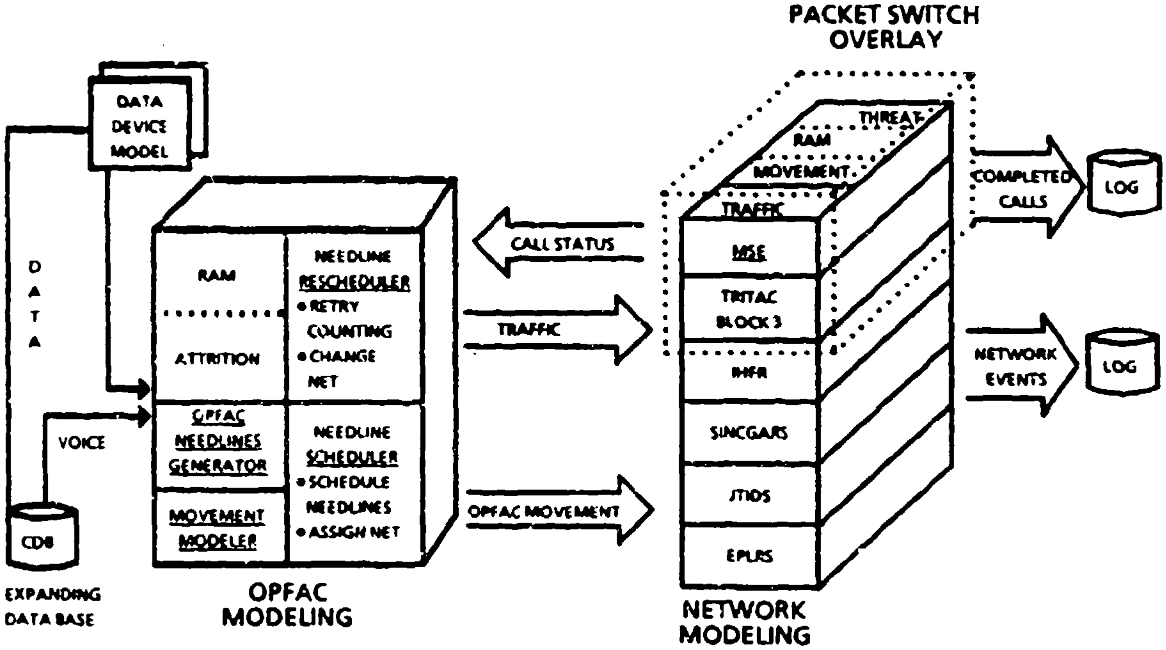

FIGURE 3-6. OFPAC modeling generates the needlines and models the effects of RAM, attrition, and movement, as well as provides needline scheduling and rescheduling for network modeling. Network modeling stores completed calls and network events in log files, as well as returning call status to OPFAC modeling.

