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SATURN - A USER'S MANUAL
AMDAHL V7 VERSION

by

L. J. A. Ferreira, M. D. Hall and D. Van Vliet

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```
SSSSSSSS      AA       TTTTTTT    U       U    RRRRRRR     NN      N
S            A  A         T       U       U    R      R    N N     N
S           A    A        T       U       U    R      R    N  N    N
SSSSSSSS    AAAAAA        T       U       U    RRRRRRR     N   N   N
       S   A      A       T       U       U    R   R       N    N  N
       S   A      A       T       U       U    R    R      N     NN
SSSSSSSS   A      A       T        UUUUUU      R     R     N      N
```

Simulation & Assignment of Traffic in Urban Road Networks

SATURN - A USER'S MANUAL - AMDAHL V7 VERSION

By: L.J.A. FERREIRA, M.D. HALL AND D. VAN VLIET

THE INSTITUTE FOR TRANSPORT STUDIES
THE UNIVERSITY OF LEEDS
LEEDS LS2 9JT

TEL: (0532) 31751 EXT. 7211 OR 393

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ABSTRACT

SATURN is a detailed traffic simulation and assignment model intended for use in the evaluation of traffic management schemes. This document describes the preparation of the required input data and gives information on how to run the model on the Leeds University Amdhal V7 computer. Also included here are details on how to update a trip matrix from traffic counts using the ME2 program in conjunction with SATURN. Other facilities available for use with the model,such as network plotting and matrix manipulation,are also described.

Note : This document is available on file at the Leeds University AMDHAL V7 computer.

TABLE OF CONTENTS

I. INTRODUCTION

SATURN, a detailed assignment model developed in the Institute for Transport Studies at the University of Leeds, is intended for use in the evaluation of traffic management schemes. Using the model it is possible to examine the effects of proposed schemes without the need for implementation.

The basic model has two essential component programs:

- The Simulation, SATSIM, which models in detail the passage of traffic through the network and the resulting delays.
- The Assignment, SATASS, which assigns traffic on the basis of the delays given by thesimulation.

The two programs are run iteratively, beginning with a simulation of synthesised flows, followed by an assignment based on these, then a simulation of the assigned flows and so on until convergence has been achieved; i.e., no appreciable re-assignment takes place. Flow Chart I under Section XIV illustrates this procedure.

This document is intended as a user's guide for users both inside and outside the University to run SATURN. Different Sections may be more relevant to different types of users than others. For example Sections III and IV deal specifically with running SATURN on the Amdahl and are not entirely relevant to users outside the University of Leeds. On the other hand Sections V, VI and VII are relevant to all users, whereas Sections VIII and IX are more Amdahl-specific. Other topics include : updating a trip matrix from counts (Section X); plotting link flows (Section XII) and using SATURN outputs to evaluate alternative schemes (Section XIII).

SATURN is compatible with the TRADVV suite of transportation programs and with the ME2 set of programs to estimate O-D matrices from traffic counts. Further details of the model itself may be obtained from the the authors or from the references given in section II.

SATURN was originally developed using an ICL 1906A computer at the University of Leeds and has since been modified to run on the new University computer, an Amdahl V7. As a consequence of this transfer the FORTRAN coding was revised so that ICL-specific conventions were removed. As a result of this the FORTRAN used is effectively a low- level FORTRAN so that it should be easily transferrable to different machines. Users wishing to mount SATURN on their own machines are encouraged to do so, although clearly the operation would be easiest with ICL- or Amdahl/IBM-style computers.

In addition this particular document is intended for use of SATURN on the Leeds Amdahl; documents to cover its use on other machines will be set up as required.

II. INDEX OF SATURN DOCUMENTATION

The following Amdahl computer files which provide information on SATURN are presently available :-

SATURN TECHNICAL

This contains a description of the main variables used in the SATSIM and SATASS programs plus compilation instructions. It is intended primarily for programmers who may wish to alter SATURN as opposed to users.

SATURN SUBS

The name and purpose of each subroutine called by SATSIM and SATASS is given here. Again this is intended for programmers.

In addition both TRADVV DOCUMENT and ME2 DOCUMENT contain certain pieces of information of use to SATURN users - these are referred to in the relevant sections of this document.

The following publications are also available from the authors:-

- SATURN - A model for the evaluation of traffic management schemes. Working Paper 106, University of Leeds, Institute for Transport Studies, January 1979.
- SATURN- A simulation-assignment model for the evaluation of traffic management schemes. Traffic Engng. & Control, April 1980.
- Applications of SATURN to the analysis of Traffic Management Schemes. P.T.R.C. Summer Annual Meeting, July 1981.

III. ACCESS TO SATURN ON THE AMDAHL V7

Master copies of all files that make up SATURN are stored under the user ID TRA6SMO. However copies of those files which are necessary to run the model are also stored on the 'fixed disk' of user ID TRA6LIB.

The first step for a user wishing to run SATURN under his/her user name is to 'access' the required files from the fixed disk under TRA6LIB. This can be done by typing the following two commands:

```
LINK TRA6LIB 191 1A2 RR
ACCESS 1A2 B/A
```

The following files on TRA6LIB are relevant to SATURN users:-

a) Modules:

```
SATSIM MODULE  ----- Simulation program
SATASS MODULE  ----  Assignment program
SATLIB TXTLIB  ----  Library of SATURN subroutines
M1 MODULE      ----- Matrix manipulation program
P1 MODULE      ----- Network plotting program
ME2 MODULE     ----- Matrix update program
```

b) EXEC'S:

SATURN EXEC ------	EXEC to run SATURN
SATURNOD EXEC -----	EXEC to produce an unformatted mag. tape O-D matrix file
SATUP EXEC --------	EXEC to update an O-D matrix using the ME2 program
SETPIJA EXEC ------	EXEC to obtain PIJA's using the assignment program SATASS

IV. RUNNING THE BASIC SATURN MODEL USING AMDAHL V7 PROCEDURES

IV-1. The 'SATURN' Procedure

This section describes how a user can run the basic SATURN model using procedures set up on TRA6LIB. The basic steps carried out in running SATURN are illustrated in Flow Chart 1 (Section XIV). Thus there are two essential input files to be prepared by the user: (1) A "card image" data file describing the network; and (2) A "magnetic tape" file describing the trip matrix to be assigned.

(It is assumed here that the reader is familiar with the basic handling of files on the Amdahl V7. If not he should consult Amdahl notes 14, 18 and 20 issued by the University Computing Service. The essential difference between what we refer to as "card image" and "magnetic tape" (MT) files above is that a card image file can be created and edited by a user working directly from a terminal (or in very primitive installations working from a card punch!) while a mag tape (MT) file is created by a program and cannot be directly modified by a user.)

Detailed instructions for preparing the network data file are given in Section VI while instructions for setting up the MT trip matrix file are given in Sections IV.1 and V.

Note also from Flow Chart 1 that there are two mag. tape files created during the iterative simulation-assignment sequence - one of which is created by SATSIM and input to SATASS and the other output from SATASS to SATSIM. While the precise contents of these files need not concern the user he must define file names for them (and also keep track of these files as he may wish to use them in SATURN auxiliary programs such as the matrix update or network plots).

In order to run SATURN the user must issue the following "procedure" command from his terminal of the form:

SATURN NETWORK MATRIXMT FILENAME

where:

NETWORK DATA is the "card image" file containing the network data following the specifications given in Section VI.

MATRIXMT UNFMAT is the MT file containing the trip matrix.

FILENAME UNFS is the MT file produced by the (final) run of the simulation.

FILENAME UNFA is the final MT file produced by an assignment.

FILENAME LPO is the line-printer file output from the first run of the simulation program.

FILENAME LPA is the line-printer file produced by the last assignment.

FILENAME LPS is the line-printer file produced by the last simulation.

This does not of course imply that the network file must have the name NETWORK DATA - the user can choose any filename that he wishes for his input file, but it must have filetype DATA. Similarly he may choose any filename he wishes for his other MT files but again they must all be of the filetypes specified above.

IV-2. The 'SATURNOD' Procedure

The MT trip matrix file may be created in a number of different ways, some of which are described in greater detail in Sections X and XI. In this section we will describe only the simplest procedure, illustrated in Figure 2, whereby the MT file is created by another procedure, SATURNOD, from a card image input file. The appropriate command is of the form:

SATURNOD CARDOD MATRIXMT LPNAME

where: CARDOD DATA is a "card image" file prepared by the user following the specifications given in Section V; and MATRIXMT UNFMAT is the output MT matrix file suitable for input to the SATURN procedure as described above. LPNAME LP is the line-printer file produced by the program.

V. PREPARATION OF THE O-D MATRIX FILE

The O-D must be supplied in centroid-to-centroid form, ordered (as is usual) first by origin and then by destination.

The card-image O-D file must have four header records, viz

