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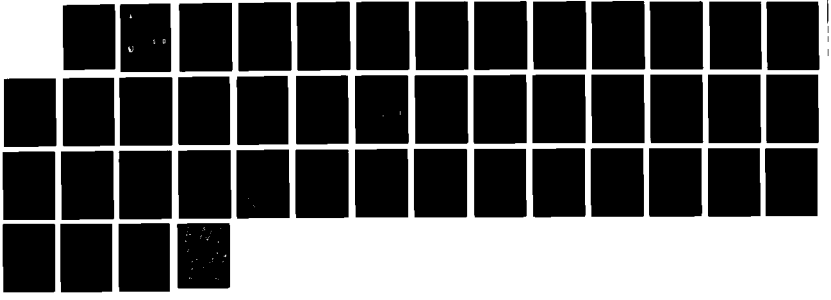

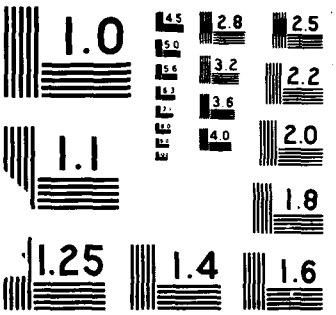
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TECHNICAL REPORT OR-SA-89-06

MANAGEMENT, MAINTENANCE, AND UPKEEP OF THE MICOM BASELINE COMO III AIR DEFENSE MODEL JANUARY 1988 - JANUARY 1989

BY

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1 MARCH 1989

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The purpose of this report is to provide a summary of significant COMO Model related efforts accomplished by the MICOM COMO Model manager during January 1988 - January 1989.

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SUMMARY

The purpose of this report is to provide a summary of significant COMO Model related efforts accomplished by the MICOM COMO Model manager during January 1988 - January 1989.

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I. INTRODUCTION

1. General

1.1 The MICOM COMO model Management Board (CMMB) is continuing to oversee the MICOM baseline COMO model efforts within the Command. The baseline COMO model software is being managed and kept up-to-date to be responsive to internal MICOM and external air defense analysis needs. COMO maintenance, enhancements, and development types of effort are being accomplished by the MICOM Systems Analysis and Evaluation Office (SA&EO) through in-house efforts and efforts with the COMO support contractor, SRS Technologies. This report will provide significant COMO related efforts accomplished by the SA&EO during the timeframe of January 1988 - January 1989. A brief description will be provided which gives an overview of each effort.

II GENERAL DISCUSSION

1. General

2.1 A major effort undertaken during the past year has been the hosting of the COMO T Frame and CAP on the VAX 11/785 mainframe along with the entire ensemble of baseline weapon decks. That effort has been very successful and is now complete; All weapon decks are now executing with the COMO T Frame and CAP. During the rehosting effort and subsequent benchmaking of VAX 11/785 results with CYBER 74 results an inordinate increase in the COMO CPU execution time materialized for the VAX runs. An investigation was launched in an attempt to identify and pinpoint the reasons for this increase and implement techniques, if possible, for the reduction of CPU runtime on the VAX. A brief summary of that effort is included in this report.

2.2 Specific COMO Tasks

2.2.1 Enhancements to the FAADS Line-of-Sight (FLOS) weapon deck, ---- Additional Logic for Tracker Lock-on Time Delay.

Figure 1 shows a functional flowchart of critical events for the FLOS weapon deck, and Figure 2 shows the relationships between weapon system time-lines, cyclic updates and the critical events in the model. The FLOS weapon deck allows a fire unit to have three types of tracking devices (FLIR, RF,TV/ Optics), TKDEV1, TKDEV2 and TKDEV3, respectively. Due to the intrinsic differences and capabilities between these three types of devices COMO modeling logic had to be developed and implemented which would simulate these differences. This was accomplished by allowing input parameters to be included in the COMIL for TKDEV1, TKDEV2 and TKDEV3. The user may specify as many as three tracking devices at a fire unit. Figure 3 shows the revised tracker lock-on logic with the addition of delay times DT31, DT32 and DT33 with the redefining of DT3, DT4 and DT12.

2.2.2 Enhancements to the FAADS Line-of-Sight (FLOS) weapon Deck ---Refined the Missile Flyout for updated Intercept Point.

Analysis of the detailed results being generated by the FLOS weapon deck was revealing that the x, y, and z positions of the missile and target at the calculated intercept point were sometimes not in close agreement. The problem lay in the rather crude fashion in which the FLOS missile was being "flown out" by the missile fly-out routines. More detailed flyout logic, similiar to the Roland flyout logic, was incorporated and replaced the original flyout logic. A new input parameter, DTM was added in the type statements and is defined as the delay time for the missile flyout routine to recycle.

