



D. Changes in SATURN Versions 8.1 - 10.9

D.1 Changes in SATURN 8.1

SATURN 8.1, introduced for the first time to users in September 1990, represents a major upgrade to **SATURN 7.1** with both changes to existing programs in addition to totally new facilities. The inevitable bad news is that files produced with **SATURN 7** are no longer “legible” under **SATURN 8** although - the good news - the raw data files should, generally speaking, be upwards compatible (though certain minor corrections may be necessary).

Thus it is quite feasible to transfer work already begun using **SATURN 7** onto **SATURN 8** but starting with the original data files as input to **SATNET** to define the network and as input to **M1** to define a trip matrix, not the output binary files.

If you no longer have the matrix data files, or a matrix has been modified such that only a binary file is available, you should make use of the VVDART option within **M1** (N.B. **SATURN 7 M1**) to “dump” the binary into a card image file which may then be input into **M1** of **SATURN 8**. Alternatively a one-off program MATUP78 has been written to convert **SATURN 7** binary matrix files into **SATURN 8** binary matrix files, but it may need to be tailored to local systems.

With network data files the situation is different in that there is no program to “dump” network binary files into card image, although on the other hand the opportunities to “edit” network files in version 7 were very limited. Hence you should still have the original card image files. (If not, ring DVV for advice.)

It should however be noted that you will not produce exactly the same results, e.g., flows and times, using version 8 as were obtained with version 7 since certain aspects of the simulation have been changed(/improved?). Whether these differences will be large or small is hard to predict since it depends on whether or not your network contains many nodes which are critically different under **SATURN 8**. The only answer is to try it! (Buffer-only networks, on the other hand, should give identical results, provided that all control parameters are unchanged.)

The following material describes in greater depth the main differences between **SATURN 7** and **SATURN 8.1**, divided into various categories.

D.1.1 General New Features

- 1) A system of “pseudo-namelist” input is now available within all programs, whether or not a user’s compiler supports the “proper” namelist facility. This applies in particular to micro users. This makes the input of parameters considerably easier and obviates the old system which required that records be input in a very precisely defined order. It also allows for the upwards compatibility of **SATURN 7** data files.

See Section Appendix B for details.

- 2) A set of “conventions” has been established for high level procedures (bat files to micro users) whereby all operating systems can be made to “look

alike” in terms of their command structures. This allows for a more “universal” documentation and is described in Section 3.4.

- 3) Equally a universal set of conventions has been established for filenames - or, more precisely, for filename extensions. Thus, for example, all input data files should have the extension “dat” as in “livnet.dat”. See Section 3.3.
- 4) A system of “help” files has been added to all interactive programs such as **SATLOOK**, **P1**, etc., to provide an on-line help with the menus. See Section 9.1.2.
- 5) Updating the programs to accommodate different maximum network dimensions prior to compilation is now much simpler and can be done purely and simply by changing dimensions; all the “exceptions” have been “programmed out”.
- 6) New PC 386 versions are available based on the Salford FNT77 compiler which incorporates its own graphics routines and therefore enables more graphical facilities combined with easier programming. Equally for users who wish to compile the programs themselves using their own graphics library the “conversion logic” is much improved with all graphics calls being contained in well-defined subroutines within a new graphics library. Things ARE easier - trust me!

The documentation is much improved, with a more logical structure, more sub-sections, better cross-references and a (still fairly basic) index.

D.1.2 Changes to Existing Programs

Various “major” program specific changes are noted below; “minor” changes such as the re-ordering of menus are ignored.

D.1.3 SATNET

- 1) 5 digit simulation node numbers now permitted.
- 2) Turn priority “modifiers” have been added to change the impact of priority markers in certain (probably unusual) situations; see 6.4.2.
- 3) Each record in a UFS file now has a “title”; a new data file (SATTIT.DAT) is therefore needed as input to **SATNET** to define them.
- 4) Users are recommended (as a consequence of allowing 5 digit node numbers) to use 99999 instead of 9999 to mark the ends of data segments in the input to **SATNET**.
- 5) Roundabouts may now be coded as simulation node type 5 which implies that U-turns are permissible.
- 6) New parameters include KORN, KOB
See Section 6.3.

D.1.4 SATASS

- 1) An improved multiple user class assignment algorithm has been introduced which should improve the division of link flows between user classes.
- 2) New options ROSIE and DIDDLE introduced, largely as yet for experimentation; see Sections 7.1.3 and 7.8 respectively.
- 3) The method by which random costs in stochastic assignment are determined has been changed to make them capable of being repeated later on for analysis purposes; refer to parameters KORN and KOB in Section 7.2.3 and 7.2.4.

D.1.5 SATSIM

- 1) The lane choice mechanism has been updated, maybe EVEN improved!
- 2) Delays to turns in shared lanes are more self-consistent, reflecting the fact that they share the same queue.
- 3) Unblocked vehicles at the head of a lane when lights go green can now “go” before a blocked vehicle arrives.
- 4) Output statistics now include estimates of, e.g., vehicle-kms in later time periods due to queued traffic.

D.1.6 SATLOOK

- 1) A new option provided to give summary statistics of errors and convergence parameters from a full **SATURN** run.
- 2) The tree building options have been considerably extended.