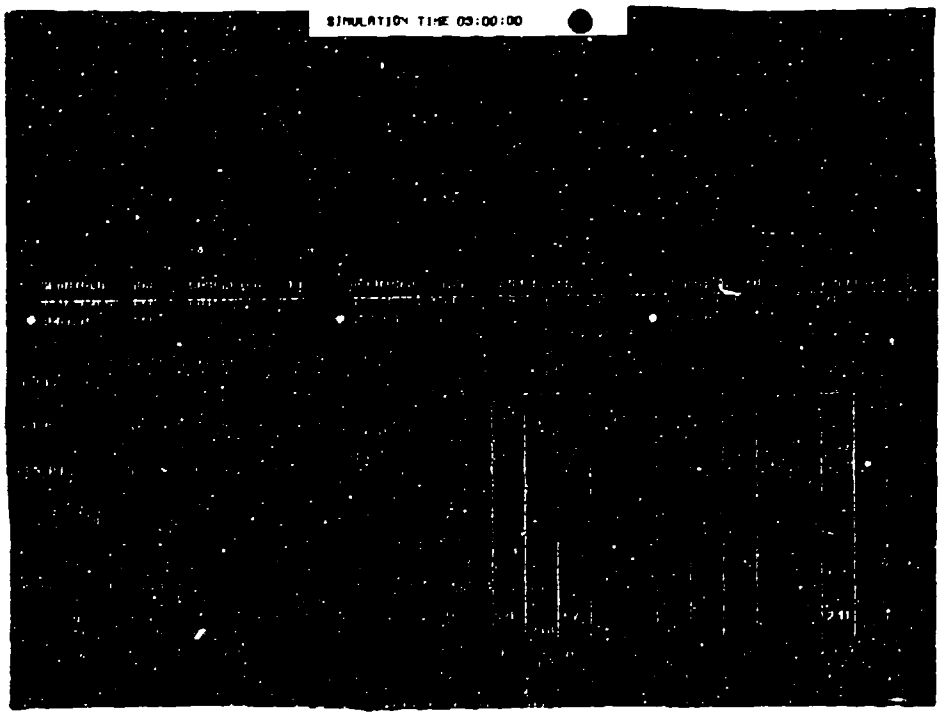

FIGURE 3-7. The PMONITOR Program reads the simulation interface and control files and then begins reading the SIMRUN output. It updates the graphical performance display each user-defined epoch until the simulation execution terminates.

3.4 TACTICAL SITUATION DISPLAY

TSD, a primary NAM output, displays for the user a visual representation of the network, the deployed forces, and the manner in which the network is handling the traffic load during the course of the scenario. The output of this function is a display. Via menus, the user can choose the detail he requires to monitor the network status.

The selection available to the user include the following items:

- Map background
- OPFAC force laydown
- Any subset of the force by proponent or echelon
- Network laydown over the force
- Network laydown in isolation
- Network laydown of specified system components.

Figure 3-8 is a depiction of TRI-TAC TSD. As TSD plays back the simulation and the scenario begins, the screen reveals the events that occured in the scenario. Defined in the SIMBUILD process and exercised in SIMRUN, the CUMs affiliate and deaffiliate with the network. In addition, they move according to their movement profiles, and they originate and receive calls. The display visually represents traffic transitting the network. It also depicts the multichannel network loading as traffic (calls) is serviced on each link. TSD visually represents destroyed or shut down Node Central Switches (NCSs) in those operational and nonoperational states at the appropriately scheduled scenario time. The links change colors, depending on the traffic load. Red indicates channel usage greater than or equal to 90%, and blue represents channel usage less than 50%. White depicts channel usage greater than or equal to 50%, but less than 90%.

These graphics enable the analyst to focus on a particular aspect of the simulation. For example, one can scrutinize a portion of the MSE network to see how it is responding. One can view the effect of OPFAC movement during the scenario on traffic loading. Or, one can see the effects of inserting or shutting down NCSs at key times in the simulation.

