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Volume III
The Greedy Algorithm

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SCHEDULING ALGORITHM FOR MISSION PLANNING AND LOGISTICS EVALUATION (SAMPLE)

VOLUME III

THE GREEDY ALGORITHM

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FOREWORD

These reports document the eighth baseline version (SA8) of the Scheduling Algorithm for Mission Planning and Logistics Evaluation (SAMPLE). Volume I is the Users' Guide for SAMPLE, Volume II documents the Mission Payloads (MPLS) subsystem, the primary computational portion of SAMPLE, and Volume III discusses the GREEDY algorithm, the technique used to solve a set covering problem and determine a traffic model.

CONTENTS

FIGURES

DEFINITIONS

1. INTRODUCTION

This documentation provides a general description of the GREEDY computer program and includes functional specifications, functional design and flow, and a discussion of the program logic.

The GREEDY computer program is a submodule of the Scheduling Algorithm for Mission Planning and Logistics Evaluation (SAMPLE) program and has been designed as a continuation of the Mission Payloads (MPLS) program. The MPLS uses input payload data to form a set of feasible payload combinations; from these, GREEDY selects a subset of combinations so all payloads can be included without redundancy. This subset of feasible combinations is called a traffic model. The program also provides the user a tutorial option so that he can choose an alternate traffic model in case a particular traffic model is unacceptable.

The GREEDY progam was begun with an input of 100 payloads and 1000 combinations. To date, this program has been expanded to solve 2000 combinations per year with options of eight different value indices and three possible solution strategies.

2. PROGRAM DESCRIPTION

2.1 DEFINITION OF SYMBOLS

A — An m×n matrix with zeros and ones as elements. Each column corresponds to a particular combination and each row corresponds to one particular payload. Element $a_{ij} = 1$ implies payload i is contained in combination j. n is the total number of feasible combinations considered to generate a traffic model, whereas m is the total number of payloads in a particular year.

$\bar{c}$ — The vector of combination cost coefficients $\bar{c} = (c_1, c_2, \ldots, c_n)$

c_j — The cost coefficient of combination j

$\bar{e}$ — An m×1 column vector with all elements equal to one

J — Index set $J = \{1, \ldots, n\}$

Q — An m×n matrix with payload ID's, m is the maximal number of payloads allowed in each feasible combination

q_j — jth column of matrix Q, $Q = (\bar{q}_1, \bar{q}_2, \ldots, \bar{q}_n)$

$\bar{x}$ — A vector of zero-one variables, $\bar{x} = (x_1, x_2, \ldots, x_n)$

x_j — A zero-one variable, $j = 1, \ldots, n$

2.2 GENERAL DESCRIPTION

2.2.1 Program Capabilities

The GREEDY program heuristically solves the traffic model problem over an objective function such as Orbital Maneuvering System (OMS) weight, load factor, or Shuttle cargo bay utilization for each feasible combination. This problem also includes a set of constraints that assures no redundancy of payloads in the traffic model. The main advantage of this algorithm is that it permits a rather efficient and simple solution procedure. This procedure is basically the selection of combinations with the maximum number of payloads first and continuing until all payloads are included in the chosen combinations.

The formulation of a traffic model problem has the following form:

$$\text{(I)} \quad \text{Min} \quad \bar{c}^T \bar{x}$$

$$\text{Subject to} \quad A\bar{x} = \bar{e}$$

$$\text{And} \quad x_j = 0 \text{ or } 1$$

The value x_j is taken as a decision variable on a particular feasible combination j (or flight j). Flight j is considered to be chosen when $x_j = 1$, otherwise $x_j = 0$. For each payload, there is a corresponding constraint that ensures the nonredundancy of this payload in the traffic model. Vector $\bar{c}$ stores the performance criteria for all the feasible combinations.

2.2.2 Operational Capabilities

The operational capabilities of the GREEDY program were designed to permit the user to specify his particular optimization problem according to his needs. One feature allows the user to specify a value index for each flight and the solution strategy to be used in the traffic model selection. At present, GREEDY permits the user to

SET THE VALUE OF EACH FLIGHT EQUAL TO:
1: UNITY
2: MAXIMUM OF WEIGHT LOAD FACTOR UP OR DOWN
3: ON-ORBIT OMS PROPELLANT REQUIRED
4: MINIMUM OF UNUSED WEIGHT CAPABILITY UP OR DOWN
5: MAXIMUM OF LENGTH LOAD FACTOR UP OR DOWN
6: CARGO WEIGHT UP
7: CARGO LENGTH UP
8: MAXIMUM OF WEIGHT LOAD FACTOR UP OR DOWN, OR LENGTH LOAD FACTOR UP OR DOWN
9: PRODUCT OF PRIORITY OF CONSTITUENT PAYLOADS
10: SUM OF SHARABILITY OF CONSTITUENT PAYLOADS
11: CHARGE FACTOR (UNAVAILABLE)
12: UNALLOCATED

The solution strategy options for traffic model selections are

SOLUTION FOR TRAFFIC MODEL PROCEEDS ACCORDING TO:
1: CHOOSE AVAILABLE FLIGHTS WITH HIGHEST VALUE
2: RANDOMLY CHOOSE AVAILABLE FLIGHTS
3: RANDOMLY CHOOSE FROM AVAILABLE FLIGHTS WITH N PAYLOADS, N=6, 5, . . . , 1

Another available option is the suppression or addition of certain missions in the traffic model; the program gives the user an error message if he attempts to suppress or add feasible combinations that would lead to a solution that either contains redundant payloads or does not include all payloads.

2.3 TECHNICAL DESCRIPTION

2.3.1 Method of Solution

The available flights (feasible combinations) are first reordered in terms of increasing value, where value is defined by the value index.

The solution strategy choice is then applied in the selection of feasible combinations for the traffic model.

