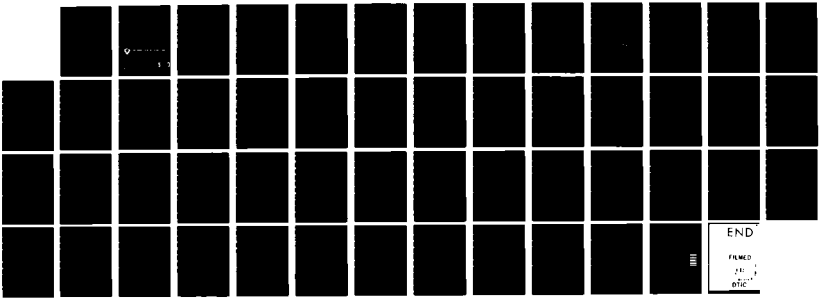
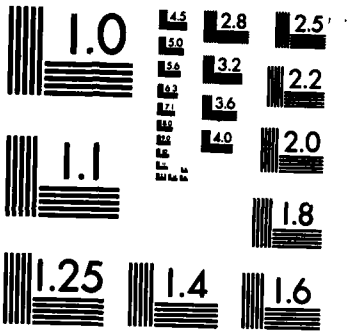
AD-A125 950 THE BRL MESSAGE PROCESSING MODEL (BRLMPM)(U) ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND ABERDEEN PROVI... M A HIRSCHBERG JAN 83 ARBRL-TR-02464 1/1

UNCLASSIFIED SBI-AD-F300 174 F/G 19/6 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(2)

TECHNICAL REPORT ARBRL-TR-02464

THE BRL MESSAGE PROCESSING MODEL (BRLMPM)

Morton A. Hirschberg

January 1983

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
BALLISTIC RESEARCH LABORATORY
ABERDEEN PROVING GROUND, MARYLAND

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TECHNICAL REPORT ARBRL-TR-02464	2. GOVT ACCESSION NO. AD-A125 950	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* THE BRL MESSAGE PROCESSING MODEL (BRLMPM)		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)* Morton A. Hirschberg		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Ballistic Research Laboratory ATTN: DRDAR-BLB Aberdeen Proving Ground, MD 21005		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1L162618AH80
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research & Development Command US Army Ballistic Research Laboratory (DRDAR-BL) Aberdeen Proving Ground, MD 21005		12. REPORT DATE January 1983 13. NUMBER OF PAGES 61
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Communications Modeling	Field Artillery
Message Processing	Communications Networks
Computer Modeling	Queues
TACFIRE	

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)* (a1)

The BRL Message Processing Model (BRLMPM) is a FORTRAN computer code for the study and evaluation of communications systems, message processes, and tactical doctrine. Messages are generated and placed in a queue for processing. Doctrinal rules select messages from the queue and step them through a series of stages until they reach the completed state at which time they are removed from the queue. Inputs characterizing one or more communications systems are

(Continued)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

20. ABSTRACT (Continued)

used in conjunction with the doctrinal rules to simulate the flow of messages through a communications system.

Presently, the model is configured to simulate TACFIRE and/or BCS fire missions using scenarios developed by the Human Engineering Laboratory (HEL), Aberdeen Proving Ground, Maryland.

Model outputs consist of a message history file which can be analyzed over many parameters of interest, such as, unit, link, or net usage.

Further uses of the model are the incorporation of statistical analyses, or the entire model itself into larger existing or planned war games or simulations.

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

The BRL Message Processing Model (BRLMPM) is a heavily input driven, well-commented FORTRAN computer code. The code, consisting of 4500 lines (2200 of which are comments), is contained within 47 program modules and has three major functions:

1. Input/Output and bookkeeping
2. Message generation and queuing
3. Doctrine

A simple flow diagram of the model is shown in Figure 1.

The impetus for the model was the study of artillery communication systems; however, the model is much more general and can be used to study and evaluate:

1. Communications systems (digital, wire, voice)
2. Message processes and queues
3. Tactical doctrine

In order to achieve generality and flexibility, the code requires a large number of inputs. Presently there are five input classes which are:

1. General
2. Unit, Link, Net
3. Message
4. Equipment
5. Delays

In general, doctrinal rules are embodied in the computer code and are not greatly affected by the inputs. On the other hand, changes in message rates reflecting different equipment types are easily handled by the inputs and require little, if any, coding changes.

The model as it is presently configured does not include a link status component or complete rules for link switching; therefore, PLRS/JTIDS or packet radios cannot be simulated.

The remainder of the report will describe the model presenting:

1. Input/output
2. Doctrine
3. Current capabilities
4. Possible modifications

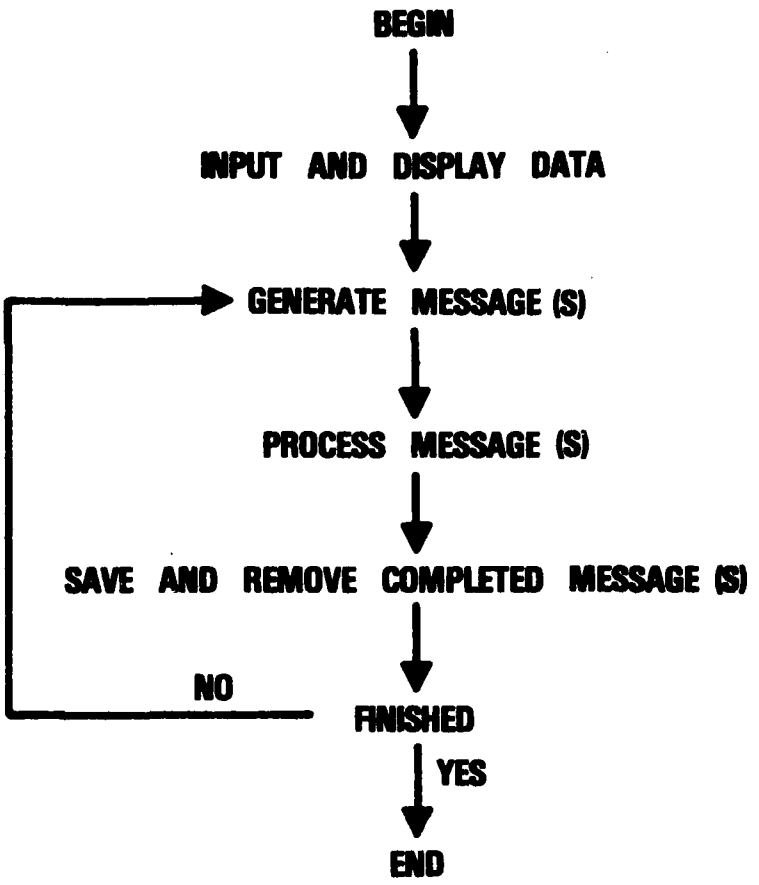


Figure 1. BRLMPM Simple Flow Diagram

II. MODEL DESCRIPTION

The BRL Message Processing Model (BRLMPM) is a time - based simulation capable of processing messages over a 24 hour period. There is nothing sacred about this choice and it may easily be changed. The model begins and ends at user specified times and runs using a game time cycle or increment also specified by the user. The minimum cycle time is one second. Typically, message events are processed in the cycle immediately following the action time. This does not denigrate the validity of the model; the communications systems, message processors, or tactical doctrine tested; or the trends produced.

The BRLMPM normally runs 60 times faster than real time. That is, 60 seconds of game time using a one second game cycle time uses one second of computer time.

To facilitate the following discussion, a flow chart of the main driving program (DRVMPM) appears as Figure 2.

The model begins by reading and displaying the inputs. A description of the inputs and the required formats for them appear in Appendix A. The inputs, as displayed by the program, may be found in Appendix B.

There are five classes of inputs:

1. General (GENRD)
2. Unit,link, and net (UNLKNT)
3. Message (MESRD)
4. Equipment (not used at present) (EQUIPD)
5. Delays (DELYIN)

Each class of input is read and printed by the routine indicated in parentheses and called by a master routine (CMINOT). In the following discussion, individual inputs will only be described to clarify the model, show flexibility, or provide emphasis.

The model next initializes various counters, masks, and values not set by the input routines. This is done in subroutine (SETVAL) and by the main driver (DRVMPM).

Next, the message queue is initialized in subroutine (INTLMS). The message queue is basically a successor list with pointers to the lowest message, last message, and the next message. Provision has been made to handle 1500 messages, of which the first five are used as an artifact in the initialization process. No attempt was made to emulate the message queue sizes of existing tactical computer hardware.