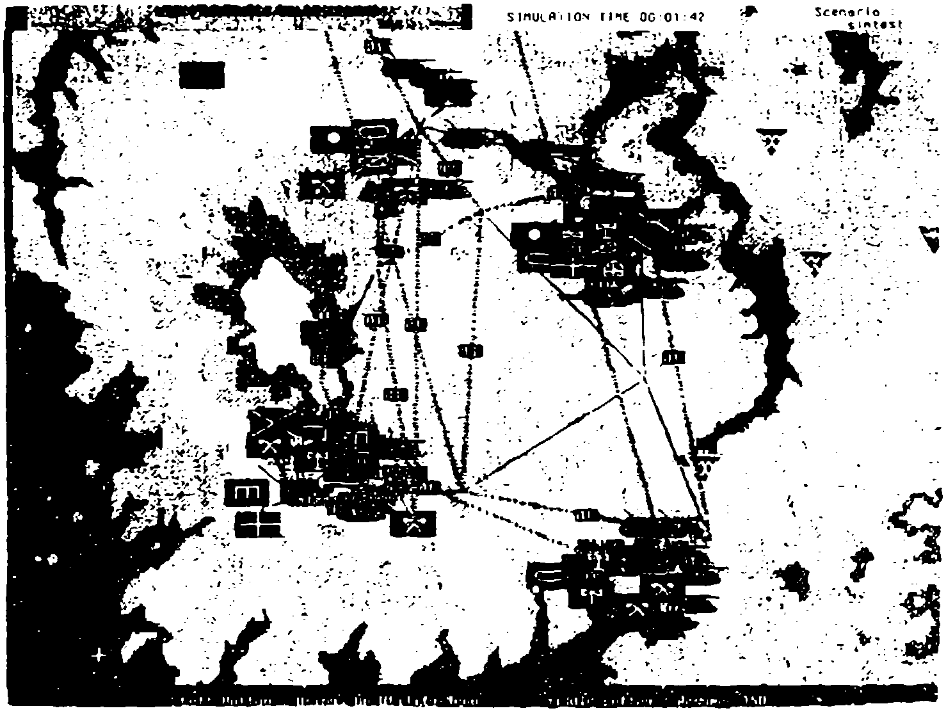

FIGURE 3-8. TRI-TAC Tactical Situation Display (TSD) allows the user to view a playback of the net activities for the scenario. This picture shows the traffic load serviced on the links. The red links show channel usage of greater than or equal to 90%. The blue links show channel usage of less than 50%. The white links depict link usage of greater than or equal to 50%, but less than 90%. The analyst can see the effects of traffic loading, shutdown of NCSs, or other significant programmed events in TSD.

3.5 POSTSIM

The POSTSIM process provides the user with summary statistics from a simulation that has been executed. MSE POSTSIM reviews traffic, node/switch, and link performance, while TRI-TAC, SINCGARS, and HIGH FREQUENCY POSTSIM review only traffic performance. The summaries are displayed in both table and graphical form, showing the epoch and cumulative statistics. Reading and understanding these summaries will require some knowledge of these types of communications networks. POSTSIM also has a call log summary displaying call statistics for all of the networks exercised during the SIMRUN. Cross reference files in POSTSIM enable the user to review all OPFAC, threat and node titles deployed in the selected scenarios, along with the needlines for the scenario.

In all of the POSTSIM processes, the user can jump from any one display to another as long as it is within the options of that network. Also, in all of the POSTSIM processes, the user has the ability to send the table that is being displayed to the printer for a hardcopy. Figure 3-9 is a display of the POSTSIM outputs.

3.5.1 Node/Switch Performance

Node/switch performance reviews the node utilization of an MSE network. Both epoch and cumulative data are displayed as a ratio of nodes utilized for a specific type of call to the total number of nodes utilized.

3.5.2 Link Utilization

Link performance reviews the link utilization of an MSE network. Both epoch and cumulative data are displayed for each individual node as well as for each different type of node. All of the link data displayed are done with regard to the maximum, minimum, and average link utilization.

3.5.3 Traffic Performance

Traffic performance reviews the traffic statistics of all of the networks listed above. Both epoch and cumulative statistics are displayed, reflecting the ratio of need for calls to total calls and the ratio of reason for failure to total failures.