Option 1 specifies that the flights shall be chosen from highest valued to lowest valued flights. Generally, the selection of one flight (e.g., a flight with payloads A, B, and C) precludes other flights (i.e., flights which contain payloads A, B, or C) for which the same payloads (i.e., A, B, and C) are "covered" or flown.

Option 2 dictates that the flights are randomly chosen, regardless of the value specified in step 15.

Option 3 requires that the traffic model be chosen randomly from flights with N payloads where N = 6, 5, . . . , 1.

The cost vector $\bar{c}$ is applied to record the status of feasible combinations. Initially, each c_j for $j \varepsilon J$ is a positive cost coefficient of combination j. Vector $\bar{c}$ is updated according to the following procedures.

1. All feasible combinations with positive c_j are free to be chosen into the traffic model.

2. c_j is set to $-c_j$ if a feasible combination $j \varepsilon J$ has been selected as a member of the traffic model.

3. c_j is set to zero if feasible combination j has a payload that is also contained in the combination having just been chosen into the traffic model.

The program repeats procedures 1 to 3 until all c_j's are either of zero value or negative value. The traffic model is constituted by the feasible combinations with $-c_j$. When the cost coefficients are not unity, the program will select a feasible combination with the minimum cost per payload first. In case there is a tie (i.e., a group of feasible combinations has the same minimum cost per payload), a combination will be selected at random from that group.

Instead of using matrix A as an input of GREEDY, a reduced matrix Q is created. Column j of Q stores the ID's of those payloads contained in combination j.

Example:

Combinations

$$A = \begin{array}{cc} & \begin{array}{cccccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{array} & \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \end{bmatrix} \end{array}$$

$$Q = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 1 & 3 & 3 & 5 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2 & 4 & 5 & 6 & 3 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 5 & 4 \end{bmatrix}$$

2.3.2 Outline of the Algorithm

1. Initialization

   Set $J = \{1, \ldots, n\}$ where n is the total number of feasible combinations.

   Set $\bar{c}$ to be the cost vector for all combinations, c_j stands for the cost coefficient of combination j. Construct matrix Q as indicated in section 2.3.1. Define F as the set of ID's of feasible combinations with maximum number of payloads and positive cost coefficients.

2. Pick up a candidate for traffic model

   2.1 If $\bar{c} > 0$, go to 2.2; otherwise, go to 4.

   2.2 Update F as defined and randomly select an element, say j^*, from F.

3. Update cost array

   3.1 Set $c_{j^*} = -c_{j^*}$

   Set $c_j = 0$ for any $j \varepsilon J$, $c_j > 0$, such that q_j and q_{j^*} have at least one payload ID in common, and go to 2.1.

4. Traffic model completed

The traffic model is the set of combinations with negative cost coefficients in $\bar{c}$; i.e., $\{j/c_j < 0, j \in J\}$. The traffic model cost is the total of cost coefficients associated with the feasible combinations in the traffic model.

2.3.3 Example

Consider a problem of 12 feasible combinations and 6 payloads with unity cost coefficients. The payload-combination relationship is displayed as of Q in section 2.3.1. The computing sequence follows the steps in section 2.3.2.

1. Initialization

Define the index set

$$J = \{1,2,3,4,5,6,7,8,9,10,11,12\}$$

cost array

$$\bar{c} = (1,1,1,1,1,1,1,1,1,1,1,1,)$$

matrix

$$q = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 1 & 3 & 3 & 5 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2 & 4 & 5 & 6 & 3 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 5 & 4 \end{bmatrix}$$

2. Pick up a candidate for traffic model

2.1 $\bar{c} > 0$, go to 2.2.

2.2 Define $F = \{11, 12\}$ and randomly pick up an element from F, say $j^* = 12$.

3. Update cost array

3.1 $\bar{c} = (0,0,1,0,1,1,0,0,1,1,0,-1)$ go to 2.1.

2.1 $\bar{c} > 0$, go to 2.2.

2.2 Define $F = \{9,10\}$ and randomly pick up an element from F, say $j^* = 9$, go to 3.1.

3.1 $\bar{c} = (0,0,0,0,0,1,0,0,-1,0,0,-1)$, go to 2.1.

2.1 $\bar{c} > 0$, go to 2.2.

2.2 Define $F = \{6\}$, since there is only a single element left in F, so set $j^* = 6$, go to 3.1.

3.1 $\bar{c} = (0,0,0,0,0,-1,0,0,-1,0,0,-1)$, go to 2.1.

2.1 $\bar{c} \leq 0$, go to 4.

4. Traffic model completed

Traffic model is {6,9,12}, which is the set of combinations with negative cost coefficients.

Traffic model cost $= -(c_6 + c_9 + c_{12}) = +3$

3. PROGRAM USAGE

3.1 INPUT DESCRIPTION

The GREEDY program uses two types of input data. One is the source input from a file on logical unit 1 and the other is from the tutorial input specified by the user. Logical unit 1 is a temporary file assigned in the main program to store the feasible payload combinations from the MPLS. The description of that file is detailed in Volume II - SAMPLE Mission Payloads Subsystem Description. Because of the core storage limitations, GREEDY is designed to handle a traffic model problem with a maximum of 2000 combinations and 100 payloads. The information on each feasible combination is read in from logical unit 1 by subroutine TABLE. Within the information, combination ID, different payloads in that combination and combinations cost coefficients are retained. The cost vector is stored in the column array KCJ. All the payload ID's and combination numbers are stored in the matrix Q. The elements in each column are the payload ID's that combination contains. The sequence of columns is arranged in descending order according to the cost per payload of the combination.

The tutorial input data required for the GREEDY program can be either user-specified data from a demand terminal or from card decks. These data are read via logical unit 5 using a free field format.