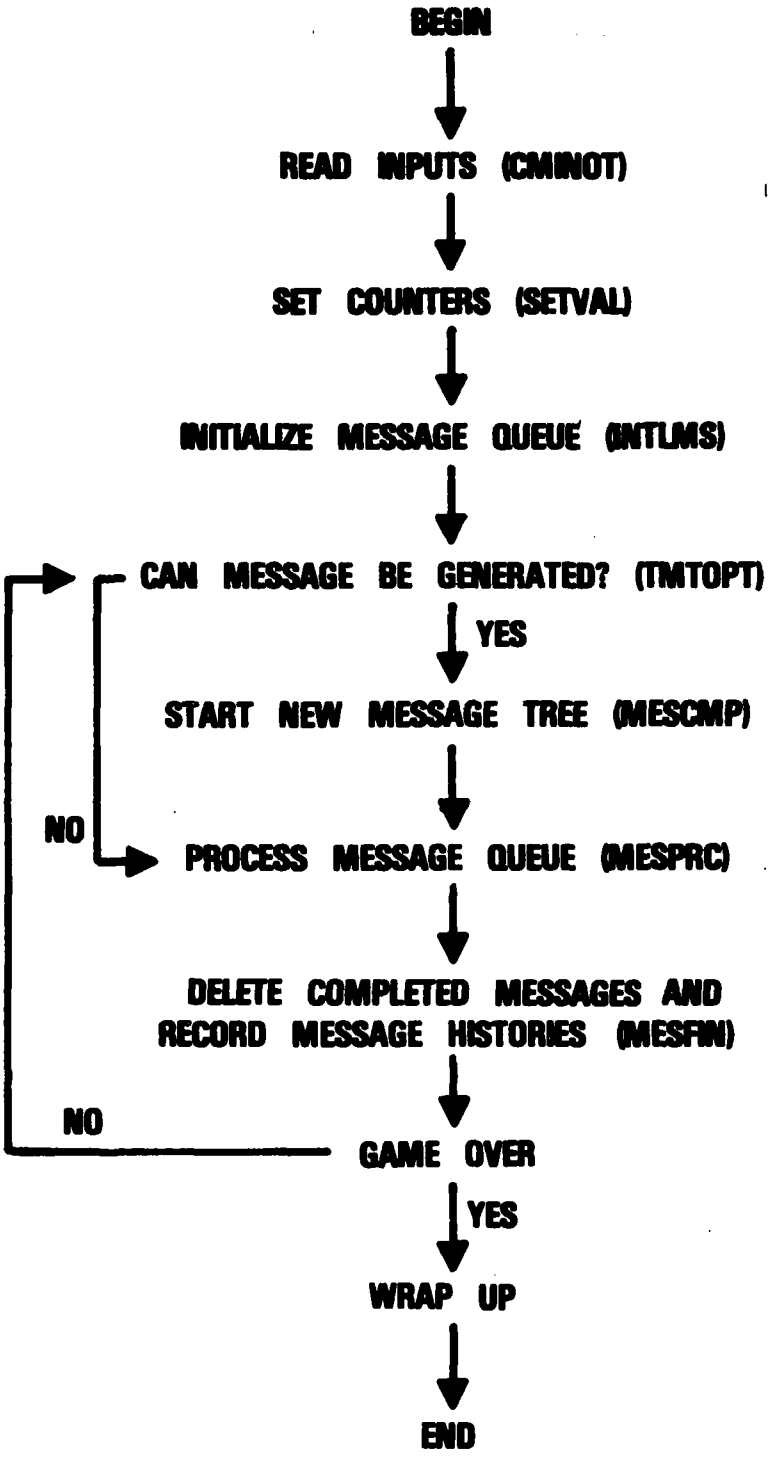


Figure 2. BRLMPM Main Program Flow Chart

The model now looks to see if it is possible to insert a message. Subroutine (TMTOPT) finds the time interval containing the current time and insertion rate for that interval. A random number is drawn and using the insertion rate and game time cycle increment, the appropriate number of messages (possibly none) is determined for this game cycle.

If a message can be inserted, subroutine (MESCMP) is called. MESCMP generates the first message of a series of messages using mission profiles supplied by the Human Engineering Laboratory (HEL), Aberdeen Proving Ground, Maryland. A mission profile is the collection of messages necessary to complete a mission. Mission profiles are input to the program and used as a template or skeleton with other program data filling in the template as the simulation progresses. We call each such series of messages a mission message tree or message tree. Mission profiles need not conform to existing doctrine and are quite flexible, handling from 1 to 40 messages with provisions for repeating a contiguous set of messages as many as five times. This is the way an artillery mission including all the adjust fire messages is modeled.

MESCMP begins by selecting a mission profile. Up to 15 profiles may be supplied for any simulation. Once the mission is selected, a valid sender unit is found. In addition, the unit structure, which holds the sender, is also selected. All following units (senders or addressees) must belong to this unit structure. This way we always insure that the proper FIST will be associated with his FOs, etc. Unit structures are very flexible and it is up to the user to determine the format for a unit structure. The model allows 10 unit structures each containing up to 50 units. (NOTE: The model is presently limited to 150 unique units.) MESCMP now searches for an appropriate addressee. MESCMP requires that a direct link be found between the sender and the addressee because the BRLMPM does not currently handle link switching. Once link switching is incorporated, this restriction will be removed. If a direct link cannot be found, an error message is printed and the simulation is terminated. If a direct link is found, the appropriate message parameters are selected using the message type supplied in the mission profile. Message parameters include sender, addressee, unit structure, message tree number, an external message number, an internal message number (non-unique for use by the message queue), link number, net number, message precedence, message priority, message length, message type, message number in the message tree, mission type, message count, starting time of message, ending time of the message, extraordinary delay time, status, and provision for up to 5 links when switching is incorporated.

Once the message parameters have been selected, MESCMP attempts to enter the message into the message queue using subroutine (INSMSG). If successful, the number of adjust fires (possibly none) for the mission is computed, and the units selected as sender and the addressee are recorded so that no new units of the same generic class will be used for this mission message tree. MESCMP then determines whether or not the

message just processed is a simultaneous message. If so, subroutine (SIMMSG) is called to see if the next message is also tagged as a simultaneous message. If so, subroutine (GENNXT) is called to set up, generate, and insert into the message queue the next message for this mission message tree. MESCMP will continue to call SIMMSG and GENNXT until all contiguous simultaneous messages have been inserted. The routine is then exited.

If MESCMP is not able to insert a message into the message queue, a warning is printed and the routine exited.

Subroutine GENNXT, mentioned above, generates the next message of the mission message tree. It is in this subroutine where the testing of repeated sets of contiguous messages (adjust fire loops) occurs, and th correct sequencing of messages is handled. Of course, there need not b any repeats. GENNXT inserts, at most, one message into the messag queue. In addition, GENNXT recognizes when it has finished insertin the last message of a mission message tree.

If it was not time to enter a message, or MESCMP completed successfully, it would now be the logical place to generate background messages or special messages. The former would be used to put a load on the system; the latter to model a known scenario. Currently, neither is modeled.

The model continues by calling (MESPRC), which is the heart of the simulation. MESPRC contains the algorithms for stepping a message through a series of stages from insertion to completion. The flow chart shown in Figure 3 will be most helpful for the discussion of subroutine MESPRC.

The algorithms chosen for the initial version of the model are:

1. Messages will be processed on a first come - first serve basis. That is, the lowest time message will always be looked at first and serviced if possible. Note: the mechanisms for priority and precedence handling exist through the inputs but have not been implemented.

2. There is no link switching - a direct link between units is a current necessity.

3. There is no bumping.

4. A message must be in the completed state awaiting final processing time to expire before an acknowledgement message is sent.

5. The acknowledgement message must be completed before the message which generated it.

6. The next message on the mission message tree will not be inserted into the message queue until its predecessor has been removed (with the exception of simultaneous messages).