```
(1) RUN runname
(2)  &PARAM  KARDS=T,NROWS=nc,NCOLS=nc,MPNEXT=T, &END
(3) TRIPS TRIPS
(4) matrixname
```

Note - Capital letters above denote mandatory input; lower case letters denote inputs which must be chosen by the user.

- All spaces in the above are significant.

- Record (1) begins in col 1; runname should be chosen by the user

- Record (2) begins in col 2; nc is the number of centroids in t[illegible] network. [illegible]e Appendix A for a description of "[illegible]elist" inputs

- Card (3) must begin in col. 1 and have three blanks between the first S and the second T. The purpose of this card is to define the matrix as a trip matrix.

- Record (4) begins in col 1; matrixname should be chosen by the user

- The above formats are in fact those required to run the TRADVV program M1; for more details see section XI below and TRADVV document.

Following the header records, the O-D matrix should be given, with up to 15 entries on each card in cols 1-5,6-10,....71-75. (Fortran format 15I5). A new record is begun for each origin. The first entry for each new origin, i.e., cols. 1 to 5 on the first record, contains the "name" of that zone, followed by nc entries for trips to destinations 1, 2, 3, ... nc.

A fuller description of what is meant by zone "names" is given in note (5) under VI-3 below.

The following sample file lists the beginning of the trip file for a network with 11 centroids.