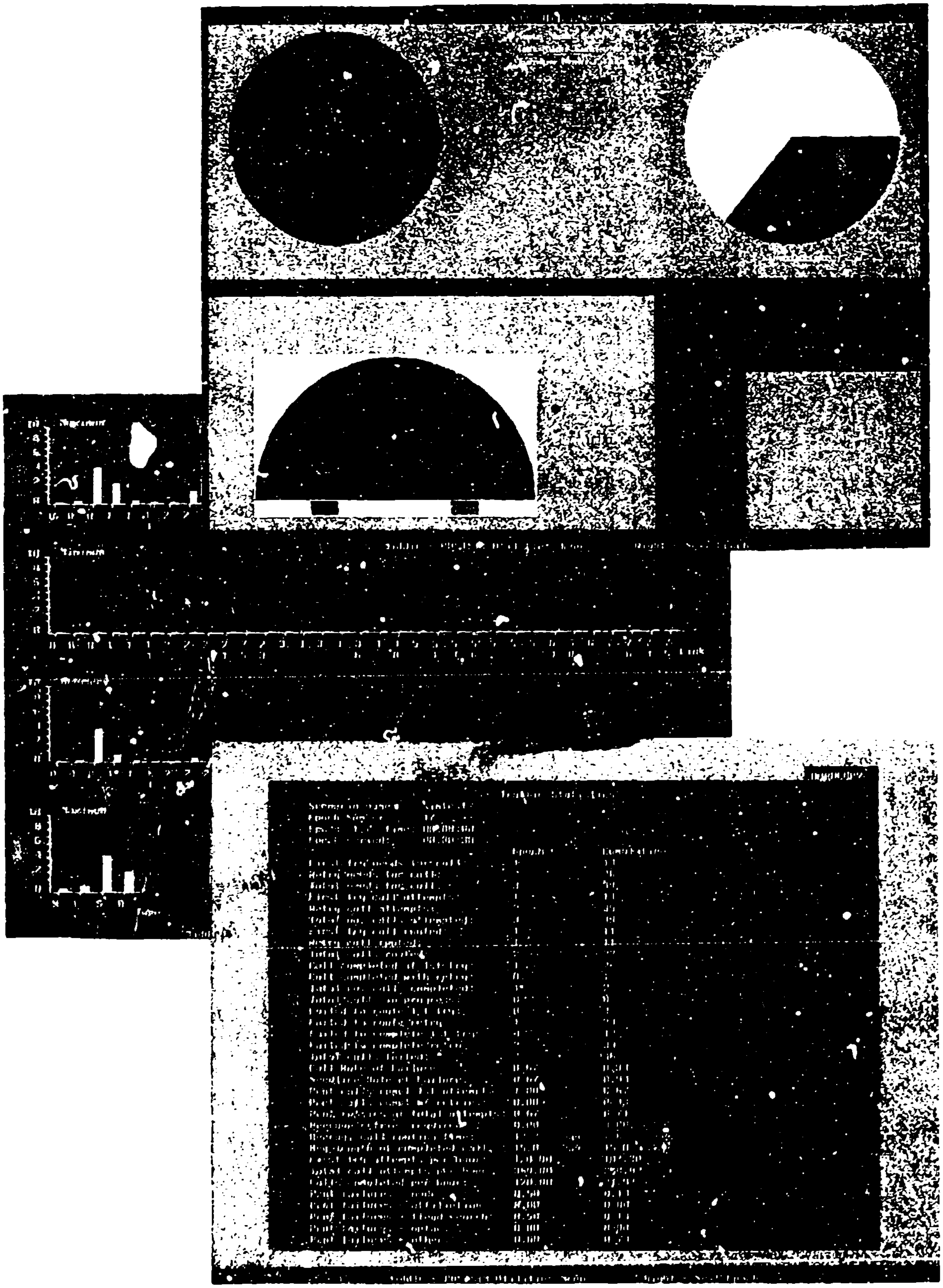

FIGURE 3-9. POSTSIM provides the user with graphic or statistical data on nodes/switch, link utilization, and traffic performance.

SECTION 4.

MODEL EXPANSION

SECTION 4. MODEL EXPANSION

4.1 CURRENT EXPANSION EFFORTS

The NAM development is a continuous process. New and changing communications requirements generate the need for expansion of the NAM. Currently, a Battlefield Automated Systems (BAS) Model, a Packet Switch Model and an EMC module are under development. The NAM can also be interfaced to work with other models such as the Tactical Missile Defe[illegible] MD) C3ISIM and the Field Artillery's Target Acquisition Fire Support M[illegible] SM). The Battlefield Automated Systems (BAS) Model is a generi[illegible] odel modularly built to allow for expansion into the family of Arm[illegible] tems by loading system specific data from user defined data files. [illegible] Model is in the design phase of development. This design will addr[illegible] message handling capabilities between automated systems and the packet sw[illegible] network. The EMC module, a mutual interference modeling capability for the NAM, will add the ability to evaluate EMC impact on NAM modeled systems over a Corps size area. It will also add the ability to use Digital Features Analysis Data (DFAD) from Defense Mapping Agency (DMA) in propagation modeling.