3.2 PROGRAM RUN PREPARATION

GREEDY has been implemented on the UNIVAC 1110 EXEC 8 system as a subprogram of SAMPLE. FORTRAN V standard logical input and output devices are used for tutorial input (logical unit 5) and printed out (logical unit 6). For the source input of GREEDY, logical unit 1 is used. Usage instructions have been elaborated in Volume I - SAMPLE User's Guide. A discussion of the different interactive options is introduced in sections 3.2.1 to 3.2.7.

3.2.1 Interactive Options

1: USE PREVIOUSLY DEFINED FEASIBLE COMBINATIONS

2: USE INTERACTIVE FEATURE IN TRAFFIC MODEL

3: NONE OF THE ABOVE

Option 1 will enable the user to use a data file input that contains previously defined feasible combinations for GREEDY execution. In this way, the execution time of the MPLS can be saved.

Option 2 mainly supports the communication between GREEDY and the user. In case the traffic model is not desired for some reason, this option gives the user the means of changing the traffic model.

Option 3 implies that the user does not desire to select option 1 or 2 and the control goes to Personal Data Base tutorial of the MPLS.

3.2.2 Cost Criteria Option

This option gives the user the choice of one of the performance criteria against which the traffic model will be generated. The meanings of different criteria have been discussed in section 2.2.2.

3.2.3 Alternate Traffic Model Option

DO YOU WANT ANOTHER SCHEDULE?

1: YES.

2: NO.

This option gives the user the choice of generating another traffic model (using the same value index and solution strategy).

3.2.4 Mission Omit Option

The display statement is

WHICH MISSION DO YOU WANT OMITTED?

After the user views some information on the traffic model, he may need to delete certain missions by use of this option.

3.2.5 Combination Specification Option

The tutorial of this option is

WHICH COMBINATION DO YOU WANT TO ENTER?

It gives the user the means to include certain specific combinations in the traffic model.

3.2.6 Traffic Model Information Option

The tutorial of this option is

DO YOU WISH TO SEE INFORMATION ON THESE MISSIONS?

0: NONE

-1: PRINT ALL

-2: PRINT ALL AND SAVE ON SCRATCH FILE

-3: SAVE ON SCRATCH FILE ONLY

N: ENTER MISSION "N"

This tutorial follows the alternate traffic model option. If the user does not need to see any detail information on the traffic model, he just enters 0. He can enter -1 to see them all or enter N, the mission number, to get the information on a particular one. Options -1 and -3 provide the user an opportunity to store the traffic model on a scratch file (logical unit 2) for further analysis.

3.2.7 Terminate Option

The display image is

SELECT AN OPTION: (5 TO TERMINATE)

Input 5 to terminate execution.

3.3 OUTPUT DESCRIPTION

3.3.1 Normal Output

Normal output for the GREEDY program can be classified into four basic types.

1. Source input data - The initial output of GREEDY is the source input data displayed in a table format. The title of that table is printed out as "n OCCURRENCE TABLE," where n is the year with which the particular case is executed. This is immediately followed by "PAYLOAD" and "COMBINATIONS." Under the column of "PAYLOAD" are printed out the payload identifications. Under the column of "COMBINATIONS" are combination numbers which carry that payload.

2. Tutorial instructions data - These data are printed out in the alphanumerical format and provide the user a guide of various interactive options during the execution of GREEDY.

3. Mission information data - The output of these data is in alphanumerical format and displays the relevant information about the mission in an understandable form. This output is requested by the user in the traffic model information option (section 3.2.6).

4. Traffic model data - These data give the total number of missions in the traffic model, the mission identifications, and the total cost of this traffic model.

3.3.2 Abnormal Ouput

Diagnostic messages from subroutines of GREEDY are as follows.

Diagnostic Message	Subroutine	Description/Action
TABLE ERROR***INPUT TO GREEDY IS CLOBBERED**	TABLE	This message implies that more than one payload in a combination has the same ID; this could be caused by the numbering or naming method in the MPLS.
GREEDY ERROR	GREEDY	This display indicates either a certain payload is not covered or is overlapped in the traffic model.
THE NUMBER ENTERED IS TOO LARGE, PLEASE ENTER A NUMBER LESS THAN XX	RESCH	In this mission omit option, the user inputs a mission ID that is larger than any existing mission ID.
MISSION XX CANNOT BE OMITTED, BECAUSE PAYLOAD YY WOULD BE UNCOVERED	RESCH	The user wants to omit some missions that will cause some payloads not to be contained in the traffic model. He should refer to the occurrence table and be sure all payloads can be included.
MISSION XX IS UNACCPETABLE	RESCH	In the combination specification option, the user entered more than one mission which contains the same payload.

4. EXECUTION CHARACTERISTICS

4.1 RESTRICTIONS

The GREEDY program has the following limitations.

a. The largest traffic model problem GREEDY can accept is 100 payloads with 2000 combinations.

b. The program is valid only if a feasible solution to the traffic model exists. The validity has been assured by an input consisting of all single-payload combinations.

4.2 RUNNING TIME

The run time for the GREEDY program may vary depending on the number of input combinations and the number of traffic models from the problem executed. Based on a typical run with 1000 combinations and 100 traffic models generated, an approximate estimate of the time needed for a solution is 100 seconds, or 1 second per traffic model.

4.3 ACCURACY/VALIDITY

The GREEDY program is written in single precision and has been verified using 10 test cases, in a range from 500 to 1000 combinations. It is believed that the program is operating correctly and is providing reliable solutions to the problems. Problems used in checkout included one data set of 130 payloads. All the problems have been tested on unity cost coefficients with a maximum of four payloads per combination. All solutions have been checked and were found to satisfy the constraints. The distribution of traffic model solutions has been explored by randomly generating 498 traffic models from 1000 combinations in 1983. On the assumption that traffic model results are normally distributed with a mean of 52, the best solution from GREEDY, which is 41, falls within the top 1 percent of solution set. A histogram of the distribution is plotted in figure 1.