```
RUN SECOND SATURNVILLE O-D RUN
 &PARAM KARDS=T,NROWS=11,NCOLS=11,MPNEXT=T, &END
TRIPS   TRIPS
SATURNVILLE O-D 11 * 11
    1    0    0    0    0    0    0    0    0    3    3    0
    2    3    0    0    3    0    3    0    0    3    0    0
    3  112    5   19    6   22   24   34    6    2    0    1
```

VI. PREPARATION OF THE NETWORK FILE

The network file may be conveniently divided into 6 parts (of which, strictly speaking, only the first is mandatory):

1 - OPTION SPECIFICATION RECORD (&OPTION NAMELIST)
2 - HEADER RECORD
3 - PARAMETER SPECIFICATION RECORD (&PARAM NAMELIST)
4 - A CODED FORM OF THE PHYSICAL NETWORK
5 - A CODED FORM OF THE CENTROID CONNECTORS
6 - THE BUS ROUTES CODING (IF APPLICABLE)

We shall deal with each of these in turn and then give an example.

VI-1. Option Specification Record (Mandatory)

This record (or records) requests the major options available within SATSIM. The specification of options is via the FORTRAN namelist facility. The user unfamiliar with this is referred to the IBM FORTRAN manuals or to Appendix A below. Essentially namelist provides a form of free format input for defining values of variables within the program. Namelist input runs to as many records as necessary but it must always be preceded by &OPTION and terminated by &END. It is essential that each & has a space in front of it and that there is a comma between each parameter.

For a complete list of the options which may be requested via &OPTION see Section IX.I; however for a user preparing a new network file the default values set for all of these parameters are those that he requires and therefore we need not be concerned with them at this stage. Thus he need only include a 'null' namelist card : &OPTION &END .

In this case the header record and the parameter specification records are mandatory, although by setting certain parameters in &OPTION (see SectionIX-1) they may be excluded.

VI-2. Header Record

This record contains a header of up to 80 characters which is reproduced on all output from the model. This enables the user to distinguish between the results of the various runs performed.

VI-3. Parameter Specification Records

These records set user-defined model parameters for this run using the FORTRAN namelist facility as described above for the OPTION cards, the one difference being that the namelist 'name' is &PARAM instead of &OPTION.

As with &OPTION a wide range of parameters may be defined but not all are relevant to the user building a new network. Therefore we list below only the parameters relevant to network building, grouped under LOGICAL, INTEGER and REAL variables. A complete list of the possible parameters is given in Section IX.I.

(A) LOGICAL PARAMETERS

OUTPUT	IF TRUE RESULTS ARE PRINTED FOR EACH RUN OF THE SIMULATION. IF FALSE, RESULTS ARE ONLY SHOWN FOR THE FINAL SIMULATION. DEFAULT:FALSE
PRSNET	IF TRUE SIMULATION NETWORK DETAILS ARE PRINTED. DEFAULT:FALSE
PRANET	IF TRUE THE DETAILS OF THE ASSIGNMENT NETWORK AND THE FLOW-DELAY RELATIONSHIPS ARE OUTPUT ON EACH ASSIGNMENT. DEFAULT:FALSE
PRINTF	IF TRUE DETAILS ARE PRINTED OF THE FLOWS GIVEN BY EACH ASSIGNMENT. DEFAULT:FALSE
MODET	IF MODET=1 OUTPUT INFORMATION IS CONTROLLED AND PRINTED AT THE TERMINAL. OTHERWISE MODET=0. DEFAULT 0 . (SEE SECTION VIII FOR FURTHER DETAILS).
LDRIN	IF TRUE THE LINK DISCHARGE RATE MUST BE INPUT. OTHERWISE THE NUMBER OF LANES ARE INPUT. DEFAUL ALSE

COMPAR — IF TRUE THE RESULTS OF ALL ASSIGNMENTS AFTER THE FIRST ARE COMPARED WITH THE PREVIOUS ASSIGNMENT, THUS PROVIDING A GUIDE TO THE CONVERGENCE (OR OTHERWISE) OF THE COMPLETE MODEL. DEFAULT:FALSE

LIST — IF TRUE A LISTING OF THE INPUT NETWORK DESCRIPTION RECORDS IS OUTPUT. DEFAULT:FALSE

PAPER — IF TRUE NOT VERY IMPORTANT INFORMATION FROM BOTH SIMULATION AND ASSIGNMENT STAGES IS PRINTED. DEFAULT:FALSE.

BUSES — IF TRUE BUS ROUTES ARE INPUT. DEFAULT:FALSE

SPEEDS — IF TRUE TRAVEL SPEEDS (IN KMH) RATHER THAN TRAVEL TIMES (IN SECONDS) ARE INPUT ON THE NETWORK DATA RECORDS. DEFAULT: FALSE.

(B) INTEGER PARAMETERS

NITS — MAXIMUM NUMBER OF ITERATIONS WITHIN EACH SIMULATION. DEFAULT: 6

NITA — MAXIMUM NUMBER OF ITERATIONS WITHIN EACH ASSIGNMENT. DEFAULT: 20

MASL — MAXIMUM NUMBER OF ASSIGNMENT-SIMULATION LOOPS TO BE PERFORMED AFTER THE INITIAL SIMULATION. DEFAULT: 5.

LTP — DURATION OF THE TIME PERIOD CONSIDERED (IN MINUTES). DEFAULT: 30

ISTOP — USED IN THE TEST FOR CONVERGENCE OF THE COMPLETE MODEL. THE MODEL STOPS AUTOMATICALLY IF ISTOP % OF THE LINK FLOWS CHANGE BY LESS THAN 5% FROM ONE ASSIGNMENT TO THE NEXT.

IQ — CONTROLS THE OUTPUT OF FLOW PROFILES: IQ=1 FOR ARRIVE AND EMERGE PROFILES AT THE DOWNSTREAM END OF ALL IN-LINKS AT THE CHOSEN NODES; 2 FOR THE CORRESPONDING QUEUE PROFILES; 3 FOR BOTH; 0 FOR NEITHER. DEFAULT:0

NLIST — ARRAY (MAXIMUM LENGTH 10) CONTAINING THE NODES CHOSEN FOR OUTPUT AS SPECIFIED BY IQ. DEFAULT:EMPTY

LCY — DURATION OF THE COMMON TRAFFIC SIGNAL CYCLE TIME, IN SECONDS. DEFAULT:75

NUC — NUMBER OF TIME-UNITS INTO WHICH THE CYCLE IS DIVIDED IN THE SIMULATION (MAX.25). DEFAULT:15

LFLOW INITIAL FLOWS ARE ASSUMED TO BE LFLOW PER CENT OF CAPACITY FOR EACH TURN.DEFAULT: 15

(C) REAL PARAMETERS

TDEL DELAY TO ALLOW FOR ACCELERATION/DECELERATION IN MAKING OPPOSED TURNS. DEFAULT: 3 SECONDS.

GAP MINIMUM GAP (SECONDS) ACCEPTED BY A MERGING OR CROSSING VEHICLE AT PRIORITY JUNCTIONS OR TRAFFIC SIGNALS DEFAULT: 5.0

GAPR AS GAP BUT FOR ROUNDABOUTS. DEFAULT:4.0

BUSPCU FACTOR TO CONVERT BUSES INTO P.C.U.'S. DEFAULT:3.0

WAITW WEIGHTING FACTOR APPLIED TO DELAYS AT INTERSECTIONS IN CALCULATING MINIMUM "GENERALISED TIME" ROUTES. DEFAULT:1.0

?I-4. General Notes on Network Coding

1) Each junction is represented by a node in the network. These are sub-divided into 'internal' and 'external' nodes. Internal nodes are simulated in detail and full data as specified below must be given for each internal node. External nodes represent intersections just outside the edge of the network of interest, and are only used to identify links entering the network. Delays For these nodes are not simulated and less detail is required for input - in fact only the starred data (*) below. Generally speaking each external node should be connected to one (and only one) centroid connector representing external trip O's and D's.

2) Nodes, whether internal or external, are identified by node numbers given them by the user. In SATURN these node numbers need not be strictly sequential, i.e., 1, 2, 3 ..., but may take any numbers desired by the user; for example the user may wish to retain the same system of node numbers as used in another study. However the one important restriction with regard to node numbers is that the node-based data described below MUST be input in order of increasing node numbers; i.e., the lowest numbered node comes first, the next lowest comes second, etc.

3) There are five possible "node types": traffic signals, priority junctions, roundabouts, external nodes (regardless of their physical layout),and 'dummy' nodes.

4) The links or roads which join nodes, the 'in-links' into each node, are numbered sequentially in a clockwise direction about successive nodes. However the actual link numbers are calculated by the computer and need not be input by the user. However the use must insure that the links at each junction are correctly input in clockwise order; otherwise largely uncheckable errors result.

Each node may have up to six in-links. One-way links are represented by giving zero discharge flow (LDR below) to the non-existing direction. However, both directions must be present in the coding described below.

5) In addition each potential turning movement in the network is assigned a sequential number, but like sequential link numbers these will be essentially invisible to the user. It is also essential that turns be defined in strict clockwise order from each in-link, starting with the first turn to the left. As part of his data input the user must define a saturation capacity for each turn; banned turns are therefore coded by setting this turn capacity to 0.