4.2 FUTURE EXPANSION AND UPDATING

Future expansion effort must address the Communications Data Base (CDB), OPFAC Data Base (ODB), General NAM maintenance, revised Traffic Generation process, revised Threat display, Graphics Library additions, movement, Database Management System, POSTSIM, multiple Area Networks modeling, NCS-J, EPLRS intercommunity and scenario dependent needlines. These will enhance not only the Signal Center's use of NAM, but all users.

4.2.1 Communications Data Base (CDB)

The CDB must be updated to reflect the latest TOE series requirements. Battlefield Automation Systems require needlines reflecting their distribution in organizations. Verify, validate, edit, and consolidate SRC lists developed in different NAM development phases. Institutionalize the CDB update process by development of a regulatory process.

4.2.2 OPFAC Data Base (ODB)

The ODB is the prime source for input to the OCM Library. Changes in organizations and functions within the Army cause the ODB to become obsolete if not updated and affect the validity of NAM use. Systematic implementation of OPFAC Rules of Allocation on a semiannual basis will document allocation changes and must be accomplished. Changes to doctrinal symbology dictates updating the symbols used in the OCM Library. The verification and validation of, and additions to, the OCM Library using the latest TOE series is necessary for continued NAM validity. The aggregating of all of a units OPFACs into a single OPFAC to satisfy large overview modeling will help in large area assessments.

4.2.3 Network Assessment Model (NAM)

A number of enhancements have been proposed. Briefly stated these are:

- Change the Threat Display to allow for display of EW efforts vis-a-vis their target band communications. This enhances the user's ability to examine a specific force's ability. Ensure terrain affects on the jamming template when viewed are accurate.

- Correcting user found flaws and installing user suggested "better way" items makes the NAM more user friendly and tool friendly. This will include modifications to the Graphics Library to reflect current Army symbology. Enhance movement to provide more movement modes and easier programming.

- Create a database management system for the OCM Library files, the scenario files, and the output files. Use DBMS for POSTSIM.

- Expand NAM to run more than one Area Network. Development of large scenarios such as Tactical Missile Defense (TMD) require integration of more than one Corps Area Network and an EAC Network.

- Expand JTIDS to model the actions of the NCS for JTIDS to include dynamic management.

- Revise EPLRS to allow for traffic to be exchanged within different communities. The capability will be key for analysis of division BAS traffic which uses EPLRS.

- Add the ability to develop and rapidly insert scenario dependent needlines that would allow the user the capability to test different communication configurations without effecting the current needline table.

APPENDIX A

TERMS AND ABBREVIATIONS

TERMS AND ABBREVIATIONS

BAS	Battlefield Automated System
BOIP	Basis of Issue Plan
CACDA	U.S. Army Combined Arms Combat Development Center
COMSIM	Communications Simulation System
CONOPS	Continuity of Operations
CDB	Communications Database
CRM	Communications Resource Model (The equipment that is used for an OPFAC to access a net.)
CUM	Communications User Models (Once an OPFAC is deployed and becomes a member of a net(s), it becomes a CUM)
DFAD	Digital Feature Analysis Data
DMA	Defense Mapping Agency
DTED	Digital Terrain Elevation Data
EAC	Echelon Above Corps
EMC	Electromagnetic Compatibility
EPLRS	Enhanced Position Location Reporting System
EPOCH	Time Period Used for Data Collection
EW	Electronic Warfare
IHFR	Improved High Frequency Radio
JTIDS	Joint Tactical Information Distribution System
LDS	Large Ditial Switch
LEN	Large Extension Node
LOS	Line of Sight
MDS	Minimum Discernible Signal
MGRS	Military Grid Reference System
MSE	Mobile Subscriber Equipment
MSL	Mean Sea Level
MSRT	Mobile Subscriber Radio Terminal
NAM	Network Assessment Model

TERMS AND ABBREVIATIONS (continued)