THIS PAGE INTENTIONALLY LEFT BLANK

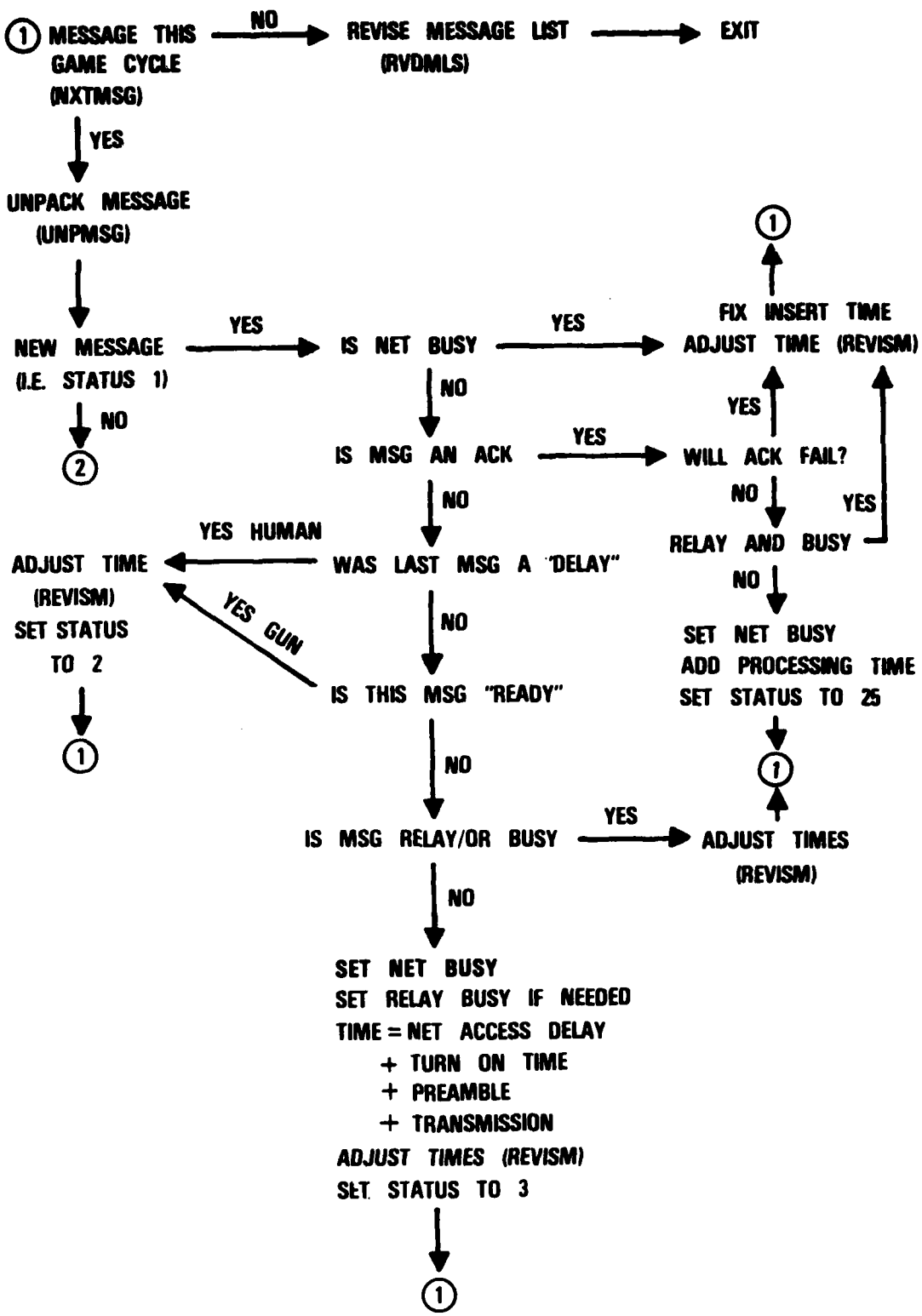


Figure 3. Message Processing

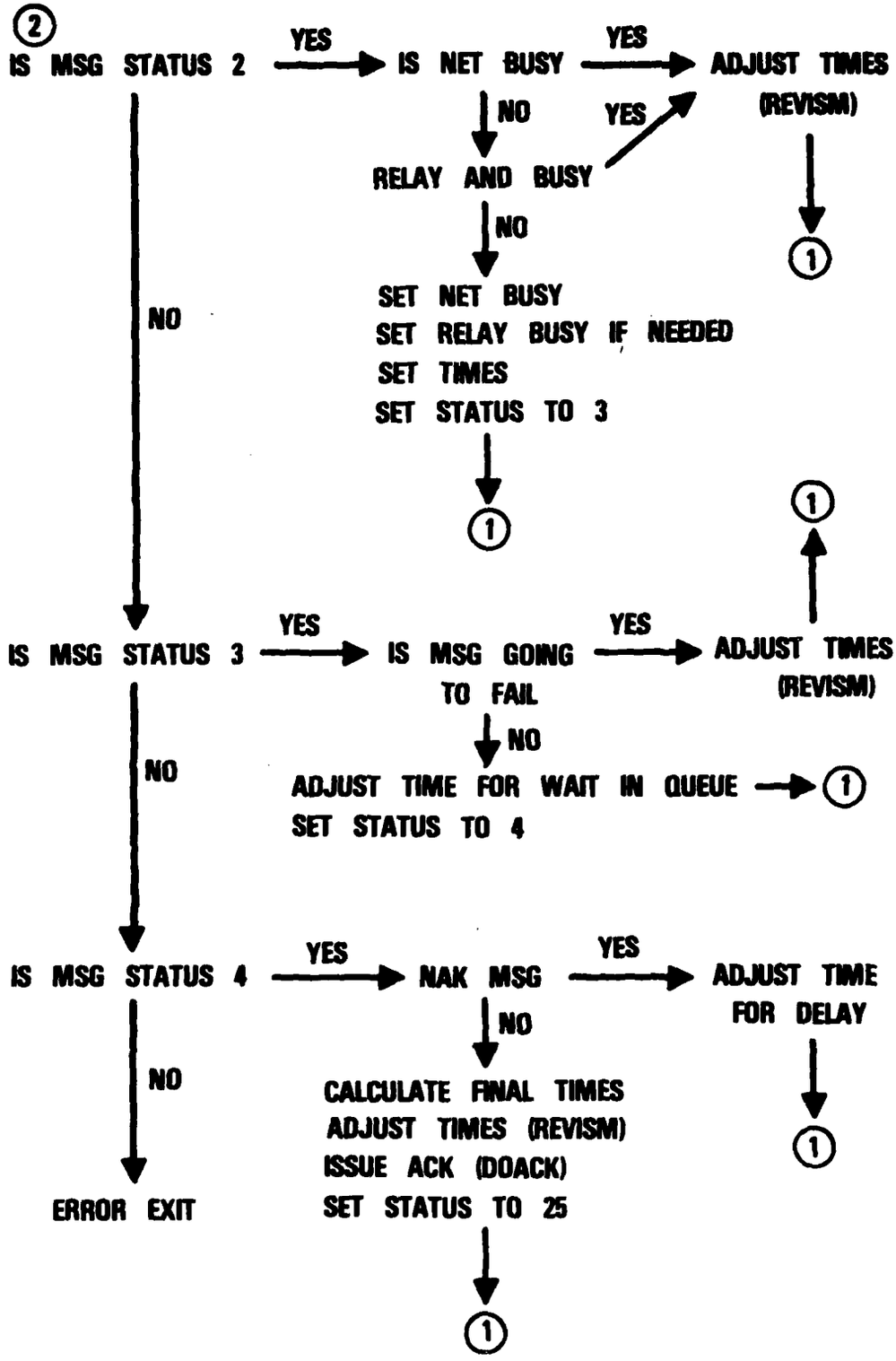


Figure 3. Continued

MESPRC begins by calling subroutine (NXTMSG). NXTMSG will return the message number of the lowest time message whose starting time is less than the current game time plus 1 game time cycle increment if such a message exists; otherwise, there are none. If one exists, NXTMSG will set its pointers to the next lowest time message. If none exists, MESPRC calls (RVDMLS) to reorder the message queue and MESPRC processing is completed.

Once a message has been found, its status is checked. If the message is in status 1, it is a new message. For a status 1 message the program first checks to see if the net is busy. If it is, the message starting time is increased to the time the net will next be free. This is done by subroutine (REVISM). MESPRC then returns to NXTMSG to select the next message meeting the time criteria above. If the net is not busy, a check is made to see if the message is an acknowledgement. If so, a test is made to see if the acknowledgement fails. If so, the message starting time is increased, and the message is flagged as having an extraordinary delay and the delay time kept. Again NXTMSG would be called. If the acknowledgement does not fail, a check is made to see if the acknowledgement is a relay message. If so, a relay flag is set and a check is made to see if the relay unit is busy. If so, the messages starting time is increased and we call NXTMSG for the next message. If not, the program calculates the processing time for the message, sets the status of the acknowledgement message to 25 (the completed state), sets the relay busy for a portion of the processing time, and sets the net busy. The program then tries to select another message using NXTMSG as above. If the acknowledgement message is not a relay message, a check is made to see if either the sender or addressee are relay units and busy. If so, the message is delayed until the relay unit is free. If not, the message is given its processing time and its status set to the completed state, and NXTMSG called.

If the status 1 message was not an acknowledgement message, a check is made to see if the previous message for this mission message tree was tagged as a "delay". If so, the starting time of this message is increased to reflect a delay attributed to human processing, the message is flagged as having an extraordinary delay, and the status of the message is set to 2. The program then calls NXTMSG for the next message.

If the status 1 message is tagged as "ready", the program tests to see if this was the first time in for this mission message tree and calculates delays for the gun setup time and then checks for the possibility of handoff to another gun battery. If this occurs, a further delay is added.

The program then further checks the possibility of stopping this mission to fire another one and if so calculate a delay which would override gun setup times. In any event, if the message is "delay" or "ready", the starting time of the message is increased, an extraordinary delay calculated, the message set to status 2, we call NXTMSG, etc.

If the status 1 message is not "delay" or "ready", the program proceeds to go through the relay and busy testing in the same manner as described for status 1 acknowledgement messages. If the message is a relay and busy the program applies the same logic described for acknowledgement messages. If the message is a relay and not busy, the net and relays are set busy. In addition, the program calculates the net delay for the message using the access delay time, preamble time, turn-on time, as well as the transmission rate (used for all messages). The message is set to status 3, and NXTMSG called for the next message. If the message is not a relay message, a check is made to see if either the sender or the addressee is a relay unit. If so, they are checked for busy and appropriate additional delays added; otherwise the delay and processing is as described above beginning with the net access delay time.

If the status of the message is 2, a test is made to see if the net is busy. If not, the program transfers to the logic for status 1 relay and busy. If it is busy, the program continues to adjust the start time.

If the status of the message is 3, a test is made to see if the message will fail. If so, the program adjusts the start and extraordinary delay times and uses NXTMSG to pick up the next message. If not, the program sets the waiting time in the queue and sets the status to 4. Status 3 may be considered to be the state where a real message would enter the tactical computer queue.

If the status is 4, a test is made to see if the message will be non-acknowledged. If so, a delay is computed and the message's status is returned to status 1. If the message is non-acknowledged 4 times a very long delay is entered which simulates the subscriber being removed from the game for this mission message tree. (Note: It does not remove the subscriber from other missions.)

If the message is not non-acknowledged, a delay for fire mission or non-fire mission processing is calculated, the status of the message is set to 25 (the completed state), and the acknowledgement message generated by subroutine (DOACK). Then NXTMSG is called to process the next message. Subroutine DOACK generates the acknowledgement message (but not an acknowledgement for an acknowledgement message), by reversing the sender and addressee and using the same message number as the message it acknowledges. The message type for an acknowledgement message is 99.

This then completes the logic for subroutine MESPRC.

The model now calls (MESFIN) to test for completed messages. To be considered completed and therefore ready to be removed from the message queue, the message's status must be 25, the current game time must be greater than the message time and the acknowledgement message for the

message must be completed or if the message is an acknowledgement, the first two conditions must be met. MESFIN will output the completed message, if the output flag is set (done by OUTMSG) and delete the message from the message queue using subroutine (DELMES). MESFIN will also try to insert the next message on the mission message tree using a call to subroutine GENNXT (discussed earlier).

The model now steps the time and tests to see if the simulation is over. If not, the program goes back to TMTOPT and the entire process described above is repeated.

There are many subroutines which have not been discussed which handle bookkeeping for finding, inserting, and removing units and mission message trees from the simulation as it progresses. Short descriptions of all the subroutines in the model appear in Appendix C.

The major output of the model is the history of completed messages. Completed messages can be displayed and saved for later processing. Messages are printed by subroutine OUTMSG and saved on a disk file by subroutine WRTAPE. Finally, a short summary of the outputs is printed by subroutine ZAPOUT.

Sample output is shown in Appendix D and a sample summary in Appendix E.

III. SUMMARY

The BRL Message Processing Model (BRLMPM) is a pure message processing model. It is not incumbered with physical phenomena which are not and should not be incorporated into it. The model, in its present state, is extremely flexible and can be used for a wide variety of scenarios.

The incorporation of a link switching model is planned and will greatly increase the utility of the model without serious side effects, such as increased running time, storage capacity, etc.

The model is valuable as a stand-alone tool; however, it may be imbedded into a large war game or simulation where other effects need to be simulated in a realistic way and depend upon a good communications model. Such effects include movement, fire rates, attrition, damage, and jamming.