FLOS MODEL OVERVIEW

FUNCTIONAL FLOWCHART

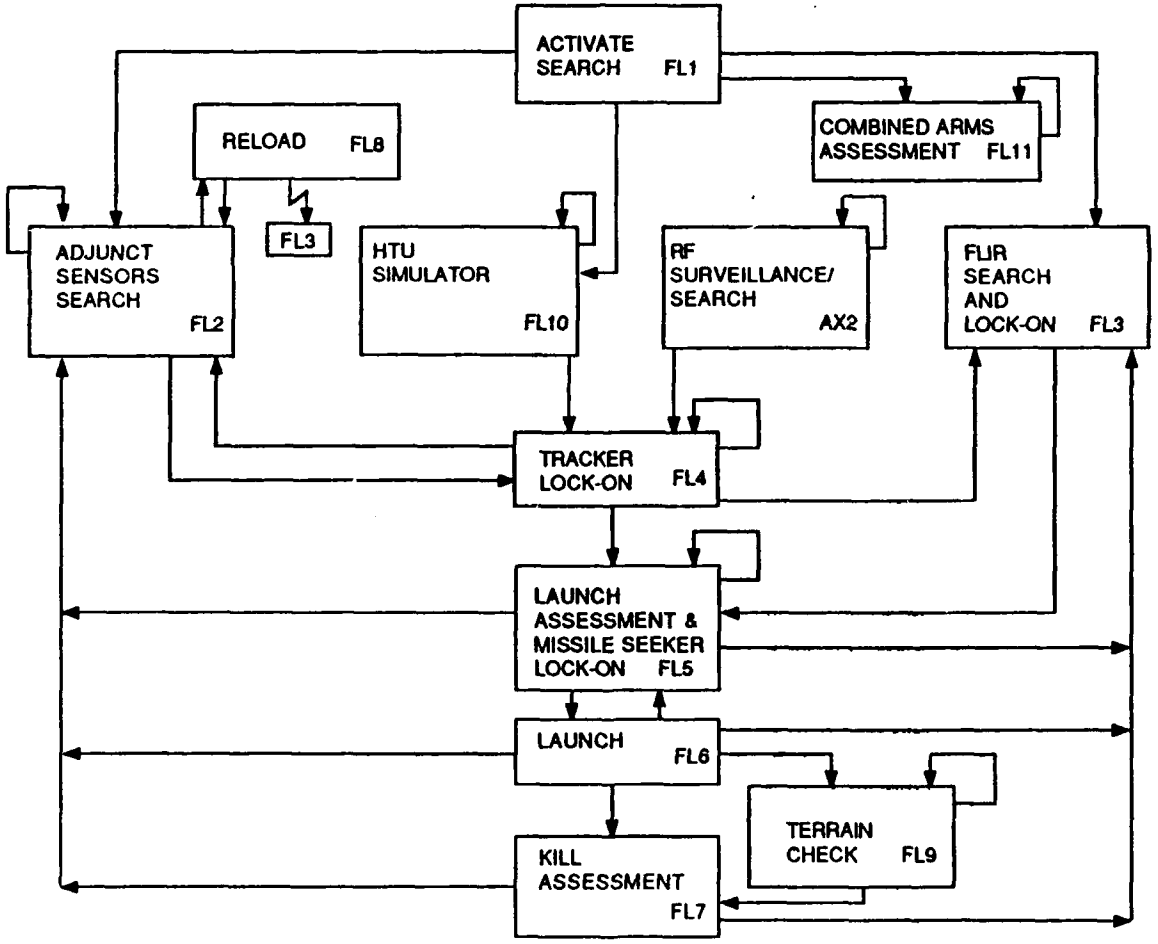
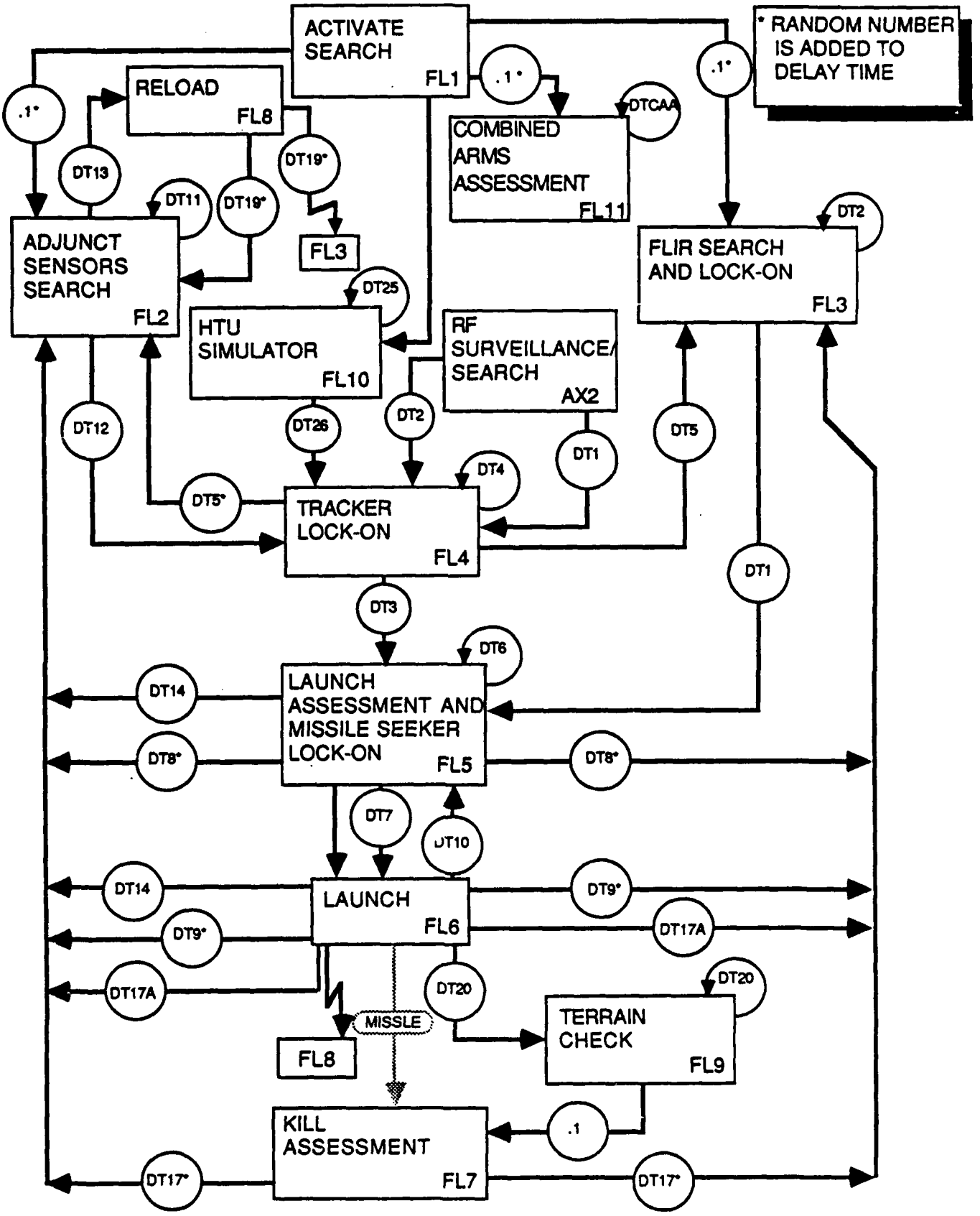


FIGURE 1 FLOS COMO MODEL FUNCTIONAL OVERVIEW



FLOS MODEL OVERVIEW

FIGURE 2 FLOS COMO MODEL TIME DELAYS

As the missile flys out every DTM seconds a new and/or revised intercept point is calculated. The end results is very close agreement between the missile and aircraft coordinates at intercept.

Table 1 contains the up-to-date listings of the FLOS COMO III model inputs.

2.2.3 Enhancements to the FAADS Non Line-of-Sight (NLOS) weapon Dcck--- Addition of Non Cooperative Target Recognition (NCTR) capability and update of COMO III NLOS Documentation.

A major enhancement was made to the NLOS weapon deck in that NCTR capability methodology was designed and implemented into the model logic. The NCTR modeling is characterized by no line-of-sight being required between the fire unit and target, probability of detection as a function of numerous variables and a standard deviation of range error.