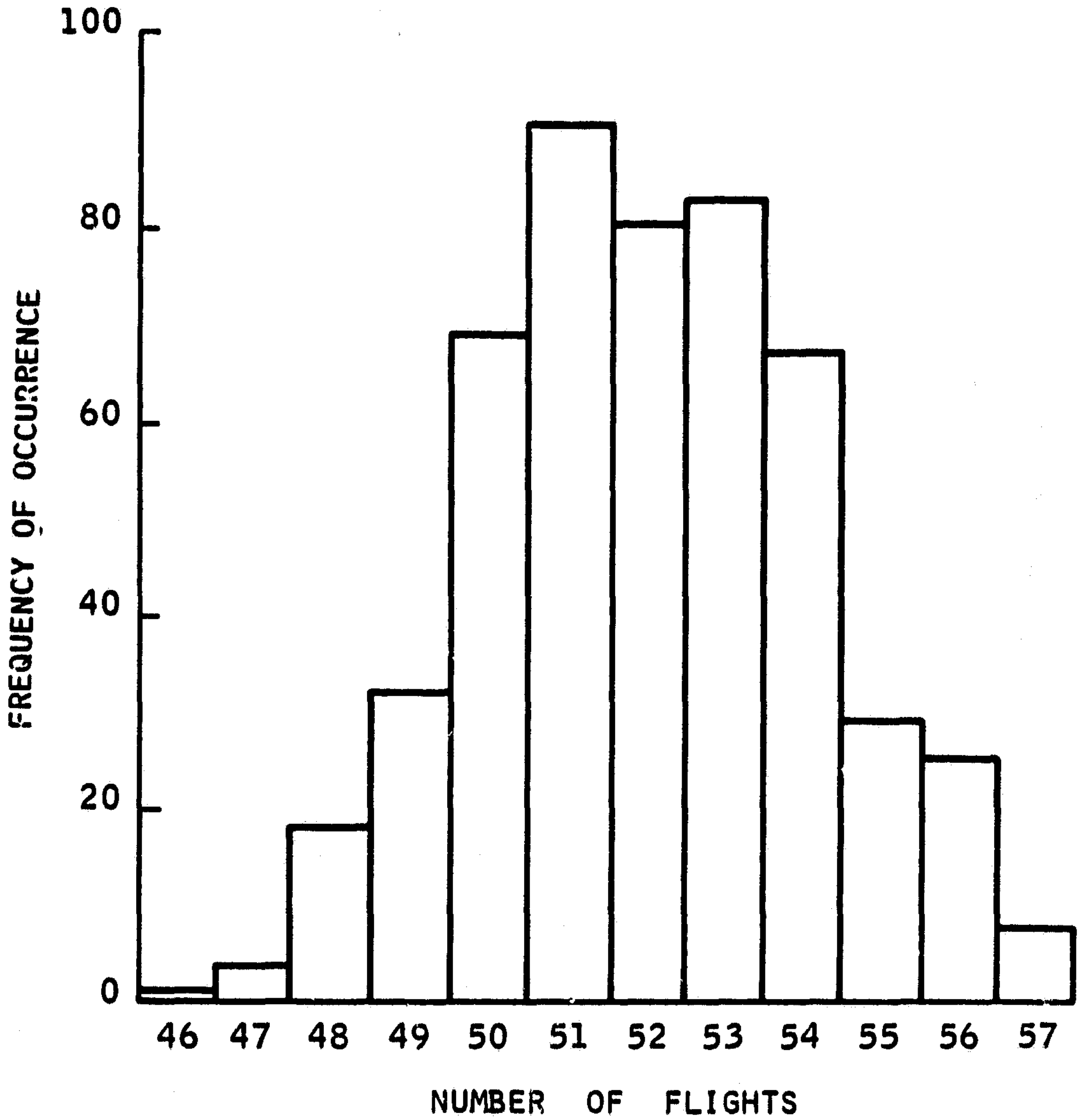

Figure 4-1.- Distribution of traffic model solution (1983).

5. REFERENCE INFORMATION

5.1 FUNCTIONAL FLOWCHART

Figure 5-1 illustrates the flow of the logic. The symbols are defined in section 2.1.