NCS	Node Central Switch
OCM	OPFAC Configuration Model (A unit or grouping of units with communications equipment, SRCs)
ODB	OPFAC Database
OE	Operational Element
ONLT	OPFAC Needline Table
OPFAC	Operational Facility (A unit with communications equipment and personnel (SRC).)
PMONITOR	Performance Monitor
POSTSIM	Post Simulation
RAU	Radio Access Unit
RAM	Reliability, Availability, and Maintainability
SDS	Small Digital Switch
SEN	Small Extension Node
SIMBUILD	Simulation Build
SIMRUN	Simulation Run
SINCGARS	Single Channel Ground and Airborne Radio System
SNR	Signal to Noise Ratio
SPL	SRC, Paragraph, and Line Number
SRC	Standard Requirements Code
TAFSM	Target Acquisition Fire Support Model
TIREM	Terrain Integrated Rough Earth Model
TM	Threat Model
TMD	Tactical Missile Defense
TRADOC	U.S. Army Training and Doctrine Command
TRI-TAC	Tri-Service Tactical Communications
TSD	Tactical Situation Display
TOE	Table of Organization and Equipment

APPENDIX B

APPLICABLE DOCUMENTS

APPLICABLE DOCUMENTS

Current Documents

1. Technical Report, MD88-CDSF-0020, Program Maintenance Manual of the Communications Simulation Network Assessment Model, 30 September 1988

2. Technical Report, MD89-CDSF-0018, Communication Simulation Network Assessment Model, Phase III Progress Report, 30 April 1989

3. Technical Report, MD89-CDSF-0037, 3.3 Release of Users Manual, 30 November 1989

4. Technical Report, MD89-CDSF-0021, Functional Requirements for the Battlefield Automation Systems (BAS), 19 July 1989

5. Technical Report, MD89-CDSF-0023, Methodology Manual for the Network Assessment Model, 30 November 1989

Historical Documents

1. Technical Report, MD86-CDSF-0044, Communications Simulation (COMSIM), Progress Report, Task Order 009, 29 August 1986

2. Technical Report, MD86-CDSF-0054, Communications Simulation Network Assessment Model, Phase I Progress Report, Task Order 009, 31 October 1986

3. Technical Report, MD87-CDSF-0020, User's Manual of Communications Simulation System (COMSIM), 26 June 1987 (Phase I User's Manual)

4. Technical Report, MD87-CDSF-0026, Communications Simulation, Network Assessment Model, Phase II Progress Report, Task Order 009, 1 July 1987

5. Technical Report, MD87-CDSF-0032, Communications Simulation, Network Assessment Model, Phase II Progress Report, Task Order 009, 1 October 1987

6. Technical Report, MD88-CDSF-0019, User's Manual of Communications Simulation System (COMSIM), 29 July 1988 (Phase II User's Manual)

7. Technical Report, MD88-CDSF-0032, Communications Simulation, Network Assessment Model, Phase I and II Final Reports, Task Order 009, 31 August 1988

8. Technical Report, MD89-CDSF-004, Communications Simulation Network Assessment Model, Phase III Progress Report, 31 January 1989

Related NAM Documents

1. Task Order Proposal for Design and Development of the Communications Simulation (COMSIM) Network Assessment Model, Volume II, Functional Description, 29 May 1986

2. Functional Description of the Communications Simulation System (COMSIM) Network Assessment Model, Updated June 1987

APPLICABLE DOCUMENTS (continued)

Related NAM Documents (continued)

3. Final Report, Mobile Subscriber Equipment Performance Analysis Model (MSEPAM) Comparative Assessment, Task Order 012, Subtask 12, 28 August 1987

4. Technical Reports, Conversion and Transfer of OPFAC Data to Network Assessment Model (NAM), 2 May 1988

5. Technical Report, MD88-CDSF-0014, Specifications for EPLRS Model, 13 May 1988

6. Technical Report, MD88-CDSF-0024, Functional Specification for the JTIDS Function of the Network Assessment Model, 1 August 1988