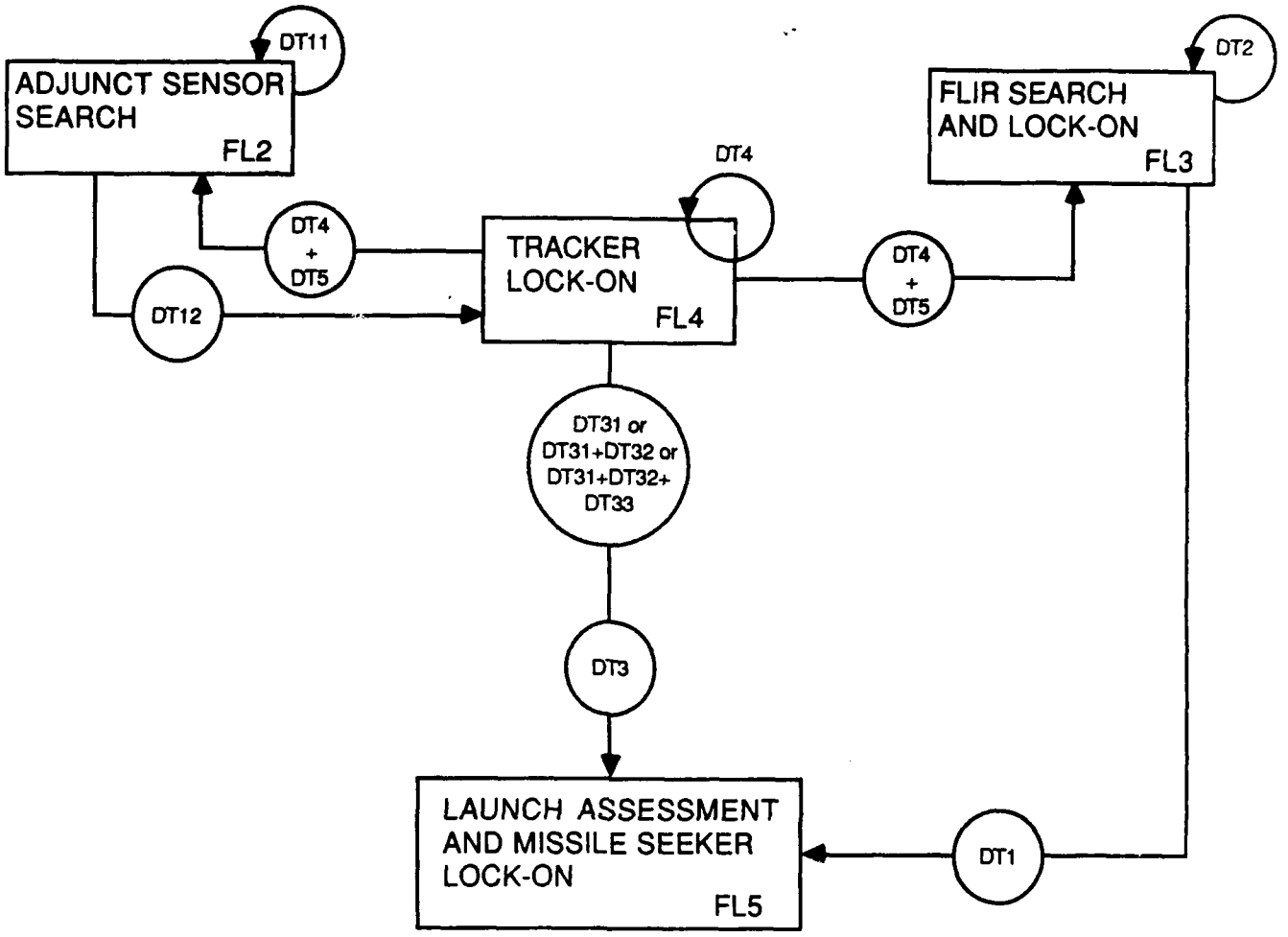
2.2.3.1 Revised NLOS Model Overview

The NLOS model is made up of the NLOS weapon deck and the NMSL weapon deck. The NLOS model contains the eight critical events shown in Figure 4. The critical events NL1, NL2, NL3, NL4 and NL5 represent activities at the fire unit. Events NM1, NM2, and NM3 represent the logic of the missile activites.

The NLOS Enter Game Routine (NLO) starts the local sensor search (NL1) and the HTU operation (NL5) which initiates the action of the NLOS system.

The Sensor Search Event (NL1) acquires targets with sensor characteristics defined by the user in COMIL. This includes NCTR, IR, or visual options. Data is gathered on targets not terrain masked (if LOS sensor specified), detected by the sensor and within the launch boundary to report to the Mission

TRACKER LOCK-ON TIME DELAY



*DT3 TIME FROM LOCK-ON COMPLETION TO LAUNCH ASSESSMENT

**DT31 TIME FOR SUCCESSFUL LOCK-ON OF DEVICE 1

**DT32 TIME FOR SUCCESSFUL LOCK-ON OF DEVICE 2

**DT33 TIME FOR SUCCESSFUL LOCK-ON OF DEVICE 3

*DT4 TIME EXPENDED DURING UNSUCCESSFUL LOCK-ON ATTEMPT BY ALL AVAILABLE TRACKING DEVICES (CUMULATIVE)

DT5 DELAY TIME FROM UNSUCCESSFUL LOCK-ON TO REINITIATION OF SEARCHES

*DT12 TIME DELAY FROM TGT DETECTION IN ADJUNCT SENSOR SEARCH TO BEGINNING OF FIRST LOCK-ON ATTEMPT

** NEW INPUT $3
* DEFINITION CHANGED

FIGURE 3 TRACKER LOCK-ON TIME DELAY

TABLE 1 FLOS COMO III MODEL INPUTS

PARAMETER	DEFINITION	VALUE
DT1	Delay Time From Target Detection With FLIR To Launch Assessment	
DT2	Cyclic Delay Time For FLIR Search	
DT3	Delay Time From Lock-On To Launch Assessment	
DT4	Cyclic Delay Time For Lock-On	
DT5	Delay Time From Unsuccessful Lock-On To Reinitiation Of Searches	
DT6	Cyclic Delay Time For Launch Assessment	
DT7	Delay Time From Missile Seeker Lock-On To Launch	
DT8	Delay Time To Cancel Engagement At Assessment And Return To Searches	
DT9	Delay Time After No Launch To Reinitiate Searches	
DT10	Delay Time To Reschedule A Launch If There Is A Launcher Failure	
DT11	Cyclic Delay Time For Adjunct Sensors Search	
DT12	Delay Time From Target Detection In Adjunct Sensors Search To Lock-On	
DT13	Delay Time From System Shut Down To Begin Reload	
DT14	Delay Time From Last Munition Expended To Reload	
DT17	Delay Time After Kill Assessment To Reinitiate Searches	

TABLE 1 FLOS COMO III MODEL INPUTS (Con't)

PARAMETER	DEFINITION	VALUE
DT17A	DT To Reinitiate Searches (FL2 and FL#) After Launch, FL6, For A Non Command Guided Ordnance	
DT19	Delay Time To Reload Before Initiating Searches	
DT20	Delay Time To Initiate Terrain Check After Launch	
DT25	DT To Receive Info Broadcast By FC^2I Network and Update TFs	
DT26	DT To Initiate Tracker Lock-On (FL4)	
DTM	DT For Missile Flyout Cycle Recycle	
DT31	Time For Successful Lock-On By Device 1	
DT32	Time For Successful Lock-On By Device 2	
DT33	Time For Successful Lock-On By Device 3	
RINTR	Range Of Interest When Selecting Target Info Broadcast By FC^2I Network	
HTUAV	HTU Operational Availability	
MAXR	Maximum Engagement Range Used By Schall	
TMX	Maximum Time To Attempt Lock-On	
TMSER	Maximum Time The Adjunct Sensors Can Search And Not Detect Before	
TMASK	Maximum Time The Target Can Be Masked And The Missile Continue Engaging	
MXTGT	Maximum Number Of Prioritized Targets To Be Considered During Search	
PDOWN	Probability The Fire Unit Will Be Unable To Power Up At Enter Game	
PDTADJ	Probability Of Detection With One Of The Adjunct Sensors	

TABLE 1 FLOS COMO III MODEL INPUTS (Con't)