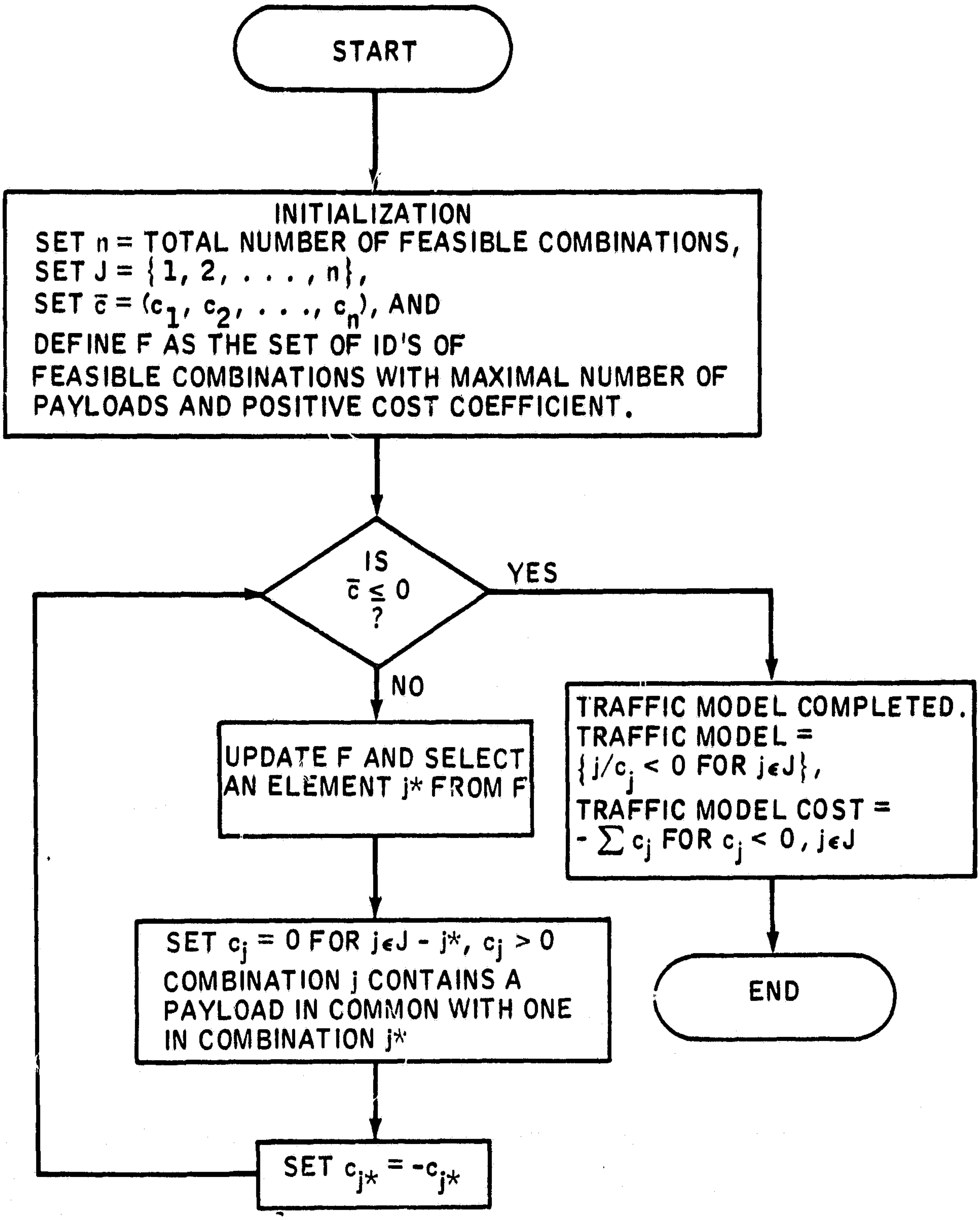

Figure 5-1.- GREEDY functional flow.

5.2 VARIABLES IN LABELED COMMON

- COMMON block name: C9

Description: C9 retains the information about the interactive selection of the cost coefficient of the objective function and the output of the occurrence table.

Location*	Name	Dimensions	Type	Description
2	MM	1	I	Total number of feasible combinations generated by MPLS
51	COSTOP	1	I	Indicator of the choice of cost coefficients on the objective function
54	NOTAB	1	I	Indicator of listing or suppressing the occurrence table output

- COMMON block name: C36

Description: C36 retains the information about the occurrence matrix and cost coefficient of each mission.

Location	Name	Dimensions	Type	Description
1-12000	Q	12000	I	An array storing payload ID's for feasible combinations in the ascending order of cost per payload.
12001-14000	MID	2000	I	An array storing combination ID's in occurrence table relative to the combination order in the Q array
14001-16000	KCJ	2000	I	A vector indicating the cost coefficient of each combination

*The unspecified cells are used for MPLS.

Location*	Name	Dimensions	Type	Description
16001-20000	NX	4000	I	An array storing combination costs and the information about omission or specifications of mission to traffic model
20001	JCOEF	1	I	Indicator of chosen cost criterion for traffic model
20002	QN	1	I	Total number of combinations to be considered in the generation of the traffic model
20003	QM	1	I	Maximum number of payloads per combination
20004-22003	KPRIOR	2000	I	Indicator of number of payloads per combination
22004	KM	1	I	Total number of payloads in traffic model
22005-22010	NF	6	I	An array indicating the number of combinations containing same number of payloads

5.3 SUBROUTINE DOCUMENTATION

Individual subroutine documentation is given in alphabetical order.

SUBROUTINE FNDFLT

IDENTIFICATION

Name/Title	- FNDFLT (Find flight)
Author/Date	- Han Chang, Nov. 1975
Machine Identification	- UNIVAC 1110
Source Language	- FORTRAN V

PURPOSE

Subroutine FNDFLT provides the necessary information about a flight by the interactive request from the user. It also saves that information from the traffic model in a scratch file of the user's choice.

USAGE

- Calling Sequence

  CALL FNDFLT (KZS, LIDRW, IPONT, KN, NTP, IYEAR)

  Arguments:

Parameter name	In/Out	Dimension	Type	Description
KZS	In	1	I	Total number of missions to be output
LIDRW	In	1	I	A vector to store the mission numbers
IPONT	In	1	I	A flag to trigger the output of the statistics of the current flight schedule
KN	In	1	I	Total number of missions
NTP	In	1	I	Dummy variable, Set = 1
IYEAR	In	1	I	Indicator for the year

METHOD

Subroutine FNDFLT searches a data file (logical unit 2) to locate particular missions specified by the user. Detailed information on those missions is output in an understandable format by calling subroutine DISPLY. Information about the missions in the traffic model is saved on the scratch file (logical unit 2) at the user's request.

SUBROUTINE GREEDY

IDENTIFICATION

Name/Title	- GREEDY (The driver of GREEDY subprogram)
Author/Date	- Han Chang, Nov. 1975
Machine Identification	- UNIVAC 1110
Source Language	- FORTRAN V

PURPOSE

Subroutine GREEDY generates the traffic model and provides interactive options to change a traffic model for scheduling purposes.