APPENDIX A

DESCRIPTION OF MODEL INPUTS AND THEIR FORMATS

ROUTINE	CARD TYPE	PARAMETER NAME	COMMON BLOCK	DIMENSION	FORMAT
	DESCRIPTION				
GENRD	General Inputs				
GENRD	1	TEMP	NONE	7	10X,7A10
	Run identification (Maximum of 70 alphanumeric characters).				
GENRD	2	NNSTR	SEEDS	1	10X,14I5
	Number of random number streams (Maximum of 6 allowed). If zero nnstr is set to 1.				
GENRD	2	INDEX	NONE	1	(see above)
	Number of indices for random number streams. If zero, card type 3 is not read.				
GENRD	3	SSEED	SEEDS	6	10X,14I5
	Kernels for random number streams.				
GENRD	4	IFOLOW	GEN	1	10X,14I5
	Flag. If non-zero message history saved for follow-on processing.				
GENRD	5	IBEG	GAMTIM	1	10X,14I5
	Game startimg time. Input in minutes and converted to seconds.				
GENRD	5	IEND	GAMTIM	1	(see above)
	Game ending time. Input in minutes and converted to seconds.				
GENRD	5	IINC	GAMTIM	1	(see above)
	Game time increment. Input in seconds.				
GENRD	6	ILNKOP	LINKOP	1	10X,14I5
	Flag. If zero, no link status update. If non-zero, number of game time increments between link status updates. Currently not used.				
GENRD	7	IDISQ	DISPLA	1	10X,14I5
	Flag. If zero, message queue is not displayed. If non-zero, number of game time increments between message queue displays.				
GENRD	8	IMDQ	DISPLA	1	10X,14I5
	Flag. If zero completed messages are not displayed, otherwise, they are.				
UNLKNT	Unit, Link, Net Inputs				
UNLKNT	9	NUNIT	UNIT	1	10X,14I5
	Number of units allowed (Maximum of 150).				
UNLKNT	10	LINKS	LINK	1	10X,14I5
	Number of links allowed (Maximum of 200).				

ROUTINE	CARD TYPE	PARAMETER NAME	COMMON BLOCK	DIMENSION	FORMAT
	DESCRIPTION				
UNLKNT	10	LTYPES	LINK	1	(see above)
	Number of link types allowed. Currently not used.				
UNLKNT	11	INDEX	NONE	1	10X6I5,2F5.0
	Link index. One type 11 card is needed for each link.				
UNLKNT	11	LKEND	LINK	200	(see above)
	Unit numbers for both ends of the link (Note: two numbers are required).				
UNLKNT	11	LKNET	LINK	200	(see above)
	Net number which contains link.				
UNLKNT	11	LKEQP	LINK	200	(see above)
	Equipment type numbers for both ends of the link (Note: two numbers are required if equipments are present). Currently not used.				
UNLKNT	11	XLMUL	LINK	200	(see above)
	Link performance multiplier. If zero, set to 1.0. If larger than 1 performance decreases, if smaller than 1 performance increases.				
UNLKNT	11	XMSMUL	LINK	200	(see above)
	Message performance multiplier for messages carried on this Link. See comments for XLMUL.				
UNLKNT	12	NETS	NET	1	10X,14I5
	Number of nets allowed (Maximum of 20).				
UNLKNT	13	LKNET	LINK	200	10X,2I5/ (10X,25I3)
	Net number followed by number of links in that net on first card. Link numbers for that net on following card. There must be as many sets of cards as there are nets.				
UNLKNT	14	NONET	NET	1	10X,14I5
	Number of links not in nets. If zero, do not read card type 15.				
UNLKNT	15	INDEX	NONE	1	10X,14I5
	Link number.				
UNLKNT	15	LNCAP	NET	50	10X,14I5
	Link capacity for link not in net (Maximum of 50 links which are not in nets).				
UNLKNT	16	IUNITS	UNIT	1	10X,14I5
	Number of unit structures (Maximum of 10 allowed).				

ROUTINE	CARD TYPE	PARAMETER NAME	COMMON BLOCK	DIMENSION	FORMAT
	DESCRIPTION				
UNLKNT	17	INDEX	NONE	1	10X,14I5
	Unit structure index. One type 17 card must be input for each unit structure.				
UNLKNT	17	IUCT	UNIT	10	(see above)
	Number of different unit types for unit structure.				
UNLKNT	18	IELEM	UNIT	10,50	10X,A10,12I5
	For each unit structure the alphanumeric name of the unit type, the number of that type, and the unit numbers of that type. Number of cards required given by card type 17.				
UNLKNT	19	IMISON	MISION	1	10X,14I5
	Number of mission types (Maximum of 15 allowed).				
UNLKNT	20	INDEX	NONE	1	10X,I5,F5.0
	Mission type index. Number of cards required given by card type 19.				
UNLKNT	20	PCIM	MISION	15	(see above)
	Percentage of missions of given type.				
UNLKNT	21	INDEX	NONE	1	10X,14I5
	Mission index.				
UNLKNT	21	INDEX	NONE	1	(see above)
	Number of messages which comprise mission.				
UNLKNT	22	MISTRE	MISION	15,161	10X,3A10,I10
	First word is sender, second word addressee (Both alphanumeric and correspond to elements listed in unit structure inputs). Third word contains relay and/or simultaneous message flags and 8 character message identification. Final word is message type.				
UNLKNT	23	NUMRLY	RELAYD	1	10X,14I5
	Number of relay units.				
UNLKNT	24	NRUNIT	RELAYD	30	10X,14I5
	Unit numbers of relay units.				
MESRD	Message Inputs				
MESRD	25	DUMIM	MESAGE	1	10X,F5.0
	Time between dummy messages in the message queue. An artifact of the model.				
MESRD	26	MESTYP	MESAGE	1	10X,14I5
	Number of message types (Maximum of 30 allowed).				

ROUTINE	CARD TYPE	PARAMETER NAME	COMMON BLOCK	DIMENSION	FORMAT
	DESCRIPTION				
MESRD	27	INDEX	NONE	1	10X,14I5
	Message type index. The number of type 27 cards is given by type 26.				
MESRD	27	MESCHR	MESAGE	30,5	(see above)
	Message characteristics-precedence, minimum, maximum, and modal length in characters, priority type.				
MESRD	28	MESPRIO	MESAGE	1	10X,14I5
	Number of message priority types (Maximum of 10 allowed).				
MESRD	29	INDEX	NONE	1	10X,I5,3F5.0
	Message priority type index.				
MESRD	29	PRIO	MESAGE	10,3	(see above)
	Percentage of urgent, priority, and routine messages for that priority type.				
MESRD	30	IHOUR	MSRATE	1	10X,14I5
	Number of hours in simulation.				
MESRD	31	IRATE	MSRATE	48	10X,14I5
	Hour and hourly rate (Maximum of 24 hours). Hours converted to seconds.				
EQUIPD	Equipment Inputs				
EQUIPD	32	IEQP	EQUIPS	1	10X,14I5
	Equipment flag. Currently 0, no equipment.				
DELYIN	Delay Inputs				
DELYIN	33	NTRAN	TRANS	1	10X,14I5
	Number of transmission rates (Maximum of 10 allowed).				
DELYIN	34	TRATE	TRANS	10,2	10X,14I5
	Transmission rate followed by probability of that rate occurring (Rate in bits per second).				
DELYIN	35	NADJ	ADJUST	1	10X,14I5
	Total number of adjust fires to consider (Including none) (Maximum of 10 allowed).				
DELYIN	36	XNJUST	ADJUST	10,2	10X,14I5
	Number of adjust fires followed by probability of that number of adjust fires occurring.				

ROUTINE	CARD TYPE	PARAMETER NAME	COMMON BLOCK	DIMENSION	FORMAT
	DESCRIPTION				
DELYIN	37	GUN	GUNSET	3	10X,14F5.0
	Minimum, maximum, and modal gun setup times (Seconds).				
DELYIN	38	HGUNS	GUNSET	4	10X,14F5.0
	Probability of gun handoff followed by minimum, maximum, and modal delay for handoff (Seconds).				
DELYIN	39	SGUNS	GUNSET	4	10X,14F5.0
	Probability of stopping a mission, resuming it later, followed by minimum, maximum and modal delays (Seconds).				
DELYIN	40	NAKS	MESDEL	1	10X,14I5
	Total number of non-acknowledgements (Including none) (Maximum of 10 allowed).				
DELYIN	41	PNAKS	MESDEL	10,2	10X,14F5.0
	Number of non-acknowledgement followed by probability of its occurrence.				
DELYIN	42	XNDEL	MESDEL	3	10X,14F5.0
	Minimum, maximum, and modal delay in processing a non-acknowledgement (Seconds).				
DELYIN	43	NPREAM	PREAMS	1	10X,14I5
	Number of preamble times (Maximum of 10 allowed).				
DELYIN	44	PREAM	PREAMS	10,2	10X,14F5.0
	Preamble times and probabilities of their occurring (Seconds).				
DELYIN	45	NTRNON	PREAMS	1	10X,14I5
	Number of turn-on times (Maximum of 10 allowed).				
DELYIN	46	TRNON	PREAMS	10,2	10X,14F5.0
	Turn-on times and probabilities of their occurring (Seconds).				
DELYIN	47	ACCDL	NETDLY	4	10X,14F5.0
	Most probable net access delay time and its probability of occurrence followed by number of intervals and time between intervals (Seconds).				
DELYIN	48	COMPDL	COMP	1	10X,14F5.0
	Computer delay for fire mission processing (Seconds).				
DELYIN	49	XNCOM	COMP	3	10X,14F5.0
	Minimum, maximum, and modal computer delays for non-fire mission processing (Seconds).				