PARAMETER	DEFINITION	VALUE
PDTFLR	Single Look Probability of Detection And Lock-On With The FLIR	
PTKFR	Probability Of Successfully Tracking A Target For Lock-On With A FLIR Device	
PTKRF	Probability Of Successfully Tracking A Target For Lock-On With A RF Device	
PTKTV	Probability Of Successfully Tracking A Target For Lock-On With A TV/Optics Device	
TKDEV1	First Choice For A Tracking Device (1 = Error, 2 = FLIR 3 = RF, 4 = TV/Optics)	
TKDEV2	Second Choice For A Tracking Device (1 = None, 2 = FLIR, 3 = RF, 4 = TV/Optics)	
TKDEV3	Third Choice For A Tracking Device (1 = None, 2 = FLIR, 3 = RF, 4 = TV/Optics)	
PRINGLR	Probability Of Acquiring Range With A Laser	
PLAUNF	Probability Of Launcher Failure	
RENG	Maximum Receding Engagement Range	
WTADJ	Weight Assigned To Target Detected By An Adjunct Sensor	
DTCAA	Delay Time To initiate And Recycle The Combined Arms Event (FL11)	
PKCA	Probability The FU Will Be Killed By Red Tanks	
INRG	Initial Number Of Missile/Gun Bursts On Th Launcher (Full Load)	
NRLRG	Number Of Missile/Gun Bursts Available For Reload	

TABLE 1 FLOS COMO III MODEL INPUTS (Con't)

PARAMETER	DEFINITION	VALUE
INMS	Initial Number Of Missiles On The Launcher (Full Load)	
NRLMS	Number Of Missiles Available For Reload	
LBDY	Launch Boundary	
LRMAX	Max Alt At Which RVISL Will Be Used In Place Of RVIS	
PMSSLK	Probability The Missile Seeker Can Lock-On To The Target	
FLRSCA	FLIR Search Sector In Azimuth	
FLRSCE	FLIR Search Sector Maximum Elevation Limit	
MAXFLT	Maximum Flight Time Of Missile/ Gun	
FLTTIME	Missile/Gun Flyout Time As a Function Of Range To The Target	
PFLTF	Probability Of In-Flight Failure	
PKIL	Probability Of Kill	
IBDY	Intercept Boundary	
TOL	Tolerance Used In Calculation Of Range Estimation Error	
ORDOPT	Flag Indicating Which Ordnance To Prefer	
CMDG	Flag Indicating If Ordnance Is Command Guided	
	RF SURVEILLANCE RADAR INPUTS	
DT1	Delay Time From Target Detection By Auxsen To Initiate FLOS Lock-On	

TABLE 1 FLOS COMO III MODEL INPUTS (Con't)

PARAMETER	DEFINITION	VALUE
DT2	Cyclic Delay Time For Auxiliary Sensor Search	
MAXR	Maximum Engagement Range Used By Schall	
TMX	Maximum Time To Attempt Lock-On (Used in FL4)	
PDTAUX	Probablity Of Detection By Auxiliary Sensor	
MXTGT	Maximum Number Of Prioritized Targets To be Considered During Search	
RENG	Maximum Receding Engagement Range	
PDQWN	Probability The CU Will Be Unable To Power Up At Enter Game	
DT3	Delay Time To Initiate TF Monitor And Broadcast Event (AX3)	
DT4	Cyclic Delay Time To update The TF Monitor And Broadcast Event	
DT5	Delay Time To Coast After The Target Becomes Masked Before Dropping The Trackfile	
TRBDY	Targets Within This Boundary Can Be Tracked By The FAADS C^2I Sensor	
MXTF	The Maximum Number Of Trackfiles Maintained At The FAADS C^2I Sensor	
AODB	Radar Range Equation (Input In DB) AODB = $(P*C^2W^2) / (4*PI)^3*L$ Where P = Average Sensor Transmitter Power C = Processing Gain W = System Wavelength L = Total Losses	

TABLE 1 FLOS COMO III MODEL INPUTS (Concluded)

PARAMETER	DEFINITION	VALUE
BNWT	Receiver Bandwidth In HZ (Input in DB)	
CODB	Pulse Processing Gain In DB When Applicable, Otherwise 0	
FNDB	Receiver Noise Figure In DB	
GMAINL	Mainlobe Antenna Gain	
G2SL	One Way Scan Loss In DB	
RAGAZ	Radar Gain in Azimuth	
ELRES	Radar Elevation Resolution	
AZRES	Radar Azimuth Resolution	