USAGE

- Calling Sequence

  CALL GREEDY (IMODE, NOSARS, IYEAR)

  Arguments:

Parameter name	In/Out	Dimension	Type	Description
IMODE	In	1	I	Indicator of whether the interactive feature is needed in GREEDY
NOSARS	In	1	I	Indicator of analysis type
IYEAR	In	1	I	Indicator of the year

- Data In/Out

  Labeled COMMON (refer to the labeled COMMON description section):

Block name	Input	Output
C36	1-12000	1-12000
	12001-14000	
	14001-16000	
	16001-20000	16001-20000

Block name	Input	Output
	20001	
	20002	
	20003	
	20004-22003	
	22004	
	22005-22010	
C31	1-4	

METHOD

- Model

  Subroutine GREEDY systematically selects the combination from occurrence table according to minimum-cost-per-payload ratio until all payloads are included in the chosen combinations.

SUBROUTINE RESCH

IDENTIFICATION

Name/Title	- RESCH (Reschedule of traffic model)
Author/Date	- Han Chang, Nov. 1975
Machine Identification	- UNIVAC 1110
Source Language	- FORTRAN V

PURPOSE

Subroutine RESCH deletes and/or adds missions to traffic model through user's interactive command.

USAGE

- Calling Sequence

  CALL RESCH ($N, INT)

  Arguments:

Parameter name	In/Out	Dimension	Type	Description
$N	Out	1	I	Nonstandard return signal when the change of traffic model is successful
INT	Out	1	I	Indicator that traffic model will be changed

- Data In/Out

  Labeled COMMON (refer to the labeled COMMON description section):

Block name	Input	Output
C36	1-12000	1-12000
	12001-14000	
	14001-16000	
	16001-20000	
	20001	
	20002	
	20003	
	20004-22003	
	22004	
	22005-22010	

METHOD

Subroutine RESCH records the omitted and specified missions and checks whether these changes would cause infeasibility of the traffic model.

SUBROUTINE SORTY

IDENTIFICATION

Name/Title	- SORTY (Sort feasible combination)
Author/Date	- Han Chang, Nov. 1975
Machine Identification	- UNIVAC 1110
Source Language	- FORTRAN V

PURPOSE

Subroutine SORTY sorts an array of M integers into ascending order and records their relative location to the original order.

USAGE

- Calling Sequence

  CALL SORTY (M, IA, ID)

  Arguments:

Parameter name	In/Out	Dimension	Type	Description
M	In	1	I	Total number of integers to be sorted
IA	In	Defined in calling program	I	Array to be sorted
ID	Out	Defined in calling program	I	Pointers referring back to the original order of IA

METHOD

Subroutine SORTY arranges an array in ascending order by searching the list to find the maximum number in the array. The tests are repeated M times.

SUBROUTINE TABLE

IDENTIFICATION

Name/Title	- TABLE (Form occurrence table)
Author/Date	- Han Chang, Nov. 1975
Machine Identification	- UNIVAC 1110
Source Language	- FORTRAN V

PURPOSE

Subroutine TABLE prints the combination payload occurrence table in a particular year by user's request and translates this table into input format for subroutine GREEDY.

USAGE

- Calling Sequence

  CALL TABLE (IYEAR, NOSARS)

  Arguments:

Parameter name	In/Out	Dimension	Type	Description
IYEAR	In	1	I	The year indicator on which data case is based
NOSARS	In	1	I	Indicator of the analysis type

- Data In/Out

  Labeled COMMON (refer to the labeled COMMON description section):

Block name	Input	Output
C9	2	
	51	
	54	
C36	1-12000	1-12000
	12001-14000	12001-14000
	14001-16000	14001-16000
	16001-20000	16001-20000
	20001	20001

Block name	Input	Output
	20002	20002
	20003	20003
	20004-22003	20004-22003
	22004	22004
	22005-22010	22005-22010

METHOD

Subroutine TABLE determines and prints a list for each payload of all feasible combinations which include that payload by reading the relevant information from a data file.