ROUTINE	CARD TYPE	PARAMETER NAME	COMMON BLOCK	DIMENSION	FORMAT
	DESCRIPTION				
DELYIN	50	HUMDEL	COMP	3	10X,14F5.0
	Minimum, maximum, and modal times for human delay (Seconds).				
DELYIN	51	SUBDEL	SUBLST	1	10X,14F5.0
	Delay if subscriber taken out of subscriber list (Seconds).				
DELYIN	52	FISTDL	FISTDL	3	10X,14F5.0
	Minimum, maximum, and modal delays for messages relayed through fist team (Seconds).				
DELYIN	53	OTHDL	GENDL	3	10X,14F5.0
	Minimum, maximum, modal delays (Seconds) to cover blanket situations (Not currently used).				
DELYIN	54	CMPTRF	MESFAL	1	10X,14F5.0
	Probability of computer failure.				
DELYIN	54	OTHERF	MESFAL	1	(see above)
	Probability of message failing.				
DELYIN	54	DELAYF	MESFAL	3	(see above)
	Minimum, maximum, and modal delay (Seconds) if CMPTRF or OTHERF above occur.				
DELYIN	55	WAIT	WAIT	3	10X,14F5.0
	Minimum, maximum, and modal waiting times (Seconds) of a message in the computer message queue.				

APPENDIX B

SAMPLE INPUTS

COMMUNICATIONS MESSAGE PROCESSING MODEL

TODAYS DATE IS 08/07/81
THE TIME IS NOW 00.37.49.

GENERAL MODEL INPUTS

GAME ID TEST INPUTS DESIGNED 20 MAY 1981

THERE ARE 1 RANDOM NUMBER STREAMS
THERE ARE NO KERNELS TO BE CHANGED

NO MESSAGE HISTORY WILL BE KEPT

GAME TIMES ARE AS FOLLOWS

START TIME	0 MINUTES OR	0 SECONDS
END TIME	240 MINUTES OR	14400 SECONDS
TIME INCREMENT		5 SECONDS

THERE IS NO LINK STATUS UPDATE

THE MESSAGE QUEUE WILL NOT BE DISPLAYED

COMPLETED MESSAGES WILL BE DISPLAYED

UNIT, LINK, AND NET INPUTS

THERE ARE 50 UNITS

THERE ARE 70 LINKS
THERE ARE 1 LINK TYPES

THERE ARE 16 NETS

THERE ARE NO LINKS NOT IN A NET

LINK	TYPE	NET	END	END	EQP TYP	EQP TYP	LINK MUL	MSG MUL
1	1	1	1	28	0	0	0.00	0.00
2	1	1	2	28	0	0	0.00	0.00
3	1	1	3	28	0	0	0.00	0.00
4	1	2	4	29	0	0	0.00	0.00
5	1	2	5	29	0	0	0.00	0.00
6	1	2	6	29	0	0	0.00	0.00
7	1	3	7	30	0	0	0.00	0.00
8	1	3	8	30	0	0	0.00	0.00
9	1	3	9	30	0	0	0.00	0.00
10	1	4	10	31	0	0	0.00	0.00
11	1	4	11	31	0	0	0.00	0.00
12	1	4	12	31	0	0	0.00	0.00
13	1	5	13	32	0	0	0.00	0.00
14	1	5	14	32	0	0	0.00	0.00
15	1	5	15	32	0	0	0.00	0.00
16	1	6	16	33	0	0	0.00	0.00
17	1	6	17	33	0	0	0.00	0.00
18	1	6	18	33	0	0	0.00	0.00
19	1	7	19	34	0	0	0.00	0.00
20	1	7	20	34	0	0	0.00	0.00
21	1	7	21	34	0	0	0.00	0.00
22	1	8	22	35	0	0	0.00	0.00
23	1	8	23	35	0	0	0.00	0.00
24	1	8	24	35	0	0	0.00	0.00
25	1	9	25	36	0	0	0.00	0.00
26	1	9	26	36	0	0	0.00	0.00
27	1	9	27	36	0	0	0.00	0.00
28	1	10	28	42	0	0	0.00	0.00
29	1	10	28	37	0	0	0.00	0.00
30	1	10	28	40	0	0	0.00	0.00
31	1	10	29	37	0	0	0.00	0.00
32	1	10	29	42	0	0	0.00	0.00
33	1	10	29	40	0	0	0.00	0.00
34	1	10	30	37	0	0	0.00	0.00
35	1	10	30	42	0	0	0.00	0.00
36	1	10	30	40	0	0	0.00	0.00
37	1	10	37	42	0	0	0.00	0.00
38	1	10	40	42	0	0	0.00	0.00
39	1	11	31	43	0	0	0.00	0.00
40	1	11	31	40	0	0	0.00	0.00

41	1	11	31	38	0	0	0.00	0.00
42	1	11	32	43	0	0	0.00	0.00
43	1	11	32	38	0	0	0.00	0.00
44	1	11	32	40	0	0	0.00	0.00
45	1	11	38	40	0	0	0.00	0.00
46	1	11	40	43	0	0	0.00	0.00
47	1	12	34	40	0	0	0.00	0.00
48	1	12	34	44	0	0	0.00	0.00
49	1	12	34	39	0	0	0.00	0.00
50	1	12	35	40	0	0	0.00	0.00
51	1	12	35	44	0	0	0.00	0.00
52	1	12	35	39	0	0	0.00	0.00
53	1	12	36	40	0	0	0.00	0.00
54	1	12	36	39	0	0	0.00	0.00
55	1	12	36	44	0	0	0.00	0.00
56	1	12	39	40	0	0	0.00	0.00
57	1	12	39	44	0	0	0.00	0.00
58	1	13	40	41	0	0	0.00	0.00
59	1	14	42	45	0	0	0.00	0.00
60	1	14	42	46	0	0	0.00	0.00
61	1	15	43	47	0	0	0.00	0.00
62	1	15	43	48	0	0	0.00	0.00
63	1	16	44	49	0	0	0.00	0.00
64	1	16	44	50	0	0	0.00	0.00
65	1	10	37	40	0	0	0.00	0.00
66	1	11	33	38	0	0	0.00	0.00
67	1	11	33	40	0	0	0.00	0.00
68	1	11	33	43	0	0	0.00	0.00
69	1	11	38	43	0	0	0.00	0.00
70	1	12	40	44	0	0	0.00	0.00

THERE ARE 3 UNIT STRUCTURES

UNIT STRUCTURE 1 COUNT 7

NAME	COUNT	UNIT NUMBERS								
FO	9	1	2	3	4	5	6	7	8	9
FIST	3	28	29	30						
BNFSE	1	37								
BNFDC	1	40								
BDEFSO	1	41								
BATT	1	42								
GUNS	2	45	46							

UNIT STRUCTURE 2 COUNT 7

NAME	COUNT	UNIT NUMBERS								
FO	9	10	11	12	13	14	15	16	17	18
FIST	3	31	32	33						
BNFSE	1	38								
BNFDC	1	40								
BDEFSO	1	41								
BATT	1	43								
GUNS	2	47	48							

UNIT STRUCTURE 3 COUNT 7

NAME	COUNT	UNIT NUMBERS								
FO	9	19	20	21	22	23	24	25	26	27
FIST	3	34	35	36						
BNFSE	1	39								
BNFDC	1	40								
BDEFSO	1	41								
BATT	1	44								
GUNS	2	49	50							

THERE ARE 2 MISSIONS

MISSION	PERCENT
1	43.00
2	57.00

MISSION TREE FOR MISSION 1
THERE ARE 26 MESSAGE PARTS

INDEX	SENDER	ADDRESSEE	RELAY	SIMUL	MSG ID	MSG TYPE
1	FO	FIST	NO	NO	DELAY	1
2	FIST	BNFSE	NO	NO	DELAY	2
3	BNFSE	BATT	NO	NO	BTRY	6
4	BATT	FIST	NO	NO	BTRY	6
5	FIST	FO	NO	NO	BTRY	1
6	FO	BATT	YES	NO	OBSRLOC	1
7	FO	BATT	YES	NO	FRGRID	1
8			NO	NO		998
9	BATT	GUNS	NO	YES	WR	3
10	BATT	FO	YES	YES	MTO	1
11	GUNS	BATT	NO	NO	READY	6
12	BATT	GUNS	NO	NO	FIRE	1
13	GUNS	BATT	NO	NO	SHOT	1
14	BATT	FO	YES	NO	SHOT	1
15	BATT	FO	YES	NO	SPLASH	1
16	FO	BATT	YES	NO	SAGRID	1
17			NO	NO		999
18	BATT	GUNS	NO	YES	WR	5
19	BATT	FO	YES	YES	MTO	1
20	GUNS	BATT	NO	NO	READY	6
21	BATT	GUNS	NO	NO	FIRE	1
22	GUNS	BATT	NO	NO	SHOT	1
23	BATT	FO	YES	NO	SHOT	1
24	GUNS	BATT	NO	NO	COMPLETE	4
25	BATT	FO	YES	NO	COMPLETE	1
26	END		NO	NO		3

MISSION TREE FOR MISSION 2
THERE ARE 25 MESSAGE PARTS

INDEX	SENDER	ADDRESSEE	RELAY	SIMUL	MSG ID	MSG TYPE
1	FIST	BNFDC	NO	NO	REQ FM	3
2	BNFDC	BATT	NO	YES	REC	1
3	BNFDC	BNFSE	NO	YES	RFAF	2
4	BNFDC	FIST	NO	YES	MTO	1
5	BNFDC	BDEFSO	NO	YES	REC MOI	4
6	BATT	GUNS	NO	NO	WR	3
7	GUNS	BATT	NO	NO	READY	6
8	BATT	FIST	NO	NO	SHOT	1
9	FIST	BNFDC	NO	NO	FRGRID	1
10			NO	NO		998
11	BNFDC	BATT	NO	NO	REC FM	3
12	BATT	GUNS	NO	NO	WR	3
13	GUNS	BATT	NO	NO	READY	6
14	BATT	FIST	NO	NO	SHOT	1
15	FIST	BNFDC	NO	NO	SAGRID	1
16			NO	NO		999
17	BNFDC	BATT	NO	NO	REC FM	3
18	BATT	GUNS	NO	NO	WR	3
19	GUNS	BATT	NO	NO	READY	6
20	BATT	FIST	NO	NO	FFE	1
21	GUNS	BATT	NO	NO	COMPLETE	4
22	FIST	BNFDC	NO	NO	REC EOM	5
23	BNFDC	BATT	NO	NO	EOM	6
24	BATT	GUNS	NO	NO	EOM	6
25	END		NO	NO		0