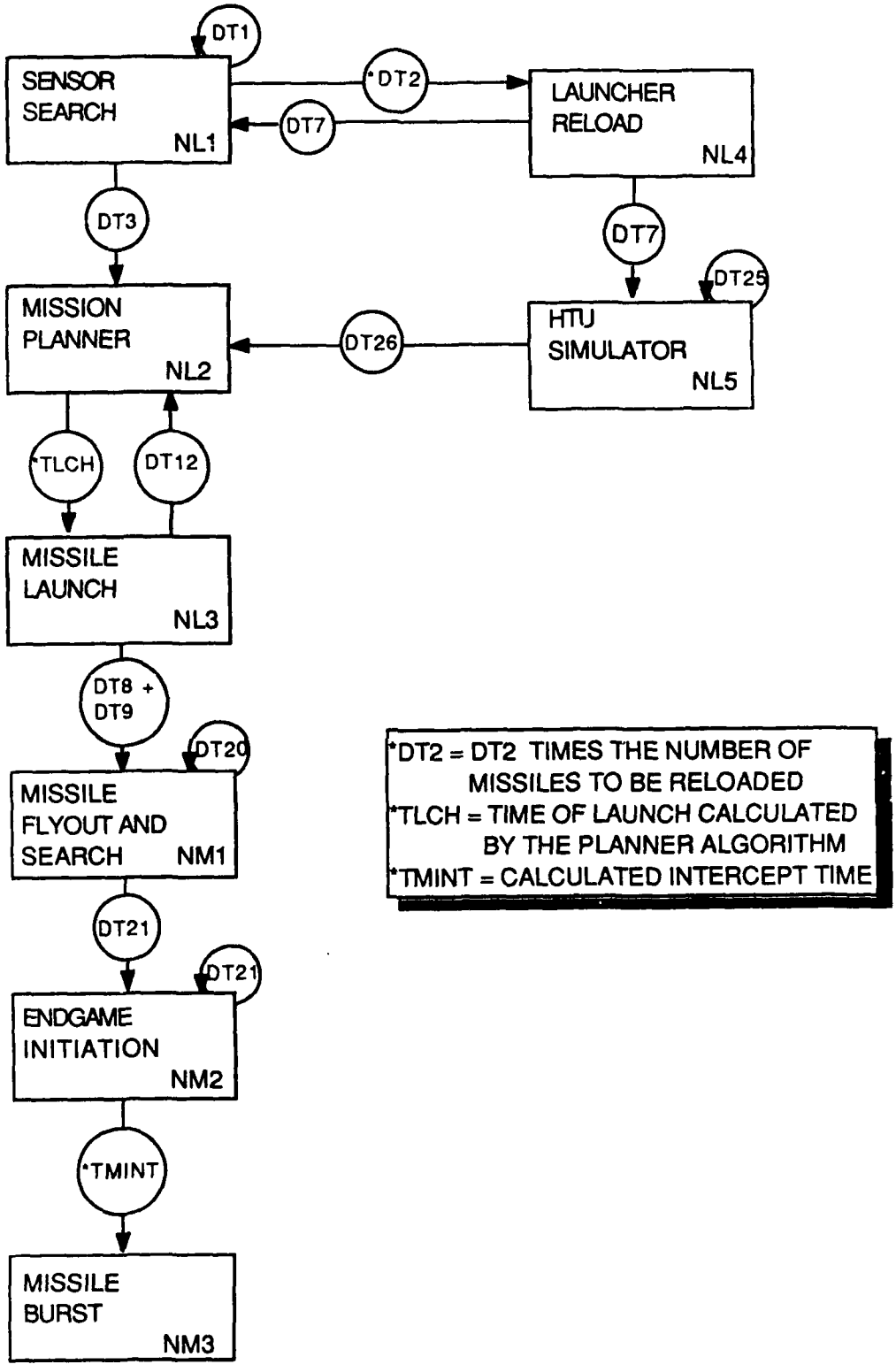


FIGURE 4 *NLOS Model Overview*

Planner, NL2. The Search Event is rescheduled on a cyclic basis (DT1) but will attempt acquisition only when the fire unit has less than five engagements in progress. Engagements include missiles on the launcher with a planned launch time and missiles currently in air.

The cyclic HTU operation (NL5) supplies EPLRS targets to NLOS via the FAADS C^2I network. Targets available through this connection are limited to those within the specified range of interest. Subsequent fire unit target selection, HTU and local sensors, is based on input threat selection POLICY. The mission planner is scheduled when a new target is selected. When the Mission Planner Event (NL2) is scheduled the Planner Algorithm (MSNPLN) calculates launch times for the targets reported. Launch requests are treated basically first in/first out with short term conflicts resolved by consideration of target area overlap, capacity for missiles in flight, estimated missile flight time, and subsequent launch window constraints. An independent missile combat unit is dynamically created through the COMO Frame routine MISSL to be launched at the calculated launch time.

The Missile Launch Event (NL3) is scheduled by NL2 at the calculated launch times (TLCH) for each missile created in NL2. When there is no launcher failure, the missile is given its position after boost and pitchover to begin its level flight in NM1. If launch failure occurs, the missile is aborted and the Mission Planner is recalled (DT12).

The Missile Flyout and Search Event NM1) updates the flight path of the missile. Checks are made for missile in-flight failure and exhaustion of maximum flight time. The search function checks intervisibility, FOV limits

(azimuth, elevation, range), and single scan probability of detection. If a target is not detected, the flyout is recycled (DT20). If a target is detected, the missile Endgame Initiation Event (NM2) is scheduled (DT21).

Endgame Initiation Event (NM2) simulates missile seeker lock-on. If lock-on is not achieved, a check is made to determine if the missile will flyover the target within the next update. If a flyover will occur, the missile returns to search mode. Otherwise, the missile continues closing and the Endgame Initiation Event (NM2) is rescheduled DT21). When seeker lock-on is achieved, the time to intercept is calculated (TMINT) and the Missile Burst Event (NM3) is scheduled.

In the Missile Burst Event (NM3) the lethal range of the missile is checked and a random draw is compared to the probability of kill to determine the result of the engagement. If the missile killed the target, the target and missile are removed from the game. If the missile fails to kill the target, only the missile is removed from the game.

The Launcher Reload Event (NL4) is scheduled from NL1 when the NLOS system has depleted missiles and there are no missiles in the air. NL1 is scheduled from NL4 for reload scheduling when Launch is scheduled with no missiles on the launcher or the last missile is launched. A full or partial reload may occur if DT7 seconds of idle time has elapsed since last engagement.

Table 2 contains the revised and up-to-date COMO input parameters for NLOS. Figure 5 contains the result indicators for the revised NLOS weapon deck. The User/Analyst manual was revised and published in September 1988 entitled: COMO NLOS USer/Analyst Manual, SRS/STD TR89-210, by Sara Laase Deaton.

TABLE 2 NLOS COMO III MODEL INPUTS

PARAMETER	DEFINITION	VALUE
COMBAT UNIT STATEMENT		
X	...	
Y	...	
Z	...NLOS Position on Battlefield	
T	Time NLOS Fire Unit Enters The Game	
FC2I	Pointer To The FAADS C^2 I Sensor	
OPCTR	Pointer To The Coordination Center To Which The FU Points	
RVIS	Range Of Visibility Based On Terrain Patterns	
TARGT	Target Engagement Criteria	
POLCY	Target Engagement Criteria	
NLTP	Pointer To The NLOS Type Statement	
NLOS TYPE STATEMENT		
PNDOW	Probability The FU Will Be Unable To Power Up At Enter Game	
MXLN	Maximum Number Of Scheduled Launches	
MXIA	Maximum Number Of Missiles In The Air	
MXEN	Maximum Number Of Engagement (MSLN+MXIA)	
TMSER	Time Search Performed Without Detecting A Target Before A Reload Attempt Is Made	
DT1	Cyclic Delay Time To Reinitiate The Sensor Search	
DT2	Delay Time To Reload A Single Missile	
DT3	Delay Time To Call The Mission Planner From Sensor Search	

TABLE 2 NLOS COMO III MODEL INPUTS (Cont'd)

PARAMETER	DEFINITION	VALUE
DT5	Maximum Time During Which Launches Can Be Scheduled Each Mission Planner Execution	
DT6	Delay Time To Launch Missile Once Given a Target Area	
DT7	Delay Time To Reinitiate Search After Reload	
DT8	Delay Time To Boost The Missile To Pitchover Altitude	
DT9	Delay Time For Missile To Arrive At Down Range Position	
DT10	Delay Time Between Missile Fires	
DT11	Delay Time For Operator To Switch To Next Engagement	
DT12	Delay Time To Call The Mission Planner After Launcher Failure	
DT25	Delay Time To Receive Information Broadcast By The FAADS C^2I	
DT26	Delay Time To Initiate The Mission Planner (NL2)	
MXTGT	Maximum Number Of Target Considered In Search (SYSNL)	
RADI	Radius Of The Circle Which Forms A Target Area	
PLAUNF	Probability Of Launcher Failure	
NLMTP	Pointer To The NLOS Missile Type Statement	
PDET	Probability Of Detecting A Target	
RMAX	Maximum Engagement Range Used By Schall Executive Routine	

TABLE 2 NLOS COMO III MODEL INPUTS (Cont'd)

PARAMETER	DEFINITION	VALUE
RENG	Maximum Receding Engagement Range For The Fire Unit	
LOSLM	Flag Indicating Whether Los is Required For Detection	
RINTR	Range of Interest When Selecting Target Information Broadcast By The FAADS C^2I Network	
HTUAV	HTU Operational Availability	
DT20	Cyclic Delay Time To Update Missile Flyout	
PLOCK	Probability The Missile Seeker Will Lock-on To The Target	
NLOS MISSILE TYPE STATEMENT		
DT21	Delay Time To Update Missile Position and Initiate Endgame Launch Boundary	
LBDY	Launch Boundary	
PFLTF	Probability The Missile Will Fail In Flight	
PINTV	Probability The Missile Will Be Intervisible To The Target	
PDETM	Probability The Missile Seeker Can Detect The Target	
RENGM	Probability The Missile Will Be Intervisible To The Target	
PDETM	Probability The Missile Seeker Can Detect The Target	
RENGM	Maximum Receding Engagement Range For The Missile	