5.4 SAMPLE INPUT/OUTPUT

This sample input/output is to provide the reader with an example of executing GREEDY interactively. The procedure to sign on the demand terminal and execute the MPLS is detailed in Volume I, SAMPLE User's Guide, and will not be repeated here. All the underlined tutorials are the options the user may encounter in the GREEDY execution.

```
XXXXXXXXXXXXXXXXXXXX  STATISTICAL ANALYSIS FOR 1981  XXXXXXXXXXXXXXXXXXXX
TOTAL NUMBER OF COMBINATIONS GENERATED:        134
       NUMBER OF FEASIBLE COMBINATIONS:         48
       NUMBER OF INFEASIBLE COMBINATIONS:       86

TOTAL ELAPSED TIME:        189
       (ALL TIMES ARE IN MILLISECONDS)
       AVERAGE TIME PER FEASIBLE COMBINATION:      3
       AVERAGE TIME PER GENERATED COMBINATION:      1

DO YOU WANT TO STORE THE FEASIBLE COMBINATION DATA?
    0: NO
    1: YES
>N0
 SPECIFY VALUE INDEX OF FLIGHTS TO BE USED IN TRAFFIC MODEL SELECTION
>
 SET VALUE OF EACH FLIGHT EQUAL TO:
      1: UNITY
      2: MAXIMUM OF WEIGHT LOAD FACTOR UP OR DOWN
      3: ON-ORBIT OMS PROPELLANT REQUIRED
      4: MINIMUM OF UNUSED WEIGHT CAPABILITY UP OR DOWN
      5: MAXIMUM OF LENGTH LOAD FACTOR UP OR DOWN
      6: CARGO WEIGHT UP
      7: CARGO LENGTH UP
      8: MAXIMUM OF WEIGHT LOAD FACTOR UP OR DOWN,
         OR LENGTH LOAD FACTOR UP OR DOWN
      9: PRODUCT OF PRIORITY OF CONSTITUENT PAYLOADS
     10: SUM OF SHARABILITY OF CONSTITUENT PAYLOADS
     11: CHARGE FACTOR (UNAVAILABLE)
     12: UNALLOCATED
 SPECIFY VALUE INDEX OF FLIGHTS TO BE USED IN TRAFFIC MODEL SELECTION
>1
  SPECIFY SOLUTION STRATEGY FOR TRAFFIC MODEL SOLUTION
>
 SOLUTION FOR TRAFFIC MODEL PROCEEDS ACCORDING TO:
      1: CHOOSE AVAILABLE FLIGHTS WITH HIGHEST VALUE
      2: RANDOMLY CHOOSE AVAILABLE FLIGHTS
      3: RANDOMLY CHOOSE FROM AVAILABLE FLIGHTS WITH N
         PAYLOADS, N = 6,5,...,1
  SPECIFY SOLUTION STRATEGY FOR TRAFFIC MODEL SOLUTION
>1
  WHICH MISSION DO YOU WANT OMITTED? (INPUT 0 TO GO TO NEXT OPTION)
>1
  WHICH MISSION DO YOU WANT OMITTED? (INPUT 0 TO GO TO NEXT OPTION)
>40
  WHICH MISSION DO YOU WANT OMITTED? (INPUT 0 TO GO TO NEXT OPTION)
>
  WHICH MISSION DO YOU WANT TO ENTER?
 (INPUT 0 TO GO TO NEXT OPTION)
>
 TRAFFIC MODEL CONTAINS THE FOLLOWING  7 MISSIONS
         3         4        12        20        26        29        38
 THE SELECTED TRAFFIC MODEL VALUE IS      7
 DO YOU WISH TO SEE INFORMATION ON THESE MISSIONS?
          0: NONE
         -1: PRINT ALL
         -2: PRINT ALL AND SAVE ON SCRATCH FILE
         -3: SAVE ON SCRATCH FILE ONLY
          N : ENTER MISSION 'N'

 INPUT OPTION :
>-1
 FLT. NO.    3     LAUNCH SITE: ETR

  PAYLOADS:    TDRSS/WESTAR
                 61001
  SHUTTLE SEQUENCE       61-D
  ALTITUDE                160.
  INCLINATION              28.5
  TOTAL LENGTH UP:  35.     TOTAL WEIGHT UP: 57633.0
  PAYLOAD MARGIN:  7367.    LOAD FACTOR:  .88666
  SHUTTLE DELTAV:   581.
```

```
FLT. NO.    4     LAUNCH SITE: ETR

 PAYLOADS:   TDRSS/WESTAR
                61002
 SHUTTLE SEQUENCE       61-D
 ALTITUDE                160.
 INCLINATION             28.5
 TOTAL LENGTH UP:  35.      TOTAL WEIGHT UP: 57633.0
 PAYLOAD MARGIN:  7367.     LOAD FACTOR:  .88666
 SHUTTLE DELTAV:   581.

FLT. NO.   12     LAUNCH SITE: ETR

 PAYLOADS:   PLA SL1 LM+P
                  92
 SHUTTLE SEQUENCE       92-H
 ALTITUDE                135.
 INCLINATION             57.0
 TOTAL LENGTH UP:  60.      TOTAL LENGTH DOWN:  60.
 TOTAL WEIGHT UP: 35000.0    TOTAL WEIGHT DOWN: 32000.0
 PAYLOAD MARGIN:     0.     LOAD FACTOR: 1.00000
 SHUTTLE DELTAV:   466.

FLT. NO.   20     LAUNCH SITE: ETR

 PAYLOADS:   INTELSAT V      SBS
                  59    63002
 SHUTTLE SEQUENCE       59-D        63-D
 ALTITUDE                160.        160.
 INCLINATION             28.5        28.5
 TOTAL LENGTH UP:  53.      TOTAL WEIGHT UP: 25718.0
 PAYLOAD MARGIN: 32000.     LOAD FACTOR:  .39566
 SHUTTLE DELTAV:   581.

FLT. NO.   26     LAUNCH SITE: ETR

 PAYLOADS:   RCA                TELESAT
                  62    80001
 SHUTTLE SEQUENCE       62-D        80-D
 ALTITUDE                160.        160.
 INCLINATION             28.5        28.5
 TOTAL LENGTH UP:  37.      TOTAL WEIGHT UP: 17896.0
 PAYLOAD MARGIN: 32000.     LOAD FACTOR:  .27532
 SHUTTLE DELTAV:   581.

FLT. NO.   29     LAUNCH SITE: ETR

 PAYLOADS:   SBS                TELESAT
                63001    80002
 SHUTTLE SEQUENCE       63-D        80-D
 ALTITUDE                160.        160.
 INCLINATION             28.5        28.5
 TOTAL LENGTH UP:  39.      TOTAL WEIGHT UP: 17896.0