NUMBER OF RELAY UNITS 9

INDEX	UNIT
1	28
2	29
3	30
4	31
5	32
6	33
7	34
8	35
9	36

MESSAGE INPUTS

THE MESSAGE QUEUE WILL HOLD 1500 MESSAGES

TIME BETWEEN DUMMY MESSAGES .0010

THERE ARE 6 MESSAGE TYPES

MESSAGE CHARACTERISTICS

TYPE	PREC	MIN LEN	MAX LEN	MODE	PRI TYPE
1	2	372	492	432	1
2	2	5400	6600	5880	1
3	2	4200	5400	4800	1
4	2	2160	4260	3240	1
5	2	2160	5400	3780	1
6	2	720	2160	960	1

THERE ARE 1 MESSAGE PRIORITY TYPES

PRIORITY DISTRIBUTION

TYPE	URGENT	PRIORITY	ROUTINE
1	20.00	30.00	50.00

HOURLY RATES FOR 8 HOURS

HOUR	RATE
1	63
2	63
3	63
4	63
5	63
6	63
7	63
8	63

EQUIPMENT INPUTS

THERE IS NO EQUIPMENT FURNISHED

DELAY INPUTS

ALL DELAY TIMES ARE IN SECONDS

ALL PROBABILITIES ARE INPUT IN PERCENT

THERE ARE 2 TRANSMISSION RATES

INDEX	RATE	PROB	CUM PROB
1	1200.	90.00	90.00
2	600.	10.00	100.00

NUMBER OF ADJUST FIRES (INCLUDING 0) 5

INDEX	ADJ FIRES	PROB	CUM PROB
1	0	5.00	5.00
2	1	15.00	20.00
3	2	70.00	90.00
4	3	5.00	95.00
5	4	5.00	100.00

GUN SETUP TIMES MIN, MAX, MODE 0.00 90.00 60.00

PROBABILITY OF HANDOFF 5.00

MIN, MAX, MODE 10.00 120.00 90.00

PROBABILITY OF INTERRUPTING MISSION 5.00

MIN, MAX, MODE 120.00 600.00 240.00

NUMBER OF NAKS (INCLUDING 0) 5

INDEX	NAKS	PROB	CUM PROB
1	0	90.00	90.00
2	1	5.00	95.00
3	2	2.00	97.00
4	3	2.00	99.00
5	4	1.00	100.00

DELAY IN PROCESSING A NAK

MIN, MAX, MODE 12.00 30.00 15.00

NUMBER OF PREAMBLE TIMES 8

INDEX	PREAMBLE TIME	PROB	CUM PROB
1	0.00	2.00	2.00
2	.20	2.00	4.00
3	.70	10.00	14.00
4	1.40	2.00	16.00
5	1.70	70.00	86.00
6	2.10	10.00	96.00
7	2.80	2.00	98.00
8	4.00	2.00	100.00

THERE ARE 3 EQUIPMENT TURN ON TIMES

INDEX	TURN ON TIME	PROB	CUM PROB
1	.05	30.00	30.00
2	.10	30.00	60.00
3	.40	40.00	100.00

MOST PROBABLE NET ACCESS DELAY TIME .50
PROBABILITY 90.00 OTHERWISE
NUMBER OF INTERVALS 98.
TIME BETWEEN INTERVALS .5

COMPUTER DELAY FOR FIRE MISSION PROCESSING 9.00

COMPUTER DELAYS NON FIRE MISSION PROCESSING			
MIN, MAX, MODE	0.00	9.00	3.00

HUMAN DELAYS			
MIN, MAX, MODE	0.00	60.00	20.00

DELAY IF UNIT REMOVED FROM SUBSCRIBER LIST 1800.00

DELAY FOR RELAY THROUGH FIST			
MIN, MAX, MODE	0.00	30.00	6.00

DELAY DUE TO OTHER SOURCES			
MIN, MAX, MODE	0.00	60.00	15.00

PROBABILITY OF COMPUTER FAILURE .0400
PROBABILITY OF MESSAGE FAILURE 10.30

DELAYS FOR FAILURES			
MIN, MAX, MODE	6.00	30.00	12.00

WAITING TIME IN MESSAGE QUEUE			
MIN, MAX, MODE	0.00	3.00	2.00

APPENDIX C

SUBROUTINE DESCRIPTION

```
NAME AND CALLING SEQUENCE (IF ANY)
PURPOSE
DESCRIPTION OF THE PARAMETERS IN THE CALLING SEQUENCE

 1
     PROGRAM DRVMPM
MAIN PROGRAM.  INITIALIZES AND CALLS MAJOR PROCESSING ROUTINES

 2
     SUBROUTINE ADDUNT(INDEX,NUN)
ADDS A UNIT TO THOSE ALREADY IN EXISTENCE  (CHANGES THE IKGUY ARRAY)
     INDEX     INDEX IN THE IKGUYS ARRAY
     NUN       UNIT NUMBER TO BE ADDED

 3
     SUBROUTINE CMINUT
EXECUTIVE INPUT ROUTINE  CALLS ALL THE OTHER INPUT ROUTINES

 4
     SUBROUTINE DELMES(MESNO)
DELETES A MESSAGE FROM THE MESSAGE QUEUE
     MESNO     INTERNAL MESSAGE NUMBER OF THE MESSAGE TO BE DELETED

 5
     SUBROUTINE DELRDY(MESNO,IMIS,IFLG,IFLAG)
SEARCHES FOR PROPER DELAY WORD
     MESNO     MESSAGE NUMBER
     IMIS      MISSION TYPE
     IFLG      FLAG  1 DELAY, 2 READY, 3 WR (WHEN READY)
     IFLAG     FLAG 1 IF FOUND, OTHERWISE 0

 6
     SUBROUTINE DELTRE(ITREE,NODEL)
SEARCHES FOR A MESSAGE TREE AND EITHER DELETES IT OR RETURNS ITS INDEX
     ITREE     TREE NUMBER SOUGHT
     NODEL     FLAG IF 0 DELETE TREE, IF NOT 0 RETURN INDEX

 7
     SUBROUTINE DELYIN
READS DELAY INPUTS

 8
     SUBROUTINE DOACK
INSERTS AN ACKNOWLEDGMENT OR OTHER HIGH PRECEDENCE MESSAGE  (E.G. AN FPF)

 9
     FUNCTION DRAND(XXXXXX)
GENERATES A UNIFORMLY DISTRIBUTED RANDOM DEVIATE IN THE INTERVAL 0-1
     XXXXXX    DUMMY VARIABLE (NOT USED)

10
     SUBROUTINE EQUIPD
READS EQUIPMENT INPUTS  (NONE AT PRESENT)
```

```
11
    SUBROUTINE ERROR(I,IVAL)
PRINTS ERROR MESSAGE AND TERMINATES A RUN
    I         ERROR NUMBER  (SET IN CALLING ROUTINE)
    IVAL      VALUE WHICH CAUSED THE ERROR

12
    SUBROUTINE FNDSND(NAME,IUN,IS)
FINDS A SENDER (ORIGINATOR) AND THE UNIT STRUCTURE IT BELONGS TO
    NAME      BCD NAME OF A POSSIBLE SENDER
    IUN       UNIT STRUCTURE HAVING THE SENDER AS A MEMBER
    IS        UNIT NUMBER OF THE SENDER

13
    SUBROUTINE FXMSLT(ORWNLT,FINLTH)
CORRECTS MESSAGE LENGTH TO FILL 16 CHARACTER BLOCKS WITH AT LEAST 4 BITS
    ORWNLT    ORIGINAL LENGTH
    FINLTH    FINAL LENGTH

14
    SUBROUTINE GENNXT(MESNO,JFLAG,ISIM)
GENERATES AND INSERTS THE NEXT MESSAGE FOR A TREE STRUCTURE
    MESNO     INTERNAL MESSAGE NUMBER OF THE MESSAGE GENNXT FORMS
    JFLAG     FLAG IF 0 TREE COMPLETED, OTHERWISE INDEX IN MISTRE ARRAY
    ISIM      FLAG IF 1 SIMULTANEOUS MESSAGE, OTHERWISE NOT

15
    SUBROUTINE GENRD
READS GENERAL MODEL PARAMETERS

16
    SUBROUTINE INSMSG(LIST,IM)
INSERTS A MESSAGE INTO THE MESSAGE QUEUE
    LIST      MESSAGE PARAMETERS
    IM        INTERNAL MESSAGE NUMBER OR 0 IF MESSAGE CANNOT BE INSERTED

17
    SUBROUTINE INTLMS
INITIALIZES THE MESSAGE QUEUE

18
    FUNCTION INTSEL(NUMBER)
GENERATES A RANDOMLY SELECTED INTEGER IN THE RANGE 1-NUMBER
    NUMBER    MAXIMUM VALUE

19
    SUBROUTINE MESCRP
GENERATES THE INITIAL MESSAGE FOR A MISSION

20
    SUBROUTINE MESFIN
REMOVES MESSAGE FROM THE GAME AND POSSIBLY OUTPUTS
```

```
21
    SUBROUTINE MESPRC
PROCESSES MESSAGES THROUGH VARIOUS STATES AND DETERMINES DELAYS

22
    SUBROUTINE MESRD
READS MESSAGE INPUTS

23
    SUBROUTINE NXTMSG(MESNO)
RETURNS THE MESSAGE NUMBER OF THE LOWEST TIMED MESSAGE NOT COMPLETED
    MESNO     INTERNAL MESSAGE NUMBER (IF ANY). OTHERWISE 0

24
    SUBROUTINE OUTMSG
PRINTS MESSAGE PARAMETERS OF INSERTED MESSAGES

25
    SUBROUTINE PRINTQ
PRINTS THE ENTIRE MESSAGE QUEUE

26
    SUBROUTINE RELOOK(NAME,IUN,LIST)
FINDS A UNIT GIVEN A NAME
    NAME      UNIT SOUGHT
    IUN       UNIT STRUCTURE
    LIST      MESSAGE INPUT ARRAY

27
    SUBROUTINE REVISM(MESNO,DELTA)
REORDERS THE MESSAGE QUEUE WHEN MESSAGE MESNO IS DELAYED BY TIME DELTA
    MESNO     INTERNAL MESSAGE NUMBER
    DELTA     DELAY TIME

28
    SUBROUTINE RLYMSG(INFRM,IUNIT,NDEX)
LOOKS TO SEE IF THIS IS A RELAY MESSAGE
    INFRM     LOUT ARRAY
    IUNIT     UNIT CARRYING RELAY MESSAGE OR ZERO
    NDEX      INDEX OF UNIT IF FOUND

29
    SUBROUTINE RLYUNT(INFRM,IUNIT,NDEX)
SEARCHES FOR RELAY UNIT
    INFRM     LOUT ARRAY
    IUNIT     RELAY UNIT
    NDEX      INDEX OF UNIT IF FOUND

30
    SUBROUTINE RVDMLS
REVISES THE MESSAGE QUEUE
```

```
31
    SUBROUTINE SCHUNT(NAME,IUN,IFLAG)
SEARCHES FOR A UNIT NUMBER
    NAME      BCD NAME  OF UNIT BEING SOUGHT
    IUN       UNIT STRUCTURE HAVING UNIT AS A MEMBER
    IFLAG     FLAG IF + UNIT NUMBER, IF - INDEX IN THE UNIT STRUCTURE

32
    SUBROUTINE SETFR(IFIRE)
RETURNS THE NUMBER OF ADJUST FIRES FOR A MISSION
    IFIRE     NUMBER OF ADJUST FIRES

33
    SUBROUTINE SETGUY(LIST)
INITIALIZES IKGUYS ARRAY BY INSERTING ADJUST FIRES AND UNITS
    LIST      TREE NUMBER, ADJUST FIRES, ADDRESSEE, SENDER

34
    SUBROUTINE SETVAL
INITIALIZES GAME COUNTERS, FLAGS, AND VALUES

35
    SUBROUTINE SIMMSG(IMIS,INDEX,IFLAG)
TESTS IF TWO MESSAGES ARE TO BE INPUT SIMULTANEOUSLY
    IMIS      MISSION TYPE
    INDEX     SIMULTANEOUS FLAG IN MISTRE ARRAY
    IFLAG     FLAG IF 0 NOT SIMULTANEOUS, IF 1 THEY ARE

36
    SUBROUTINE TAPWRT(X,IFLAG)
PACKS COMPLETED MESSAGE INTO BUFFER AND OUTPUTS BUFFER TO UNIT 10
    X         COMPLETED MESSAGE HISTROY
    IFLAG     FLAG IF 1 OUTPUTS FILLED BUFFER, IF 2 FLUSHES PARTIAL BUFFER

37
    SUBROUTINE TMTOPT(IFLAG)
DETERMINES WHETHER OR NOT IT IS TIME TO GENERATE A STARTING MESSAGE
    IFLAG     FLAG IF 1 CAN START A MISSION, IF 0 CANNOT

38
    SUBROUTINE TRNRTE(LINKY,RATE)
FINDS TRANSMISSION RATE
    LINKY     LINK
    RATE      TRANSMISSION RATE

39
    FUNCTION TRIAG(XMIN,XMAX,XMODE)
GENERATES A DEVIATE FROM A TRIANGULAR DISTRIBUTION
    XMIN      MINIMUM VALUE
    XMAX      MAXIMUM VALUE
    XMODE     MODE
```

```
40
    SUBROUTINE UNLKNT
READS UNIT, LINK, AND NET INPUTS

41
    SUBROUTINE UNPMSG(MESNO)
UNPACKS MESSAGES
    MESNO     INTERNAL MESSAGE NUMBER

42
    SUBROUTINE UNPMUN(INDEX)
UNPACKS UNITS USED IN A MESSAGE TREE
    INDEX     INDEX IN THE IKGUYS ARRAY

43
    SUBROUTINE WRTAPE(L)
EXECUTIVE MESSAGE HISTORY OUTPUT ROUTINE
    L         FLAG FOR OUTPUT OPTIONS

44
    SUBROUTINE XMIT(N,A,B)
TRANSMITS DATA FROM ONE ARRAY (A) TO ANOTHER (B)
    N         NUMBER OF VALUES TO TRANSMIT AND FLAG   IF + A TO B
    A         ARRAY TO TRANSFER                       IF - A1 TO B
    B         ARRAY TO BE FILLED

45
    SUBROUTINE ZAPOUT
PRINTS HISTORIES AT END OF GAME

46
    SUBROUTINE ZAPTRE(ITREE,IFLG)
STORES CANDIDATES FOR TREE DELETION AND DELETES TREES
    ITREE     MESSAGE TREE
    IFLG      FLAG  =1 TAG TREE,  =2 DELETE TREE
47
    SUBROUTINE ZAREMV(LIST,IFLAG)
TESTS FOR ACK COMPLETION BEFORE CALLING MESSAGE
    LIST      LOUT ARRAY
    IFLAG     FLAG  =0 REMOVE MESSAGE, =1 DONT REMOVE MESSAGE
```