6) In addition to the "real" network nodes and links the user must also define centroids and centroid connectors. The conventions used within SATURN may differ somewhat from those used in other suites. Firstly, centroid or zone numbers or "names" do not need to be numbered sequentially; like node numbers any numbers may be used, e.g., the same names as used in other studies. In addition nodes and zones may have the same numbers; i.e., you may define a zone 15 and a node 15 without fear of confusion within SATURN (although the user himself might well be confused!).

   Note as well that the zone numbers or "names" must also be defined on the trip matrix input cards described in Section V. Thus if the lowest zone number is 5 this information must be included as the first input number for the first row.

7) Secondly centroid connectors are connected to links, not to nodes as in most conventional assignment suites. Thus if zone 7 is connected to link (67, 80) this is taken to imply that trips into zone 7 do so by entering the link FROM node 67 and may, in effect, be thought of as parking somewhere between 67 and 80 (and in that direction). Similarly trips out of zone 7 are assumed to enter the network at the downstream - node 80 - end of the link, again as though they had parked on the link.

   The one exception to this rule is where the link defined is an "external" or "cordon" link, i.e., a link in which one node is an external node. In these cases trips are assumed to both enter and leave the network at the "external" node and in the appropriate direction.

VI-5. The Network Data Records

Data must be specified for every node in numerical order. For internal nodes a complete description of the node, its "in-links", capacities of turns and signal timings (for traffic signals) must be given before the next node is coded. For external nodes only card types 1 and 2 below are required and in addition only those variables starred (*) below need be included.

The file must include the following for each node in the network:

1) Card type 1 - Node description (mandatory)

2) Cards type 2 - Link description - One card (mandatory) for each 'in-link' in strict clockwise order but starting with any arbitrary link.

3) Cards type 3 - Stage descriptions. Only required for type 3 nodes. One card per stage is input.

Coding instructions are given below and worked examples for each node type appear in Section VII.

The network data records are terminated by a 99999 in the first five columns.

CODING NETWORK NODES(JUNCTIONS)

CARD TYPE	COLS.	NAME		DESCRIPTION
1	1-5	NODE	*	NODE NUMBER
11	6-10	JLEG(-)	*	NO. OF LINKS OR LEGS AT NODE
1				(Including one-way out-bound links)
1	11-15	JTYPE(-)	*	NODE TYPE - 0 FOR EXTERNAL NODES
1				1 FOR PRIORITY JUNCTIONS
1				2 FOR ROUNDABOUTS
1				3 FOR TRAFFIC SIGNALS
				4 FOR A 'DUMMY' NODE
	16-20	JLANE(-)		NO. OF APPROACH/WEAVING LANES (ROUNDABOUTS ONLY)
	21-25	JCIR(-)		TIME TO CIRCLE ROUNDABOUT(SECS). (ROUNDABOUTS ONLY)
	26-30	NSTAG		NUMBER OF STAGES - TRAFFIC SIGNALS ONLY.
	31-35	OFFSET		RELATIVE OFFSET - TRAFFIC SIGNALS ONLY.

....

CARD TYPE	COLS.	NAME		DESCRIPTION
	5-10	NODEA(-)	*	NODE AT THE "UPSTREAM" END OF THE LINK (WHICH MAY BE EXTERNAL).
	11-15	LANE(-)		LANE APPROACH TYPE (SEE NOTE A BELOW).
22 2	16-20	LDR(-)	*	MAXIMUM DISCHARGE RATE FOR LINK IF LDRIN IS TRUE. (O IF THE LINK IS ONE-WAY FROM NODE TO NODEA). OTHERWISE THE NUMBER OF LANES ARE INPUT.
2 2 2	21-25	TIM(-)	*	FREE RUN TIME FOR LINK IN SECONDS, OR THE FREE RUN SPEED IN KPH IF SPEEDS=T.
22222	26-30	LENG(-)	*	LENGTH OF LINK (METRES).
	31-34	LSAT(-)		THE CAPACITY FOR THE FIRST TURN FROM THIS LINK IN A CLOCKWISE DIRECTION. (0 IMPLIES THAT THE TURN IS BANNED)
	35	PRI(-)		THE PRIORITY MARKER FOR THIS TURN - SEE NOTE B BELOW.
	36-39	LSAT(-)		DITTO FOR THE NEXT TURN.
	40	PRI(-)		IN A CLOCKWISE DIRECTION ETC. FOR EACH OF (JLEG - 1) POSSIBLE TURNS.

....

CARD TYPE	COLS.	NAME	DESCRIPTION
	11-15	STAGL(-)	DURATION OF STAGE (SECS).
	16-20	INTG(-)	DURATION OF FOLLOWING INTER-GREEN (SECS).
3333 3	21-25	NGM	THE NUMBER OF NODE ENTRIES WHICH FOLLOW AS GNA(1), GNC(1), GNA(2) ... (SINCE TWO ENTRIES ARE REQUIRED PER GREEN MOVEMENT NGM IS TWICE THE NUMBER OF SUCH MOVEMENTS.)
3 3333	26-30	GNA(1)	THE A-NODE FOR THE FIRST GREEN (I.E., PERMITTED MOVEMENT)
3 3 3333	31-35	GNC(1)	THE C-NODE FOR THIS TURN (I.E., THE MOVEMENT 'A-NODE' TO 'NODE' TO 'C-NODE' IS PERMITTED IN THIS STAGE).
	36-40	GNA(2)	SECOND A-NODE.
	41-45	GNC(2)	SECOND C-NODE. Etc. for all green movements specified (up to 11 nodes can be input on the first record. If more are required they should start in cols. 16-20 on the following record)

N.B. If any C-NODE entry above is zero or blank it is assumed that all turning movements from that A-NODE (except of course any prohibited movements indicated by zero saturation flow) are allowed.

NOTES

A) APPROACH TYPES

0 - All turns share lanes
1 - Right turn has separate lane, others share
2 - left turn has separate lane, others share
3 - All movements have separate lanes OR only one movement is possible

For a more detailed description of approach types see Working Paper 106 - reference given in Section II.

B) PRIORITY MARKERS

For use on card type 2 - These describe a turn and enable an accurate assessment of opposing traffic flows to be made. The marker must be one of the following :

L - Left turn at priority junction. (from minor road)
A - Ahead movement at priority junction. (from minor road)
R - Right turn at priority junction. (from minor road)
M - Right turn from major road at priority junction.
F - Permanent left filter at traffic signals.
S - Opposed right turn at traffic signals.
BLANK - No opposing flow.

C) STAGE DURATION

The input values for stage duration need not add up to the total cycle time (LCY). If that is the case they will be factored by the program.

D) BUS-ONLY ROADS

Bus-only roads, i.e., roads which are only used by buses in one direction only, are coded by giving a NEGATIVE value of LDR on card 2 above. Turn capacities should be coded in the normal way. The effect of this coding change is that no car trips will be assigned to this link but the affect of buses both entering and leaving the link on other traffic will be modelled.

VI-6. Coding The Centroid Connectors

Plaese see notes 6) and 7) in Section VI-4.

The number of centroid connector records must equal the number of centroids, with one (and only one) card for each centroid as described below. (There must be at least one connector to each centroid and no more than six.)

COLS.	DESCRIPTION
1-5	Zone or centroid number
6-9	First or A-node on the connected link
11-14	Second or B-node on the connected link
16-19	Ditto for the second connector (if present)
21-24	Second B-node
	Etc.

Like the node cards the centroid connector records are also terminated by a 99999.

VI-7. Coding The Bus Routes

It is possible to input a series of bus routes which will be "seen" by SATURN as fixed loads to be added to the assignment. A route is defined on one or more cards in 16I5 format as follows :

Cols. 1 - 5	The "name" of the route (containing either numbers and/or characters).
Col. 6	'T' if the route is two-way and the order of nodes is exactly reversed (in which case the reverse route need not be coded); otherwise leave blank.
Cols. 7 - 10	The route frequency in buses per hour.
Cols. 11 - 15	The number of nodes through which the route passes.
Cols. 16 - 20	The first node on the route (which will be an external node for routes starting outside the study area).
Cols. 21 - 25	The second node on the route

etc. up to 13 nodes.

If the route passes through more than 13 nodes the list of nodes is continued on a second (or even third) record starting in cols. 16 - 20.

The bus route cards are also terminated by 99999 in cols. 1 - 5.

VI-8. Specimen File