TABLE 2 NLOS COMO III MODEL INPUTS (Concluded))

PARAMETER	DEFINITION	VALUE
INMS	Initial Number Available Reloads	
PKILL	Probability The Missile Will Kill The Target	
MSVEL	Constant Average Missile Velocity	
INTRNG	Missile Intercept Range	
BALT	Altitude To Which The Missile Boosts Before Pitchover Begins	
DRNG	The Down Range Distance The Missile Flies During Pitchover	
MAXFLT	Maximum Flight Time Of The Missile	
FLTIME	Missile Flyout Time As a Function Of Range To The Target	
SDEV	Standard Deviation Of Azimuth Error	

NL1 SENSOR SEARCH EVENT	
NL1C1	LAUNCHER EMPTY WITH MISSILES IN THE AIR - SENSOR SEARCH RESCHEDULED
NL1C2	LAUNCHER IS EMPTY - RELOAD SCHEDULED
NL1C3	FIRE UNIT HAS SEARCHED FOR TMSER SECONDS WITHOUT DETECTING - PARTIAL RELOAD SCHEDULED
NL1C4	MAXIMUM NUMBER OF ENGAGEMENTS IS PLANNED WHEN THE MISSION PLANNER IS CALLED - RECYCLE SEARCH
NL1C5	NLOS IS OUT OF ACTION
NL1C6	TARGET DETECTED
NL1C7	NO TARGET WITHIN THE LAUNCH BOUNDARY OR NO AVAILABLE TARGET STORE POSITION
NL1C8	FU HAS SEARCHED FOR TMSER SECONDS WITHOUT DETECTING BUT HAS MISSILES IN THE AIR - SENSOR SEARCH RESCHEDULED
NL2 MISSION PLANNER EVENT	
NL2C1	MISSION PLANNER BUSY WHEN CALLED
NL2C2	NO ENGAGEABLE TARGET AREA WAS RETURNED BY THE PLANNER ALGORITHM
NL2C3	LAUNCHED SCHEDULED
NL2C4	MISSION PLANNER OVERLOAD - LAUNCH WINDOW CONFLICTS WITH PREVIOUSLY SCHEDULED CASE
NL3 MISSILE LAUNCH EVENT	
NL3C1	LAUNCHER FAILURE
NL3C2	MISSILE LAUNCHED AND FLYOUT SCHEDULED
NL3C3	TARGET FOR WHICH TARGET AREA WAS DEFINED IS NOW DEAD OR OUT OF THE GAME
NL4 LAUNCHER RELOAD EVENT	
NL4C1	THE SYSTEM IS DEPLETED OF ALL MISSILES AND RELOADS - REMOVE THE FU FROM THE GAME
NL4C2	LAUNCHER FULLY RELOADED WITH MISSILES
NL4C3	LAUNCHER PARTIALLY RELOADED WITH MISSILES - NO MORE RELOADS AVAILABLE

FIGURE 5 RESULTS INDICATORS

NL5 HTU SIMULATOR EVENT	
NL5C1	HTU IS UNABLE TO POWER UP AT ENTER GAME
NL5C2	NO ENGAGEABLE TARGET - HTU SIMULATOR RECYCLED
NL5C3	THE FIRE UNIT IS CURRENTLY ENGAGING THE MAXIMUM NUMBER OF TARGETS - RECYCLE HTU SIMULATOR
NL5C4	MISSION PLANNER SCHEDULED FOR HTU TARGETS STORED IN AVAILABLE TARGET POSITIONS
NL5C5	HTU TARGETS STORED IN AVAILABLE TARGET POSITIONS FOR PENDING MISSION PLANNER EVENT
NL5C6	FIRE UNIT IN RELOAD - RECYCLE HTU
NL5C7*	WRITTEN FOR EACH TARGET RECORD DISPLAYED ON HTU
NL5C8*	WRITTEN FOR EACH TARGET IN THE FIVE HIGHEST WEIGHTED LIST WHICH ARE TARGETS TO BE SENT TO THE MISSION PLANNER
NM1 MISSILE FLYOUT AND SEARCH EVENT	
NM1C1	MISSILE BURNOUT IN AIR
NM1C2	MISSILE IN-FLIGHT FAILURE
NM1C3	MISSILE POSITION UPDATED
NM1C4	TARGET NOT FOUND
NM1C5	TARGET FOUND - ENDGAME INITIATED
NM2 ENDGAME INITIATION EVENT	
NM2C1	MISSILE SEEKER FAILED TO LOCK-ON TO THE TARGET
NM2C2	MISSILE WILL FLYOVER TARGET DURING NEXT UPDATE - ABORT MISSILE
NM2C3	MISSILE WILL REACH INTERCEPT POINT - BURST SCHEDULED
NM3 MISSILE BURST EVENT	
NM3C1	TARGET ALREADY DEAD
NM3C2	TARGET NOT KILLED - NOT WITHIN LETHAL RANGE OF MISSILE
NM3C3	NLOS MISSILE FAILED TO KILL THE TARGET
NM3C4	NLOS MISSILE KILLED THE TARGET

* THESE DEBUG RESINDS ARE AVAILABLE UPON USER REQUEST.

FIGURE 5 RESULTS INDICATORS (Concluded)

2 2.4 Routine Maintenance and Upkeep of COMO III Software Ensemble.

One of the major responsibilities of the MICOM COMO Model Manager is the day-to-day maintenance and upkeep of the entire software ensemble (weapon decks, FRAME and CAP). Continued use of the model usually identifies shortcomings and/or errors that reside within the code which must be corrected. Conversion of the ensemble to all-FORTRAN for execution on the VAX mainframe also resulted in a few "glitches" that had to be corrected. A listing of some of the more significant shortcomings and glitches discovered and corrected during the year are provided in Appendix A. The format for Appendix A is that which was provided by SRS, Technologies within their monthly progress reports provided to the MICOM COMO Model Manager.

2.2.5 Investigation of Reducing the Computer Execution Time for the COMO III Air Defense Model.

During January 1988 an effort was initiated to host the MICOM baseline COMO III air defense simulation model ensemble of software on the Systems Analysis and Evaluation Office's (SA&EO) VAX 11/785 (VAX) minicomputer. When the software ensemble began to execute and run to completion a benchmaking effort was initiated comparing the results obtained on the VAX with the results from the same scenario obtained on the CYBER mainframe. The first observation was an inordinate increase in total CPU seconds execution time for the VAX compared to the CYBER. The first obvious question was why? Was the VAX that much slower than the CYBER? If the VAX is 8-10 times slower than the CYBER can anything be done to speed up the VAX execution time? An effort was begun to investigate and address the latter question and it is that effort which was completed and documented. The techniques, methodology, investigation

and general findings, although specifically related to COMO III, are applicable for any operational effectiveness simulation model. Models that are event driven and event sequenced are specially attractive and receptive to reductions in execution time.