 PAYLOAD MARGIN: 32000.     LOAD FACTOR:  .27532
 SHUTTLE DELTAV:   581.

FLT. NO.   38     LAUNCH SITE: ETR

 PAYLOADS:   GOES               SYNCOM 1V      INSAT-INDIA
                  57       64          82
 SHUTTLE SEQUENCE       57-D        64-D          82-D
 ALTITUDE                160.        160.          160.
 INCLINATION             28.5        28.5          28.5
 TOTAL LENGTH UP:  55.      TOTAL WEIGHT UP: 37213.2
 PAYLOAD MARGIN: 27787.     LOAD FACTOR:  .57251
 SHUTTLE DELTAV:   581.

INPUT OPTION :
>
```

```
STATISTICS FOR CURRENT FLIGHT SCHEDULE

     AVERAGE NUMBER OF PAYLOADS PER FLIGHT = 1.71
     TOTAL NUMBER OF TUGS REQUIRED =    0
     TOTAL NUMBER OF INITIAL OMS KITS REQUIRED =    0
     TOTAL NUMBER OF SECOND AND THIRD OMS KITS REQUIRED =    0

DO YOU WANT ANOTHER SCHEDULE ?
    1: YES.
    0: NO .

>1
 WHICH MISSION DO YOU WANT OMITTED? (INPUT 0 TO GO TO NEXT OPTION)
>12
MISSION  12 CAN NOT BE OMITTED, BECAUSE
PAYLOAD  12 WOULD BE UNCOVERED
 WHICH MISSION DO YOU WANT OMITTED? (INPUT 0 TO GO TO NEXT OPTION)
>26
 WHICH MISSION DO YOU WANT OMITTED? (INPUT 0 TO GO TO NEXT OPTION)
>29
 WHICH MISSION DO YOU WANT OMITTED? (INPUT 0 TO GO TO NEXT OPTION)
>
 WHICH MISSION DO YOU WANT TO ENTER?
(INPUT 0 TO GO TO NEXT OPTION)
>40
 WHICH MISSION DO YOU WANT TO ENTER?
(INPUT 0 TO GO TO NEXT OPTION)
>0
TRAFFIC MODEL CONTAINS THE FOLLOWING  7 MISSIONS
          1          3          4          12          20          40          48
THE SELECTED TRAFFIC MODEL VALUE IS        7
DO YOU WISH TO SEE INFORMATION ON THESE MISSIONS?
           0: NONE
          -1: PRINT ALL
          -2: PRINT ALL AND SAVE ON SCRATCH FILE
          -3: SAVE ON SCRATCH FILE ONLY
          N : ENTER MISSION 'N'

INPUT OPTION :
>-1

FLT. NO.    1     LAUNCH SITE: ETR

 PAYLOADS:    GOES
                  57
 SHUTTLE SEQUENCE      57-D
 ALTITUDE               160.
 INCLINATION            28.5
 TOTAL LENGTH UP:   22.      TOTAL WEIGHT UP: 13994.0
 PAYLOAD MARGIN: 32000.      LOAD FACTOR:   .21529
 SHUTTLE DELTAV:    581.

FLT. NO.    3     LAUNCH SITE: ETR

 PAYLOADS:    TDRSS/WESTAR
                61001
 SHUTTLE SEQUENCE      61-D
 ALTITUDE               160.
 INCLINATION            28.5
 TOTAL LENGTH UP:   35.      TOTAL WEIGHT UP: 57633.0
 PAYLOAD MARGIN:  7367.      LOAD FACTOR:   .88666
 SHUTTLE DELTAV:    581.

FLT. NO.    4     LAUNCH SITE: ETR

 PAYLOADS:    TDRSS/WESTAR
                61002
 SHUTTLE SEQUENCE      61-D
 ALTITUDE               160.
 INCLINATION            28.5
 TOTAL LENGTH UP:   35.      TOTAL WEIGHT UP: 57633.0
 PAYLOAD MARGIN:  7367.      LOAD FACTOR:   .88666
 SHUTTLE DELTAV:    581.
```

```
FLT. NO.   12     LAUNCH SITE: ETR

 PAYLOADS:    P&A SL1 LM+P
                  82
 SHUTTLE SEQUENCE     92-A
 ALTITUDE              135.
 INCLINATION           57.0
 TOTAL LENGTH UP:  60.     TOTAL LENGTH DOWN:  60.
 TOTAL WEIGHT UP: 35000.0   TOTAL WEIGHT DOWN: 32000.0
 PAYLOAD MARGIN:      0.   LOAD FACTOR: 1.00000
 SHUTTLE DELTAV:    466.

FLT. NO.   20     LAUNCH SITE: ETR

 PAYLOADS:    INTELSAT V      SBS
                  59     63002
 SHUTTLE SEQUENCE     59-D       63-D
 ALTITUDE              160.       160.
 INCLINATION           28.5       28.5
 TOTAL LENGTH UP:  53.     TOTAL WEIGHT UP: 25718.0
 PAYLOAD MARGIN: 32000.    LOAD FACTOR:  .39566
 SHUTTLE DELTAV:    581.

FLT. NO.   40     LAUNCH SITE: ETR

 PAYLOADS:    RCA            SBS              TELESAT
                  62     63001     80001
 SHUTTLE SEQUENCE     62-D       63-D        80-D
 ALTITUDE              160.       160.        160.
 INCLINATION           28.5       28.5        28.5
 TOTAL LENGTH UP:  57.     TOTAL WEIGHT UP: 27271.0
 PAYLOAD MARGIN: 32000.    LOAD FACTOR:  .41955
 SHUTTLE DELTAV:    581.

FLT. NO.   48     LAUNCH SITE: ETR

 PAYLOADS:    SYNCOM IV      TELESAT          INSAT-INDIA
                  64     80002        82
 SHUTTLE SEQUENCE     64-D       80-D        82-D
 ALTITUDE              160.       160.        160.
 INCLINATION           28.5       28.5        28.5
 TOTAL LENGTH UP:  51.     TOTAL WEIGHT UP: 31740.2
 PAYLOAD MARGIN: 32000.    LOAD FACTOR:  .48831
 SHUTTLE DELTAV:    581.

INPUT OPTION :
>
 STATISTICS FOR CURRENT FLIGHT SCHEDULE

      AVERAGE NUMBER OF PAYLOADS PER FLIGHT = 1.71
      TOTAL NUMBER OF TUGS REQUIRED =    0
      TOTAL NUMBER OF INITIAL OMS KITS REQUIRED =     0
      TOTAL NUMBER OF SECOND AND THIRD OMS KITS REQUIRED =
 0

DO YOU WANT ANOTHER SCHEDULE ?
     1: YES.
     0: NO .

>0
```