APPENDIX D

SAMPLE OUTPUTS

```
TREE DELETED      6

TREE DELETED      4

TREE DELETED      3
INT MSG NO       30     EXT MSG NO       05     SENDER  40     ADDRESSEE   20     NET    10     LINK    30     STATUS  25
TYPE     1     PREC     2    PRI      3     TREE    34     NO IN TREE    6     UNIT     1     MISSION      2     LENGTH      496
MSG COUNT      1019     LINKS          0          0          0          0          0
START TIME            .20730903E+04     END TIME       .44012730E+04     DELAY TIME            .15905933E+04

SENDER-FO-----TOTAL DELAY TIME= 190263.39MEAN DELAY TIME/MSG      39.90
     -FIST---                   170103.46                         32.06
     -DNFSO--                   237202.20                         44.01
     -DNFDC--                    73013.70                         13.69
     -DDEFSO-                    67023.76                         12.90
     -DTRYFDC                   231700.92                         43.00
     -GUN SEC                    90596.29                         16.01

TREE DELETED      2

TREE DELETED     11

TREE DELETED     37

TREE DELETED     31

TREE DELETED     33

TREE DELETED     36

TREE DELETED     22

TREE DELETED     77

TREE DELETED     39

TREE DELETED     32
INT MSG NO       74     EXT MSG NO      213     SENDER  30     ADDRESSEE   47     NET    10     LINK    39     STATUS   1
TYPE    99     PREC     1    PRI      1     TREE   123     NO IN TREE    0     UNIT     1     MISSION      2     LENGTH       16
MSG COUNT      4070     LINKS          0          0          3          0          0
START TIME            .09947492E+04     END TIME       .40394301E+04     DELAY TIME            0.

SENDER-FO-----TOTAL DELAY TIME=1027212.6TMEAN DELAY TIME/MSG      01.60
     -FIST---                   922297.90                         40.23
     -DNFSO--                   959023.70                         20.07
     -DNFDC--                   672663.09                         33.73
     -DDEFSO-                    67003.91                          3.40
     -DTRYFDC                  1090300.21                         94.00
     -GUN SEC                   237349.40                         11.00

TREE DELETED     26

TREE DELETED     27
INT MSG NO       21     EXT MSG NO      126     SENDER  43     ADDRESSEE   14     NET     0     LINK     0     STATUS  25
TYPE     1     PREC     2    PRI      2     TREE    13     NO IN TREE   19     UNIT     2     MISSION      1     LENGTH      416
MSG COUNT      2076     LINKS          0          0          0          0          0
START TIME            .40012123E+04     END TIME       .90227034E+04     DELAY TIME            .40004093E+04
```

APPENDIX E

SAMPLE SUMMARY

QUICK SUMMARY

NUMBER OF MESSAGES GENERATED	5769
NUMBER OF MESSAGES IN QUEUE	300
NUMBER OF MESSAGES COMPLETED	3232
NUMBER OF ACKS COMPLETED	3231
NUMBER OF TREES GENERATED	209
NUMBER OF TREES LEFT	177
NUMBER OF TREES COMPLETED	32

THERE ARE 16 NETS
TOTAL TIME NETS ARE BUSY

NET	TIME BUSY(SEC)	FRACTION BUSY
1	326.52	.011
2	437.58	.015
3	563.93	.020
4	237.03	.008
5	583.85	.020
6	872.51	.030
7	261.04	.009
8	255.06	.009
9	483.67	.017
10	14002.46	.486
11	13628.49	.473
12	13383.43	.465
13	2782.72	.097
14	7851.92	.273
15	9023.80	.313
16	10711.95	.372

AVERAGE FRACTION BUSY IN NETS CONTAINING-

FO,FIST	.0155
FIST,BNFSO,BNFDC,BATTERY FDC	.4747
BNFDC,BDEFSO	.0966
BATTERY FDC,GUN SECTIONS	.3193

THERE ARE 9 RELAY UNITS
TOTAL TIME RELAYS ARE BUSY

RELAY	TIME BUSY(SEC)	FRACTION BUSY
1	736.46	.026
2	1612.92	.056
3	756.80	.026
4	945.70	.033
5	1855.62	.064
6	1659.59	.058
7	1621.08	.056
8	1147.14	.040
9	3004.94	.104