```
 &OPTION &END
SATURNVILLE CITY CENTRE (18/1/80)
 &PARAM  MASL=6,IQ=1,NLIST=26,42,
 OUTPUT=.FALSE. , ISTOP=100 ,
 NITS=2,PRSNET=F,LIST=F,LCY=75,NUC=15,ITDEL=3,
 LFLOW=15 &END
    1    3    3    0    0    2   63
        58    0 3900    0 1870    0 3900
         2    3 3400    9    823400    0
        26    1 4500   17  1503000F1500
            24.    7    6   58    2   58   26   26   58
            36.    7    6    2   26    2   58   26   58
    2    3    1    0    0    2    0
         1    0 2500    9    822500 1600M
         3    0 3400   27  2481600 3400
        29    0 1600   20  130  900L1600R

    (Remainder of physical network data)

99999
    1   59   45
    2   60   46
    3   61   62
    4   63   49   48   37
```

(Remainder of centroid connector data)

99999

400	11	7	66	12	13	14	15	16	17			
401	3	7	18	45	53	52	31	32	33			
500	7	9	18	17	16	15	14	41	13	12	66	
600	8	9	66	12	13	14	15	16	17	18	19	
601	8	10	25	26	24	23	22	21	20	19	18	17

(Remainder of bus route data)

99999

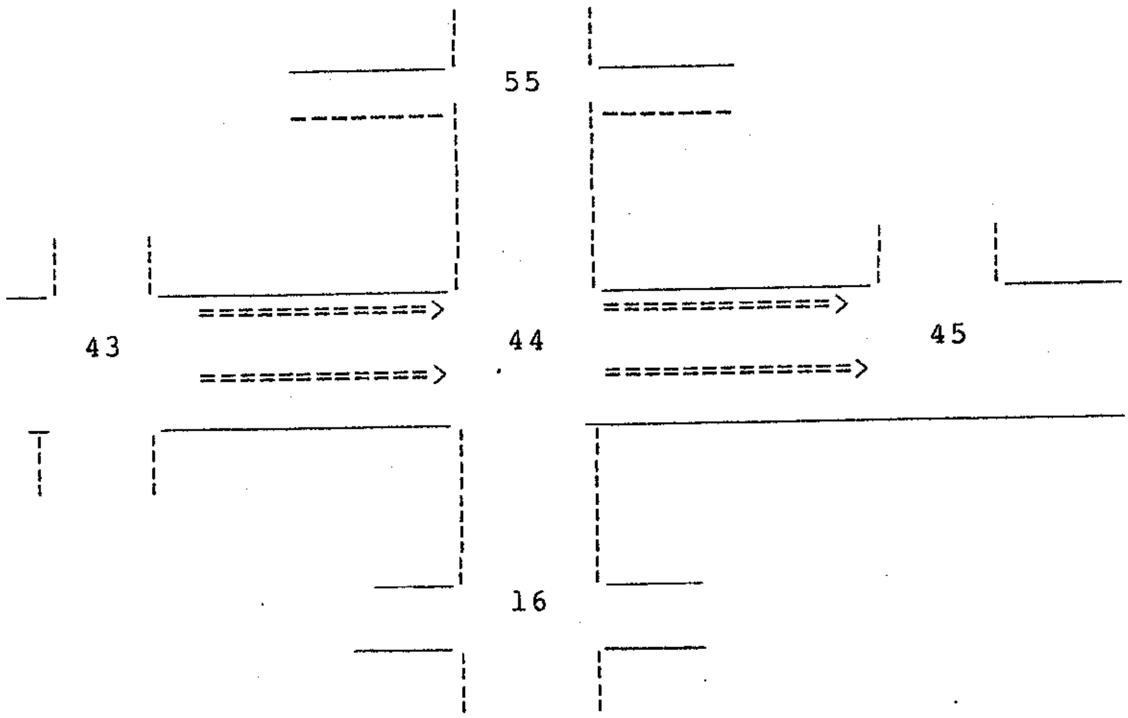
VI-9. Altering/Updating Network Files

If changes to the network need to be made it is necessary to alter the input file (i.e. NETWORK DATA) and rerun SATURN. It is our intention to develop a facility whereby the user will be able to make minor changes to the network and restart SATURN using information from the previous run.

VII. NETWORK CODING EXAMPLES

The previous Section is complemented here by means of examples on how to code each of the three types of node that can be handled by SATURN.

VII-1. Traffic Signals



Assuming that node 44 sketched above represents a signalised intersection its coding for SATURN input would be as follows:

FIRST CARD (card type 1)- Node description

Cols. Nos. Input Remarks

4-5	44	Node number
10	4	Number of in-links (N.B. This includes the banned link from node 45)
15	3	Node type (traffic signal)
30	2	Number of signal stages
34-35	61	Relative offset of first stage

SECOND CARD (card type 2) - Data for in-link from node 45 to 44

Col. Nos.	Input	Remarks
9-10	45	Node at the other end of the link
15	0	*
17-20	0	Maximum link discharge rate equal to zero here means a one-way street in the opposite direction.
24-25	0	*
28-30	0	*

* Input in these columns is not relevant for one-way streets.

THIRD CARD (Card Type 2) - Data for the in-link from node 16 to node 44.

Col. Nos.	Input	Remarks
9-10	16	As above
15	3	All turns have separate lanes
17-20	2500	Maximum link discharge rate is 2500 vph.
24-25	25	Link free run time is 25 seconds
28-30	200	The link is 200 meters from entry to stop line
34	0	Left turn to node 43 is banned
35	blank	No turn marker required
36-39	2500	Sat. flow for straight-ahead movement
40	blank	No turn marker required
41-44	1600	Sat. flow for right turn to node 45
45	S	Opposed right turn

The fourth and fifth cards will contain link data for each of the other two in-links to node 44 in clockwise order,i.e. 43 and 55.

SIXTH CARD (card type 3) - Signal stage description

Col. Nos.	Input	Remarks
14-15	38	Stage duration (sec.)
20	7	Duration of following inter-green (sec.)
25	6	Number of node entries to follow
29-30	43	The movement 43-44-55 is green.
34-35	55	
39-40	43	As is the movement 43-44-45
44-45	45	
49-50	43	And the movement 43-44-16
54-55	16	

(N.B. The coding above could have been simplified by only specifying 43 in cols. 29 & 30 and leaving the remainder blank as this would imply that all turns from 43 were green. In this case NGM in column 25 would be 1).

The seventh and last card for this node should contain similar data for the second stage.

Note 1 - The link discharge rate input here should take account of the physical characteristics of the junction but should not be influenced by opposing flow conditions
Note 2 - The free run time is that travel time which applies under uncongested conditions. It can either be based on observed off-peak times or on an assumed average free flow speed.

VII-2. Roundabouts

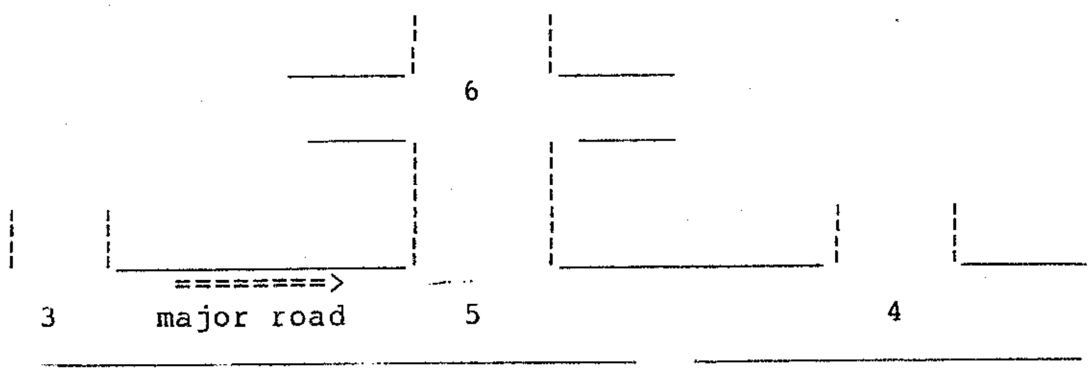
Considering the same junction sketch and assuming that node 44 represents a roundabout we would code it as follows:

FIRST CARD

Col. Nos.	Input	Remarks
5	44	Node number
10	4	Number of in-links
15	2	Node type
19-20	2	Number of weaving lanes
25	4	Time to circle roundabout (sec.)

The next four cards (card type 2) would contain the link data for the four in-links as described in VII-2 above. Since it is a roundabout Cards Type 3 are not required.

VII-3. Priority Junctions



To code node 5 as a priority junction one would proceed as follows:

FIRST CARD

Col. Nos.	Input	Remarks
5	5	Node number
10	3	Number of in-links
15	1	Node type

SECOND CARD

Col. Nos.	Input	Remarks
10	3	Link from node 3 to node 5
15	0	Both turns share lanes
17-20	2500	Max. link discharge rate
24-25	20	Free run time
28-30	100	Link length
31-34	1600	Saturation flow for turn 3-5-6
35	blank	
36-39	2500	Ditto for turn 3-5-4
40	blank	

THIRD CARD

Col. Nos.	Input	Remarks
10	6	Link from node 6 to node 5
15	3	Both turns have separate lanes
17-20	2000	The link capacity is 2000 vph
24-25	7	Free run time is 7 seconds
29-30	50	And the link length is 50 meters
31-34	1200	Saturation flow for turn 6-5-4
35	L	Turn 6-5-4 is a left turn from a minor link.
36-39	1000	Saturation flow for turn 6-5-3
40	R	This is a right turn out of link 6-5

Note: All saturation flow values are given here for illustration purposes only.

VIII. INTERACTIVE OUTPUT WITH SATURN

This section shows how the user may select part of his output interactively when running SATURN on-line.

VIII-1. Simulation Output

Output of profiles for specific nodes can be requested in one of two ways controlled by the value of MODET set in the &PARAM namelist. The following applies:-

a) If MODET = 0 node specific output is controlled by a list of nodes held in array NLIST (set in &PARAM namelist - see section VI-3). For each of these nodes the Arrive/Discharge and Queue profiles on each link are output as requested by the input value of IQ.

b) If MODET = 1 the terminal is activated as I/O channel 3 and the user is asked to specify those nodes for which he requires this detailed output.

The following questions are asked -

1) DO YOU WISH TO SEE DETAILED OUTPUT FOR A SPECIFIC NODE ? (answer Y/N)
2) PLEASE TYPE IN NUMBER OF NODE TO BE CONSIDERED.

When the required profiles have been sent to the output file the user is given the option to specify further nodes. At stage (1), if the answer is No, the summary output will be given and the run will terminate.

IX. RUNNING SATURN USING PROGRAM MODULES

This Section shows how the two main SATURN programs SATSIM and SATASS can be run individually by setting up EXEC files for the Amdahl V7.

IX-1. The Simulation Program SATSIM

(A) SATSIM FILES

The following files may be required to run SATSIM:

Channel Number	Remarks
5	A card image file containing the control parameters and network data; see IX-1 (B) below. (Mandatory)
6	An output line printer file. (Mandatory)
8	A MT file produced by the program containing the flow-delay relationships to be passed on to the assignment. (Mandatory)
9	A MT file containing a set of link flows as produced by SATASS. (Optional - only required if NEWNET=.FALSE. in &OPTION.)
3	The terminal. Optional - only required if MODET NE 0 in &PARAM.

(B) SATSIM DATA INPUT ON CHANNEL 5

FIRST RECORD - SATSIM-NAMELIST OPTIONS (&OPTION)

OPTION	TYPE	DEFAULT	INTERPRETATION
NEWNET	Logical	TRUE	TRUE if a new network is being built and full data follows on this channel.
TITLE	Logical	TRUE	TRUE if a new network title is to be read as Card 2 on this channel.
NEWPAS	Logical	TRUE	TRUE if parameters are to be read in namelist &PARAM on card 3
PASSQ	Logical	TRUE	If TRUE queues from a previous time period will be read in.

SECOND RECORD : HEADER RECORD

This record contains the network title.

THIRD RECORD : NAMELIST &PARAM as described in Section VI.

(C) Example of an EXEC to run SATSIM:

```
FI 5 DISK NETWORK DATA
FI 6 DISK FILENAME LPO (RECFM F LRECL 132 BLOCK 132
FI 9 DISK FILENAME UNFA A4 (RECFM VS LRECL 512 BLOCK 512
FI 8 DISK FILENAME UNFS  A4 (RECFM VS LRECL 512 BLOCK 512
SATSIM
```

IX-2. The Assignment Program SATASS

(A) SATASS FILES

The following files may be required to run SATASS (With, in each case, the conditions under which they must be specified):

Channel Number	Remarks
2	MT file containing the trip matrix being loaded. - Mandatory except when CMONLY is TRUE.
3	The MT file containing the PIJA factors to be input to update program ME2. In fact the file is a TRADVV matrix file. - Optional - Only required if PIJA is TRUE.
4	A MT scratch file used by the program. - Optional - Only required if PIJA is TRUE.
5	The card image data file specifying the options and parameters for this run of SATASS plus any additional data as specified below. - Mandatory
6	The output line printer file. - Mandatory
11	MT file containig the cost matrix. - Optional - Only required if CMONLY is TRUE.

8 The input MT file from the program SATSIM (Described as FILENAME UNFS in Section IV) - Mandatory

9 A MT file produced by SATASS containing the assigned flows and passed to SATSIM. - Mandatory unless CMONLY or PIJA is TRUE.

(B) SATASS DATA INPUT ON CHANNEL 5

RECORD ONE - OPTIONS (&OPTION) (MANDATORY)

The &OPTION record is used to define the specific option of SATASS which is to be used during the run plus which of the following input records are used. With respect to options there are effectively three: (i) The "default" option as used in the normal iterative loop between SATSIM and SATASS whereby a complete assignment is carried out based on the flow-delay curves calculated by SATSIM and input on the MT file on channel 8. New flows are returned to SATSIM via the MT file on channel 9. This option is assumed if neither the next two options is requested. (ii) The "PIJA" option whereby a complete assignment is carried out as above but PIJA factors for selected links are monitored during the loading sequence and output as a MT matrix file on channel 3. As this is essentially a "one-off" procedure which would not be part of an iterative loop with SATSIM no output MT file on channel 9 is produced. (iii) The "CMONLY" option whereby no trips are assigned but a matrix of zone-to-zone travel costs (based on the delays calculated by SATSIM and contained in the input file on channel 9) is created and output on channel 4.

The following table lists the variables which may be defined on &OPTION, their default values and a brief further explanation.

OPTION	TYPE	DEFAULT	INTERPRETATION
TITLE	Logical	FALSE	TRUE if a new title is to be read in
NEWPAS	Logical	FALSE	TRUE if namelist &PARAM is to be input
PIJA	Logical	FALSE	If TRUE a set of PIJA's are produced.
CMONLY	Logical	FALSE	If TRUE only a cost matrix is produced.

RECORD TWO - A new network title (OPTIONAL - If TITLE=TRUE)

RECORD THREE - Namelist &PARAM (OPTIONAL - If NEWPAS=TRUE)

This record is used to define values for certain control-type variables used in the assignment procedure. In all cases the default values of these parameters have been defined within SATSIM and passed to SATASS via the MT file on Channel 9; hence the &PARAM record is used here to essentially over-ride existing values. The following variables may be defined: (for a more complete explanation of their function please see the description of the &PARAM variables under SATSIM, Section V1-3).

NITA, PAPER, COMPAR, PRANET, PRINTF, PRPIJA, ISTOP, SLOPE1 and WAITW.

In addition a number of assignment convergence criteria can be user specified. For full details see the program listing.

RECORD FOUR - Either:

(1) The matrix title if CMONLY = TRUE
i.e., a title to be included in the output cost matrix file.

or:

(2) Count data if PIJA = TRUE. Described in Section X-2.

(D) Sample EXEC and DATA Files

1- Example of an EXEC to run the assignment program SATASS.

```
FI 5 DISK ASSNAM CONTROL
FI 6 DISK FILENAME LPA (RECFM F LRECL 132 BLOCK 132
FI 8 DISK FILENAME UNFS A4 (RECFM VS  LRECL  512 BLOCK 512
FI 2 DISK MATRIXMT UNFMAT A4 (RECFM VS LRECL 512 BLOCK 512
FI 9 DISK FILENAME UNFA A4 (RECFM VS LRECL 512 BLOCK 512
SATASS
```

Listing of the input file ASSNAM CONTROL:

```
 &OPTION &END
```

2- Example of an EXEC to run SATASS to obtain a set of PIJA's.

```
FI 5 DISK COUNTS DATA
FI 6 DISK PIJAOUT LP
FI 2 DISK OLDOD UNFMAT A4 (RECFM VS LRECL 512 BLOCK 512
FI 8 DISK FILENAME UNFS  A4 (RECFM VS LRECL 512 BLOCK 512
FI 3 DISK PIJA UNFMAT A4 (RECFM VS LRECL 512 BLOCK 512
FI 4 DISK SCR UNF A4 (RECFM VS LRECL 512 BLOCK 512
SATASS
```

Listing of the input file COUNTS DATA:

```
&OPTION PIJA=T,NEWPAS=T, &END
&PARAM &END
  32   34   31  180
  33   34   46  280
  36   37       100
  (remainder of counts)
99999
```

IX-3. "Null" Data Input Files

If one wishes to run SATSIM using the results of a previous assignment run (i.e. no new network is to be read in), then the card image file on channel 5 should contain the following:-

```
&OPTION NEWPAS=F,TITLE=F,NEWNET=F, &END
```

Similarly if no new parameters are input to a run of SATASS the corresponding card image file will contain simply:

```
&OPTION  NEWPAS=F,TITLE=F, &END
```

X. UPDATING AN O-D MATRIX FROM TRAFFIC COUNTS

X-1. Introduction to ME2

This section explains the use of the program ME2 in conjunction with SATURN to update an old or 'a priori' trip matrix using traffic counts available for a given network. The theoretical background to the technique is described in a paper by H.J. VAN ZUYLEN and L.G. WILLUMSEN 'The most likely trip matrix estimated from traffic counts', Transportation Research, VOL 14B, 281-294, Sept. 1980.

Basically ME2 takes an old trip matrix and uses current traffic counts to estimate the most likely trip matrix consistent with the information contained in the counts and using as a starting point the old trip matrix. In order to do this it requires a "PIJA" file, each element of which represents the proportion (P) of trips between a particular origin-destination pair (IJ) which uses the counted link (A). The PIJA data are obtained from an assignment.

The procedure adopted within SATURN, represented in flow chart form in Fig. 3 (Section XIV), follows an ad hoc iterative algorithm whereby an assignment is used to derive the route choice/PIJA factors which is in turn used to estimate a revised trip matrix. This is then reassigned and the process continued until stable values are found. These assignments can either be a single equilibrium assignment with fixed flow delay curves - the 'Inner Loop' in Fig. 3 - or a full run of SATURN as represented by the 'Outer Loop'. Even when the latter is followed a run of SATASS (with PIJA=TRUE) is required after running SATURN in order to obtain the PIJA's. Further information may be found in the various papers listed in Section II.

Two standard procedures may be used within this sequence: one to obtain the PIJA's via the assignment program SATASS - SETPIJA EXEC; the other to run the update program ME2 - SATUP EXEC. Examples of how to set up one's own EXEC's are given in the Appendices at the end of this Section.

An alternative method for updating a trip matrix is to use the TRADVV program M6 which "Furnesses" a matrix to satisfy certain row and column constraints. This procedure is appropriate (and much faster than ME2) when the constraints one wishes to satisfy are counts on external links entering and leaving the network as opposed to counts within the network.

X-2. Obtaining PIJA Factors using SETPIJA

The following 'procedure' command is necessary:

```
SETPIJA COUNTS OLDOD SIMFILE PIJAFILE
```

Where:

COUNTS DATA is a card image file containing the following:

First record:

&OPTION PIJA=T, &END

followed by one record for each turning movement or link for which counts are available formatted as:

Cols. 1 - 5	The A-node, A
Cols. 6 - 10	The B-node, B
Cols. 11 - 15	The C-node, C (for turning movements)
Cols. 16 - 20	The observed or counted flow in vehicles or pcus per hour.

Thus if the count is on a link only the two nodes defining the link, A to B, need be defined, while for a turning movement, A to B to C, all three need to be defined. Note that in both cases the count is "directional", i.e. it corresponds to a one-way flow.

The end of the observed counts is indicated by a blank record or by 99999 in cols. 1 to 5.

OLDOD UNFMAT is the 'old matrix' MT file, as obtained by running SATURNOD EXEC for example.

SIMFILE UNFS is the MT file output from SATURN and containing the flow-delay relationships associated with the network under consideration and the 'latest' O-D matrix input to SATURN.

PIJAFILE UNFMAT is a MT file containing the necessary PIJA information to be input to ME2.

X-3. Updating a Trip Matrix with ME2

The standard EXEC to run ME2, SATUP EXEC, can be operated by issuing the following comand:

SATUP OLDOD PIJAFILE UPCOUNTS

Where:

OLDOD UNFMAT is a standard TRADVV matrix MT file as used by SATURN containing the old or 'a priori' trip matrix.

PIJAFILE UNFMAT is the MT file of PIJA factors as obtained from running SETPIJA EXEC.

UPCOUNTS DATA is a card image file containing the following records:

FIRST RECORD:RUN runame where 'runame' is supplied by the user.

SECOND RECORD: A PARAM card. This is a namelist record(s) starting with &PARAM and ending with &END and containing the options of the run separated by commas. These options are as follows:

NAME	TYPE	DEFAULT	COMMENT
ITERMX	I	20	Maximum number of iterations
SEED	R	0.0	Seed value for 'zero' cells.
EPSILN	R	0.1	Convergence criterion; in the default option all flows are expected to be within 10% of observed ones.
RATMAX	R	5.0	Maximum ratio of updated to old trips. Used to limit excessive change to the old trip matrix.
PRINT	L	F	If TRUE the input and output matrices plus the balancing factors on each iteration are printed.
POWER	I	0	Elements of the output matrix are factored up by 10**POWER. This is useful to avoid errors in the output matrix, especially when the changes are small.

THIRD RECORD: This contains the title to be given to the updated matrix.

These three records are followed by the set of observed counts, input in exactly the same format as described above under COUNTS DATA for SETPIJA; i.e., one record per count, four entries per record and terminated by 99999 in cols. 1-5.

The program will terminate iterations if either ITERMAX is reached OR all estimated and observed link flows are, in relative terms, within EPSILN of one another.

For further details on running ME2 at Leeds see the file ME2 DOCUMENT under TRA6LIB.

-4. Specification of ME2

(A) ME2 FILES

The files and corresponding channel numbers to set up one's own EXEC to run ME2 are given below: (N.B. All these files are mandatory.)

Channel Number	REMARKS
3	The updated trip matrix file (MT).

5 Input card image file containing the set of traffic counts and the parameter options as described in UPCOUNTS DATA above.

6 The output line printer file.

8 The 'old' O-D matrix.

9 The MT file containing the PIJA's.

An example of such an EXEC is shown below.

```
FI 5 DISK UPCOUNTS DATA(RECFM F LRECL 80 BLOCK 80
FI 6 DISK UPDATE1 LP A (LRECL 132 RECFM F BLOCK 132
FI 8 DISK OLDOD UNFMAT A4 (RECFM VS LRECL 512 BLOCK 512
FI 3 DISK NEWOD UNFMAT A4 (RECFM VS LRECL 512 BLOCK 512
FI 9 DISK PIJA UNFMAT A4 (RECFM VS LRECL 512 BLOCK 512
ME2
```

XI. MATRIX MODIFICATION

As mentioned a number of times above the MT matrix files used by SATURN conform to the specifications of the TRADVV Suite, a suite of transport planning programs also developed in the Institute for Transport Studies, University of Leeds. This Suite contains a number of matrix manipulation programs, some of which are particularly useful as well to SATURN users, either for preparing trip matrix files or for analysing them. For example the trip matrix file need not be created only by setting up a card image file and running SATURNOD - there are a number of alternative and potentially more useful methods of producing the same file using TRADVV programs.

It is not the intention of this section to give a detailed description of the TRADVV Suite - users should consult TRADVV DOCUMENT for this purpose. What we do wish to indicate here is some of the matrix manipulation programs which are available under TRADVV and some of their potential applications for SATURN users.

The following programs are relevant:

(1) M1

This is a general matrix manipulation program with the following pertinent functions:

(a) Creation of a MT file from card image input (in fact SATURNOD uses M1 in this way).
(b) Factoring of MT files - useful for converting trip matrices from, say, 15 minute flows into hourly flows, or for converting a trip matrix to pcu's.
(c) Matrix printing, either element by element or row and column totals.
(d) Adding two matrices together, e.g., to produce a total trip matrix from a private matrix and an HGV matrix.
(e) "Multiplying" two matrices together in the sense that an trip matrix and an O-D cost matrix may be combined to produce a matrix of O-D vehicle costs.
(f) Conversion of a TRAMP or MINITRAMP matrix into the proper TRADVV format for use in SATURN.

(2) M2

This program compares two matrices element by element and prints out relevant statistics. It is useful to SATURN users for comparing trip matrices (updated vrs. old for example) or cost matrices from two different networks.

(3) M4

This program enables one to "reduce" a matrix by simply removing a specified set of rows and columns. For example one might use M4 to produce a trip matrix for a small sub-area from a larger matrix. (Note however that this procedure does not allow for trips crossing the "cordon" around the sub-area, only the intra-area trips. There is however another TRADVV program, C4, which will do this in conjunction with a tree build sequence on the complete network.)

(4) M5

M5 is a general program for matrix expansion (splitting zones into sub-zones), compression (adding zones together) and recoding (changing zone names). The expansion capability is particularly relevant for SATURN users who frequently wish to sub-divide zones which have been defined for a strategic model into smaller sub-zones more suitable for the network definition required by SATURN.

(5) M6

M6 is a Furness style program which updates a trip matrix (or indeed any sort of matrix) such that the row and column totals (zone origins and destinations for a trip matrix) match input totals. It is useful for updating a matrix in which the only counts are trip end totals.

XII. NETWORK PLOTTING

In addition to the matrix manipulation programs mentioned above TRADVV also contains a program, P1, for plotting networks, either directly to a terminal or to a hard-copy plotting device. P1 may be used for plotting SATURN networks by using the data stored on either one of the two MT files produced internally by SATURN; i.e., either the FILENAME UNFA or the FILENAME UNFS as described in Section 1 .

The plots produced give node numbers at each junction with different geometric shapes to represent different junction types; e.g., roundabouts are represented by circles with the node number inside, traffic signals by squares and priority junctions by rectangles. In addition certain properties such as flows, speeds etc. can be annotated on each link.

Again it is not the purpose of this section to give a detailed description of the capabilities or use of P1. Details are given in TRADVV DOCUMENT and a sub-file P1 DOCUMENT.

We should also stress that P1 is essentially concerned with the display of link-based information as opposed to node-based data. For example it displays flows along links but not turning movements at intersections. It is however planned to produce a second plot program, P2, which will graphically display junction data for individual nodes.

P1 is also a program which is specific to the Amdahl V7 and, unlike the remainder of the SATURN programs, would be complicated to transfer to other machines.

XIII. EVALUATING ALTERNATIVE SCHEMES USING SATURN

The following system-wide performance measures are output by SATURN to enable alternative traffic management schemes to be compared:

- Total distance travelled
- Total time spent travelling
- Total delayed time
- Total number of stops made
- Total number of first time stops
- Total fuel consumed
- Average travel speed
- Average travel time

In addition it is possible to obtain interzonal time matrices and the corresponding trip time frequency distributions for each alternative using the CMONLY option described in IX-2. Using the TRADVV matrix manipulation program M2, these time matrices can be compared cell by cell. M2 also outputs overall comparison statistics for any two matrices.

Detailed information on turning movements and delays at each node (road junction) can also be obtained from the SATURN simulation program SATSIM. The latter also provides the user with a list of nodes where over-saturation occurs and its extent.

One can also see the arrival and discharge patterns and the queuing profiles for each turning movement at a node(s) by specifying such node(s) as part of the namelist parameters NLIST defined on &PARAM.

XIV- FLOW CHARTS

FLOW CHART 1- Running the basic SATURN model