The COMO III baseline software ensemble which has hosted on the VAX included the following ensemble parts:

a. All-FORTRAN COMO FRAME (FRAME)

b. COMO Assembly Program (CAP)

c. COMO III Weapon Decks

PATRIOT	JAMMER
HAWK	ASSETS
CHAPARRAL	MANTAR
STINGER	FAADS Line-of-Sight (NLOS)
AIRCRAFT	FAADS Non-Line-of-Sight (NLOS)

The tactical "benchmaking" scenario which was scripted and input into the COMO model consisted of a "notional" US Army heavy division deployed in Europe defending against a hypothetical "D-day" type of attack. Divisional air defense assets consisted of PATRIOT, HAWK, CHAPARRAL, Forward Area Air Defense System (FAADS) Line-of-Sight Rear (LOS-R), FAADS Line-of-Sight Forward-Heavy (LOS-F-H-), FAADS None Line-of-Sight (NLOS) and the FAADS Command and Control Information (FAADS C2I) System.

The Initial VAX benchmarking effort began by attempting to run the full divisional scenario which had recently been executing on the CYBER 74 mainframe. After minor COMO adjustments for the VAX operating system requirements, the

scenario ran to completion. The results produced on the VAX were very similiar to those produced on the CYBER 74 with the exception of radar performance in a heavy ECM environment. This has since been investigated and fixed. An immediate observation which caused great anguish was the huge increase in CPU execution time for the VAX as compared to the CYBER 74. The first VAX benchmarking effort was done with a fill division slice of air defense artillery. This resulted in an inordinate amount of VAX CPU execution time. Due to the activeness of the LOS-R's within the division, it was decided to conduct the investigation with only the LOS-R's, FAADS C2I sensors and Aircraft in the game. Initial inspection of the statistics revealed four major contributions to CPU runtime---AC2, FL10, AX2, AX3. It is immediately obvious that the success in speeding up the COMO execution time depends upon the speed-up of these four events. The following brief description of each of these four events is provided for clarity:

AC2---Aircraft Search--This is the event in the AIRCRAFT weapon deck which simulates aircraft searching for ground targets as the aircraft "fly" along it preplanned track.

FL10--HTU Simulator----This event, in the FLOS weapon deck, simulates a fire unit obtaining and using a trackfile from the Hand-Held Terminal Unit (HTU). These track-files are created by the FAADS C2I sensors and broadcast throughout the division via the EPLRS radio network.

AX2--Surveillance Radar Search--This event simulates the search and detections of airborne targets by a RF Surveillance radar.

AX3--Trackfile Monitor and Broadcast--This event simulates the trackfile

update by a FAADS C2I sensor and the boradcast of that trackfile throughout the division over the EPLRS radio network.

Approximately 100 sensitivity runs were made systematically varying the cyclic delay times associated with the (1) aircraft search, (2) HTU simulator, (3) Surveillance radar search and (4) FAADS C2I trackfile monitor and broadcast events. A final comparison between the base case and a "near optimum" case is shown in table 3.

The data generated by this study effort clearly demonstrates that the COMO III Model execution time can be speeded up by an intelligent choice of cyclic delay times. The choice of specific cyclic delay parameters and these "near optimum" values must be determined for each COMO application. This investigative effort was documented and is contained in reference 2.

TABLE 3 - BASE CASE AND NEAR OPTIMUM CASE COMPARISON

MEASURES OF EFFECTIVENESS	BASE CASE DTSRCH = 3, DT2 =5 DT4 = 3, DT25 = 5	NEAR OPTIMUM CASE DTSRCH = 9, DT2 = 25 DT4 = 15, DT25 = 15
ORDNANCE EXPENDED BY AIRCRAFT		
BOMBS	15.3	17.7
MISSILES	13.3	15.7
VITAL ASSETS KILLED BY AIRCRAFT	10.0	11.0
FAADS C2I SENSOR DETECTS	3176	1131
TRACKFILES INITIATED BY FAADS C2I	2836	1129
LOS-R		
FLIR LOCK-ON	483	363
MISSILES LAUNCHED	191	187
KILLS (TOTAL/KBORS)	100/93	99/88
TOTAL GAME CPU EXECUTION TIME	8448	2407

2.2.6 COMO III Bulletin Board System

A COMO Bulletin Board System (CBBS) has been installed on the MICOM Systems Analysis and Evaluation Offices' VAX 11/785. The CBBS was completed and installed by SRS, Technologies. The CBBS has been demonstrated and maintenance procedures reviewed. The CBBS information is currently organized as follows:

- o Bulletins
  - CBBS software change history
  - CBBS software (planned)
  - Software trouble reports (planned)
- o COMO Changes
  - Synopsis of changes
  - Individual software change proposals
- o Messages
  - User comments and dialogue
- o Transfer files

Initial information, divided into three areas, has been created for the file transfer which includes (1) a starter set, (2) primer and (3) COMO -T users manual. The starter set contains the SHAPE Technical Center documented example weapon deck (Gun, Dummy, OPCENTRE), COMIL and output. The primer section contains basic files such as instructions on how to set up and run COMO. The COMO -T users manual area is currently blank.

The bulletins, COMO changes and transfer files may be added, edited and/or deleted only by the MICOM COMO Model manager. The message area will be the medium for user exchange of COMO information.

Interested COMO users will be approved and granted log-on privileges

into the VAX. These users will have full access to all CBBS files. A CBBS management instruction package is presently being written. It will be provided to all interested users when completed.

III REFERENCES

1. COMO NLOS User/Analyst Manual, SRS/STD TR 89-210, SRS Technologies, Sara Laase Deaton, September 1988

2. Investigation of Reducing the Computer Execution Time for the COMO III Air Defense Simulation Model, TR OR-89-02, U.S. ARmy Missile Command, Charles E. Colvin, etl., 1 February 1989

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APPENDIX A

COMO III Software Ensemble Maintenance

Weapon Deck	SCP Number	Routine	Description	Originator
IAIR	01	USRCOM ZTRINC	TRINC array should be dimensioned (800,6), MRCOL by (160), and MRBIT by (160).	T. Smith
	02	DYNMAN	CALL to REPLAC ( ) should be substituted with CALL CANCEL ( ) and CALL SCHEDL( ).	T. Smith
		CHGVEL	Substitute a call to CANCEL and call to SCHEDL for the call to REPLAC.	
	03	$3 card	$3 TURNHK should be TURNH.	T. Smith
	04	SPEC1	25 Format (A3) should be (A4).	T. Smith
	05	AC8	ACTCU(2) not set properly before call to SCHTGT. REDNAG argument (P) left off.	M. Binner
	06	MXBTN	Incorrect test for RMAX settings. Test should be on 'AIRCRAFT' not ' AIRCRAF'.	M. Binner
	07	SPEC1 SPEC3	Debug output code added for FC²I and NLOS HTU.	SRS

Weapon Deck	SCP Number	Routine	Description	Originator
ASSET	01	CHILD	Force the Combat unit store overflow condition to bomb with a traceback. Corrects Missile not being given a name properly. More readable test added for target class pointer.	T. Smith
AUXSEN	01	$1 Card	Coordination bit should be 1 not zero.	T. Smith
	02	$3 Cards	OCPTR should be OPCTR. RAGAZ should be RGAZ.	T. Smith
	03	TFINIT	Force the combat unit store overflow condition to bomb with a traceback. Corrects missile and combat unit type from being named improperly.	T. Smith
	04	AX2, AX3	FC2I debug prints	SRS
	05	AX2, AX0	Corrects improper usage of common block AXSN.	T. Smith
	06	$4 cards	$4 cards for NEXCU and PREVCU missing.	M. Binner
	07	AX2	Radar number should be set before call to SCHALL	J. Hancock
FLOS	01	FL2 FL6	Safety check which provides for DO loop from 1 to NSEN not being from 1 to 0.	SRS