AVERAGE FRACTION RELAYS BUSY- .0515

DISTRIBUTION LIST

No. of Copies	Organization
12	Administrator Defense Technical Info Center ATTN: DTIC-DDA Cameron Station Alexandria, VA 22314
2	Director Defense Advanced Research Project Agency ATTN: Info Processing Techniques Office 1400 Wilson Boulevard Arlington, VA 22209
3	Director Defense Advanced Research Projects Agency ATTN: Tactical Technology Ofc 1400 Wilson Boulevard Arlington, VA 22209
2	Director Institute of Defense Analysis 1801 Beauregard St. Alexandria, VA 22311
1	HQDA (DAMO-C4) Washington, DC 20310
1	HQDA (DAMA-RQA) Washington, DC 20310
1	HQDA (DAMA-RAC) Washington, DC 20310
1	HQ (DAMA-ARZ-A) Washington, DC 20310
1	HQ (DAMA-CSC) Washington, DC 20310
1	Commander US Army Material Development and Readiness Command ATTN: DRCDMD-ST 2001 Eisenhower Avenue Alexandria, VA 22333
1	Commander US Army Material Development and Readiness Command ATTN: DRCDE-SB 5001 Eisenhower Avenue Alexandria, VA 22333
1	Commander US Army Material Development and Readiness Command ATTN: DRCDE-SC 5001 Eisenhower Avenue Alexandria, VA 22333
1	Commander US Army Material Development and Readiness Command ATTN: DRCDE-SS 5001 Eisenhower Avenue Alexandria, VA 22333
1	Commander US Army Armament Research and Development Command ATTN: DRDAR-TDC (Dr. D. Gyorog) Dover, NJ 07801
2	Commander US Army Armament Research and Development Command ATTN: DRDAR-TSS Dover, NJ 07801

DISTRIBUTION LIST

No. of Copies	Organization
4	Commander US Army Armament Research and Development Command ATTN: DRDAR-RAR DRDAR-LCS DRDAR-SCF, J. Bevelock L. Ostuni Dover, NJ 07801
1	Commander US Army Armament Material Readiness Command ATTN: DRSAR-LEP-L, Tech Lib Rock Island, IL 61229
1	Director US Army Armament Research and Development Command Benet Weapons Laboratory ATTN: DRDAR-LCB-TL Watervliet, NY 12189
1	Commander US Army Aviation Research And Development Command ATTN: DRDAV-E 4300 Goodfellow Boulevard St. Louis, MO 63120
1	Director US Army Air Mobility Research and Development Laboratory Ames Research Center Moffett Field, CA 94035
7	Commander US Army Communications Research and Development Command ATTN: DRDCO-COM DRDCO-COM-RF DRDCO-COM-RF2 (3 cys) DRDCO-COM-RN DRDCO-COM-RX Ft. Monmouth, NJ 07703
3	Commander US Army Communications Research and Development Command ATTN: DRDCO-PPA-SA DRDCO-SEI DRDCO-TCS Ft. Monmouth, NJ 07703
1	Commander US Army Electronics Research and Development Command ATTN: DRSEL-SAD, J. Husselman Ft. Monmouth, NJ 07703
1	Commander US Army Electronics Research and Development Command Technical Support Activity ATTN: DELSD-L Ft. Monmouth, NJ 07703
2	Director Electronic Warfare Laboratory ATTN: DELSO-L Ft. Monmouth, NJ 07703
3	Commander US Army Harry Diamond Labs. ATTN: DELHD-I-T DELHD-PP DELHD-D-OE 2800 Powder Mill Road Adelphi, MD 20783
4	Director US Army Signals Warfare Laboratory ATTN: DELSW DELSW-CE DELSW-RA DELSW-DT Vint Hill Farms Station Warrenton, VA 22186

DISTRIBUTION LIST

No. of Copies	Organization
1	Commander US Army Missile Command ATTN: DRSMI-R Redstone Arsenal, AL 35898
1	Commander US Army Missile Command ATTN: DRSMI-YDL Redstone Arsenal, AL 35898
1	Commander US Army Tank Automotive Rsch and Development Command ATTN: DRDTA-UL Warren, MI 48090
3	Project Manager, Cannon Artillery Weapon Systems ATTN: DRCPM-CAWS Dover, NJ 07801
1	Project Manager Multiple Launch Rocket Systems ATTN: DRCPM-RS Redstone Arsenal, AL 35898
1	Project Manager Operations Tactical Data Systems ATTN: DRCPM-OPTADS Ft. Monmouth, NJ 07703
1	Project Manager Single Channel Ground and Airborne Radio Systems ATTN: DRCPM-GARS Ft. Monmouth, NJ 07703
3	Project Manager TACFIRE/Field Artillery Tactical Data Systems ATTN: DRCPM-TF Ft. Monmouth, NJ 07703
1	Project Manager, TACFIRE Software Support Group ATTN: DRCPM-TF Ft. Sill, OK 73503
1	Commander US Army Research Office Box 12211 Research Triangle Park, NC 27709
1	Commander US Army Concepts Analysis Agency 8120 Woodmont Avenue Bethesda, MD 20014
4	Commander US Army Training & Doctrine Command ATTN: ATCD ATCD-AN ATCD-C ATCD-F Ft. Monroe, VA 23615
5	Director US Army TRADOC Systems Analysis Activity ATTN: ATAA ATAA-SL/Tech Library ATTA-TEC, P. M. Parish J. L. Lyman R. Wadsworth White Sands Missile Range, NM 88002
9	President US Army Field Artillery Board ATTN: ATZR-BD ATZR-BDCT (3 cys) ATZR-BDWT ATZR-BDAS HEL Liaison Officer (3 cys) Ft. Sill, OK 73503

DISTRIBUTION LIST

No. of Copies	Organization
4	Commander US Army Field Artillery Center and School ATTN: ATZR-CG (2 cys) ATSF-AC ATSF-CA Ft. Sill, OK 73503
3	Commander US Army Field Artillery Center and School ATTN: ATSF-CD ATSF-CD/CSWS-SSG ATSF-CD/DSWS-SSG Ft. Sill, OK 73503
5	Commander US Army Field Artillery Center and School ATTN: ATSF-CD/Concepts ATSF-CD/Analysis ATSF-CD/Systems ATSF-Data Systems (2 cys) Ft. Sill, OK 73503
2	Commander US Army Field Artillery Center and School ATTN: ATSF-CE ATSF-TSM-TF Ft. Sill, OK 73503
1	Commander US Army Signal Center ATTN: ATZH-CD Ft. Gordon, GA 30905
2	Commandant Command and General Staff College Ft. Leavenworth, KS 66027
2	Commandant US Military Academy West Point, NY 10996
1	US Naval Academy Annapolis, MD 21040
2	US Air Force Academy Colorado Springs, CO 80901
1	Commander XVIII Airborne Corps ATTN: Comm Elec Bd, ADDS Experiment Ft. Bragg, NC 28307
2	Commander Naval Surface Weapons Center ATTN: Technical Director Silver Spring, MD 20910
1	CACI, Inc ATTN: Claude Delfosse 1815 North Fort Myer Drive Arlington, VA 22209
2	Calculon Corporation ATTN: Bill Cave Martin Paskman 1250 State Highway #35 Middletown, NJ 07748
1	Computer Sciences Corporation ATTN: Wayne Rickard 1250 Highway 35 Middletwon, NJ 07748
1	General Dynamics Electronics Division P.O. Box 85106 San Diego, CA 92138
3	Litton Data Systems ATTN: Rich Bergfeld Gene Wilson Leon Bloom 8000 Woodley Avenue Van Nuys, CA 91409

DISTRIBUTION LIST

No. of Copies	Organization
5	Magnavox Electronics Systems Company Tactical Systems ATTN: S. Charles S. Moore G. Dixon J. Budde D. Willis 1313 Production Road Ft. Wayne, IN 46808
1	Mitre Corporation ATTN: Frank Owens Westgate Research Park McLean, VA 22102
2	Norden Systems, Incorporated ATTN: Greg Conron D. Baxter Norden Place Norwalk, CT 06856
1	Science Applications, Inc. ATTN: Kathleen Nardini SAI Tower -11-2 McLean, VA 22102
1	Sperry-Univac ATTN: Dr. Artz UNIVAC Park, P.O. Box 3525 St. Paul, MN 55165
1	TELOS P.O. Box 846 Lawton, OK 73502
3	TRW Systems Group ATTN: R. H. Douglas P. A. Harper W. V. Neisius One Space Park Redondo Beach, CA 90728

No. of Copies	Organization
1	Massachusetts Institute of Technology Lab for Information and Decision Systems Cambridge, MA 02139

Aberdeen Proving Ground

Dir, USAMSAA
ATTN: DRXSY-D
DRXSY-MP, H. Cohen
DRXSY-CC, R. Stanley
B. Cooper
DRSXY-CI, P. Kunselman
DRSXY-RE, K. Matthews

Cdr, USATECOM
ATTN: DRSTE-TO-F

Dir, USACSL, Bldg 3516, EA
ATTN: DRDAR-CLB-PA

Dir, USAHEL
ATTN: DRXHE
DRXHE-FS (Library)
DRXHE-SP, G. Horley
N. Correira
B. Cummings

USER EVALUATION OF REPORT

Please take a few minutes to answer the questions below; tear out this sheet, fold as indicated, staple or tape closed, and place in the mail. Your comments will provide us with information for improving future reports.

1. BRL Report Number _____

2. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which report will be used.)

_____

_____

_____

3. How, specifically, is the report being used? (Information source, design data or procedure, management procedure, source of ideas, etc.) _____

_____

_____

4. Has the information in this report led to any quantitative savings as far as man-hours/contract dollars saved, operating costs avoided, efficiencies achieved, etc.? If so, please elaborate.

_____

_____

5. General Comments (Indicate what you think should be changed to make this report and future reports of this type more responsive to your needs, more usable, improve readability, etc.) _____

_____

_____

_____

6. If you would like to be contacted by the personnel who prepared this report to raise specific questions or discuss the topic, please fill in the following information.

Name: _____

Telephone Number: _____

Organization Address: _____

_____

_____

FOLD HERE

Director
US Army Ballistic Research Laboratory
ATTN: DRDAR-BLA-S
Aberdeen Proving Ground, MD 21005

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO 12062 WASHINGTON, DC
POSTAGE WILL BE PAID BY DEPARTMENT OF THE ARMY

Director
US Army Ballistic Research Laboratory
ATTN: DRDAR-BLA-S
Aberdeen Proving Ground, MD 21005

FOLD HERE


4-8
DTI