```
              NETWORK                              TRIP
               DATA                               MATRIX
        (Card Image file)                       (MT file)
                 |                                  |
                 |                                  |
                 |                                  |
                 V                                  V
  --------------------------------------------------------------
  |                                                            |
  |                       SATURN                               |
  |                                                            |
  |         **************************                         |
  |         *                        *                         |
  |         *       SIMULATION       *                         |
  |         *        (SATSIM)        *                         |
  |         *                        *                         |
  |         **************************                         |
  |              |                  ^                          |
  |              |                  |                          |
  |              |                  |                          |
  |              |                  |                          |
  |  FILENAME UNFS           FILENAME UNFA                     |
  |     (MT file)              (MT file)                       |
  |              |                  |                          |
  |              V                  |                          |
  |         **************************                         |
  |         *                        *                         |
  |         *       ASSIGNMENT       *                         |
  |         *        (SATASS)        *                         |
  |         *                        *                         |
  |         **************************                         |
  |                                                            |
  |                                                            |
  --------------------------------------------------------------
```

FLOW CHART 2- Obtaining a trip matrix for SATURN input

```
         CARDOD DATA
      (card image file)

              |
              |
              |
              |
              |
              V
 ********************
 *                  *
 * M1 MATRIX PROGRAM *
 *  (SATURNOD EXEC)  *
 *                  *
 ********************
              |
              |
              |
              |
              |
              V
       MATRIXMT UNFMAT
   (Unformatted MT file)
```

FLOW CHART 3- Updating a trip matrix

```
                                                              Base year
                                                             trip matrix
                                                             (MT file)
                                                                  |
                       ****************                           |
                       *              *                           V
   Network             *    SATURN    *                    |==============|
    data  ------->*                   *<-------------------| Current      |
   (card image)        ****************                    | trip matrix  |
                              |                            |  (MT file)   |
                              |                            |==============|
                              V                                   ^
                       ***************                            |
                       *   SATASS    *                            |
                       * (PIJA=TRUE) *<--------------,            |
                       ***************               |            |
                              |                      |            |
                              V                      |            |
                         ===========                 |            |
                         |  PIJA   |                 |            |
                         |(MT file)|                 |            |
                         ===========                 |            |
                              |                      |            |
 Base year                    V                      |            |
 matrix                ****************              |            |
(MT file)---------->*                 *              |            |
                       *   UPDATE     *              |            |
                       *    (ME2)     *              |            |
Observed---------->*                  *              |            |
 counts                ****************              |            |
 (Card Image)                 |                      |            |
                              |                      |            |
                              V                      |            |
                       ===================           |            |
                       | NEW TRIP MATRIX |           |            |
                       |    (MT file)    |           |            |
                       ===================           |            |
                              |                      |            |
                              V                      |            |
                       -------------------           |            |
                      | New flow-delay   |  NO       |            |
                     | curves required?  |---------->'            |
                     |                  |   'INNER LOOP'          |
                     ---------|---------                          |
                              |                                   |
                              V YES     'OUTER LOOP'              |
                              ----------------------------------->'
```

APPENDIX A - DATA INPUT VIA NAMELIST

All input of simple control parameters for programs in SATURN uses the namelist facility, a feature of standard FORTRAN which is however generally not appreciated by the 'casual' user. In effect it is a method of free-format data input in which the user defines directly the values of certain key parameters or variable names to be used by the program. The essential alternative method is input via fixed column conventions whereby, for example, a '1' in column 10 might indicate that the user wishes a certain file to be produced or a '3' in column 5 might indicate that he wants a total of 3 trees to be printed.

The problem with this method is that it is difficult for the user to remember which column corresponds to which variable and it is sometimes difficult for the program to detect that the user wishes to have certain default values used. By associating easily-remembered variable names the first problem is overcome by namelist.

A namelist input command consists of essentially three segments :

1) An identifier which gives the 'name' associated by the program the following variable list. This has the form: &PARAM ... Where a blank in the first column and an '&' in the second indicate that the namelist identifier follows. Here 'PARAM' is the name associated with certain list of variables by the program.

2) Variable definitions of the form:

   NTREES=1,TRFILE=F,USER='harry', ...

   Where NTREES is an integer variable used within the program TRFILE is a logical variable and USER is a variable (presumably real) which stores text. Note that each definition is separated by a ',' from that following and that the final entry is also followed by ','.

   The following rules should also be noted:

   - Input may continue over more than 1 card and the second card must commence with a blank in the first column.

   - Arrays may be defined without specifying the individual subscripts for each variable. E.g. NLIST=7,4,16,NTREES=1, ... where NLIST is an array declared to be of dimension, say, 10 by the program. The above input would set NLIST(1) = 7, NLIST(2) = 4, NLIST(3)=16, and NLIST(4) ... NLIST(10) would retain their default values.

   - When a variable associated with a particular namelist is not included in the list a default value pre-set by the program is used instead.

(3) -An 'END' identifer which indicates the end of the variable definitions and has the form:-

TRFILE=T, &END.

Note that the ',' and blank following the final variable are essential. If &END appears on a new record it must have a blank in the first column.

Thus a complete input record for data input using namelist might be:

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&PARAM TRAMP=T,PRINT=T,NSFR=20, &END
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