Weapon Deck	SCP Number	Routine	Description	Originator
	02	FL4	Code enhancement to make tracker lock-on delay time as a function of tracker device.	SRS
	03	new event FL12 Create	Code enhancement to add a Missile Flyout routine.	SRS
	04	TTYPE	Name conflict with CPTYPE. Change TTYPE to TTYP.	T. Smith
	05	SYSFL	Search Sector corrected for 360° azimuth.	SRS
	06	$9 TTYP	Moved $9 routine to Mantar to allow usage by other decks not dependent on FLOS.	SRS
	07	FL7	Improper setting of $4 NLOCK for Aircraft instead of Helicopter	SRS
HELI/COPTR	01	MOVHEL	Prevents a divide by 0.	T. Smith
	02	HL11	Subroutine name and schedule conflict. Should be HL11 not H11.	T. Smith
	03	$3 Cards	RINTCP should be RTCP. DTLOCK should be LOCKDT. DTSRCH should be DTSCH. MAXR should be RMAX. ATMOUS should be ATMUS.	T. Smith
	04	HL4	LOCKDT not declared real.	T. Smith
		HL5	LOCKDT not declared real.	T. Smith

Weapon Deck	SCP Number	Routine	Description	Originator
	05	HL2	Calls to VECMUL and VECMG with incorrect argument list causes COPTR speed and altitude to be incorrect.	SRS
	06	HL3,MH1	Helicopter NAGRS problem corrected.	T. Smith
	07	HLX	Leader re-assignment problem corrected.	SRS
	08	$3 HVRSPD	Unit class corrected from 2 to 4.	SRS
IJAM	01	$3 Card	$3 ACIR missing.	T. Smith
NLOS	01	NL2	PASCU not set.	T. Smith
	02	MSLCHN	Argument on call to NLSORT should be PARNT not PARENT.	T. Smith
	03	$3 Card MSVEL	Minimum value should be set to one instead of zero.	M. Binner
	04	NM2	Prevents a divide by zero.	M. Binner
	05	NL2	Mission planner pack/unpack code replaced.	T. Smith SRS
	06	NL1	Removes integerized variables P1-P5 which are not used.	SRS
	07	SYSNL	Corrects inequality and possible target overwriting error in building target list and weights to return to sensor search (NL1).	SRS
	08	SYSNL	Additional code required to prevent multiple launches to same target area.	SRS

Weapon Deck	SCP Number	Routine	Description	Originator
	09	MSNPLN	Use of variable NTGG. $4 NTGG added.	SRS
	10	MSNPLN	Integer overflow. Reduced initializing of T(I) and TP(I) from 1E15 to 1.07E9.	SRS
		EZONE	Integer overflow. Reduced initializing of TMIN from 1E15 to 1.07E9.	SRS
	11	NM1	Left over unreachable code needs removing.	SRS
	12	MSNPLN NL2, EZONE	$4 NTGG added. 'A' added to common block Planing.	SRS
	13	TFSORT	Prevents multiple launches in same target area.	SRS
	14	NL5, SYSNL	NLOS HTU debug prints	SRS
	15	SYSNL	Connects OPCENTRE logic to HTU	SRS
	16	EZONE	Corrects type o's in calculation.	SRS
	17	TFSORT, SYSNL	Corrects useage of TX and TY of missile to current X and Y position of missile.	SRS
	18	SYSNL	Targets which are in the same formation as previous target should be rejected.	SRS
	19	FLYOVR	Calculation error corrected.	SRS
	20	NL2	Corrects the initializing of target velocity to zero.	SRS
	21	NL2,NLSORT	Improves test on which target slot to clear after a missile is removed from the game.	SRS
	22	MSNPLN	Corrects for subscript being out of range.	SRS

Weapon Deck	SCP Number	Routine	Description	Originator
	23	NL2	Clears unengageable targets from target list.	SRS
	24	SYSNL	Removes duplicated check in SYSNL on PAR10.	SRS
	25	NL1, NL2 NL5, SYSNL	NCTR enhancement.	SRS
	26	NM2, NM3	Move clearing of SFLG until intercept.	SRS
	27	NM2	Included SRAD test in End-game initiation routine.	SRS
	28	NL2	Erroneous calculations should be cleared for JTP1-JTP5 for non-engageable targets.	SRS
STINGER	01	ST7	Handover code restored	SRS
	02	ST7	Argument left off PASCU (1) causing output to be written incorrectly.	SRS
		MSLTGT	Integer MCHST not NCHST.	M. Binner
	03	SRSC	Search Sector corrected for 360° azimuth.	SRS
OPCENTRE	01	OCREQ1	Looping problem corrected.	M. Ann Tatum
PATRIOT	01	TF1	Corrects FU count of number of missiles in TVM	SRS
	02	MFO,TF4 MLX,CCLNCH	SHIFT function should be declared integer in calling routine	J. Hancock
	03	TRINK	Replace calls to ZTRINC (IT,JCOL,MASK) with TRINC (IT,JCOL) = MASK for efficiency	J. Hancock

Weapon Deck	SCP Number	Routine	Description	Originator
HAWK	01	HP5	$4 ALKDD should be set for Missile rather than FU.	M. Binner
CHAPARRAL	01	CH6	$3 OPTON should be declared integer	SRS
	02	CH3	Incorrect call to IND2 (A,0) should be call ZIND2 (A,.False.)	SRS
FRAME	01	MOVEO	Addition of CLOSE(2) at end of routine; frees up COMIL for other uses while job is executing.	T. Smith
	02	PRTASS	Check for PASCU(1) = 0 on call to UNPID2 sets PASCU(1) = ACTCU(1).	T. Smith
	03	ERRDMX	FORMAT 21032 changed to (I8, I12, 7I8).	T. Smith
	04	MISSIL	Duplicate calls to schedule NWGRD. Remove call to EXTREV (..., TL)	SRS
	05	COMDECK COMOTBS	Increases number of table, function, type and policy statements from 511 to 1023 allowed in COMIL input.	SRS
	06	PRTASS	Increase Integer field on format to prevent output converison error.	SRS
	07	ASSGEN	Gridsx, Gridsy check added.	SRS
	08	POSTPR, KILLSM	Adds kill summary to SUMMARY.DAT file	T. Smith
	09	GCOUNT	Corrects improper summing of group counts over multiple subsamples	SRS

Weapon Deck	SCP Number	Routine	Description	Originator
	10	EXEC	Log file printout of game status every 100 sec	SRS
CAP	01	LUNIT	Allows multiple SPEC files to be open in same directory.	T. Smith
	02	P2IFN, QQQP2I	Removes production of references to spurious identifiers ORGX,ORGY,RANG	SRS
	03	KILLCUX	Inserted production of CALL KILLSM in KILLCU routines.	T. Smith

END

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