D.1.7 P1

- 1) A new option to automatically display ALL trees from an interactive assignment for a single O-D pair.
- 2) Forests may now be built and displayed directly in **P1** (rather than transferring them from **SATLOOK**).
- 3) Options to “shift” the window, e.g., to the left or right, and to “zoom” or “pan”.
- 4) Turn data may now be annotated, e.g., turning volumes.
- 5) Similarly node data other than simply node numbers may be displayed.
- 6) An informative “banner” giving details of the plot is available.
- 7) The “scale” of the plot is calculated, e.g., 1:10000, and may be used to set the window size.
- 8) 2-way flows may be chosen.

D.1.8 SATED

- 1) Node graphics introduced.

- 2) Cyclical flow profiles may now be disaggregated by lane as well as by turn.

D.1.9 Changes to Matrix Facilities

- 1) In the matrix furness program **M6** new origin and destination totals may now also be defined as differences or factors from the existing totals as opposed to defining each total explicitly.
- 2) Most matrix-based programs, which in version 7 would only run in a “batch-mode”, may now be run in an “interactive mode”; see Section 10.9. Indeed the interactive mode is now much the easiest way to run matrix programs so that the hassle of preparing a control file first may now be avoided.
- 3) Binary matrix files are now stored in the same “Dirck Access” format as the network binary files, thus simplifying certain analysis functions.
- 4) A new matrix program, **M7** carries out a matrix transformation in the sense that the (i,j)th element becomes the (j,i)th.

D.1.10 New “Major” Programs

SATDB

Although introduced in later versions of **SATURN 7** **SATDB** is now offered “officially” as part of **SATURN 8**. See Section 9.5 for a more complete description of its extensive data base facilities.

SATCH

Equally the cordon program **SATCH** was included in later versions of **SATURN 7** but is now released in a more polished form as part of **SATURN 8**. See Section 12.1.

SATOFF

A totally new program in **SATURN 8**, **SATOFF** optimises signal offsets, mainly with a view to deciding on appropriate offsets in future networks with very different flow patterns from the present. See Section 12.2.

SATU2

SATU2 is a supplementary program for PIJA analysis which converts PIJA values calculated by **SATASS** into matrices of trips using the selected links. See Section 11.6.

D.1.11 New “Minor” Programs

Programs **DALOOK**, **DACHEX**, **DADUMP** and **DALOAD** have been added with slightly esoteric functions which generally speaking are not required by the normal user. See Sections 12.3, 12.4 and 12.5 for further details.



D.2 Changes in SATURN 8.2

For users who are upgrading directly from version 7 to version 8.2 directly, read Appendix D first. **SATURN 8.2** was first released in May 1991.

Welcome to the Club!

First, the good news! Matrix files, both .dat and .ufm, are unchanged. Network .dat files have been extended but version 8.1 files are equally valid under 8.2. However network .ufs and .ufa files treat co-ordinates differently; networks with no co-ordinates should be upwards compatible - although they will miss out on a good deal of the fun! Re-running jobs from the same .dat files should however produce identical results.

Now for the new developments.

The biggest change between versions 8.1 and 8.2 is largely invisible to users, although its eventual affects will be great. Thus a new "level" of network definition has been created - the "map network" - in addition to the existing buffer and simulation definitions. A map network consists exclusively of "lines" or non-directional roads in the sense that both a 1-way and a 2-way section of road are represented by a single "line" on a map. Thus a plotted network may be considered as a network of lines, some of which may have a 1-way property.

As a result of introducing the map network **P1** has been substantially re-written internally, although the menus as seen by users are essentially the same.

A resulting new concept is the idea of "interpolated" routes whereby, e.g., a bus route may now be specified by a series of unconnected nodes and the program builds up a complete route by "filling in" the intermediate nodes in the route. The interpolation is based on map network definition. This feature appears thus far in several programs - **SATNET**, **SATCH**, **P1** and others. See Section 15.18.

We note that the map-based features are only available in those networks where co-ordinates are defined for (all) nodes in the original .dat file. Thus including node co-ordinates should be increasingly seen as mandatory - although strictly the programs can still be run without them.

One - inevitable! - consequence of the mapping concept is that networks created under 8.1 are no longer compatible with 8.2, unless they happen to contain no co-ordinate data.

Another new concept in 8.2 is that of "sectors" whereby every zone may be defined as part of a larger "sector" - a common feature in most studies already. This enables, e.g. zone-to-zone trip matrices to be automatically grossed up into sector-to-sector format for easier analysis.

A further new general concept concerns interactive programs such as **SATDB**, **SATED**, etc. which now automatically produce a "log" file which records all the user's terminal inputs. This may then be used as a "dummy" input terminal file to repeat the same set of commands in a "batch" or "off-line" mode. Thus all interactive programs may all be run repeatedly in "batch". See Section 9.1.3 for complete details.



Various “major” program specific changes are noted below; “minor” changes such as the re-ordering of menus are ignored.

D.2.1 SATNET

- 1) The parameter FOZZY is introduced to enable bus routes to be defined via “interpolation” - a godsend for users with many routes! See 6.3.1 and 6.9.
- 2) “Sectors” definition has been introduced as (an optional) part of the co-ordinate data input section. See Section 6.8 and the new parameter IROCKY in 6.3.2.
- 3) Link/turn count data may be sub-divided into several different “sub groups”, generally referred to as “screen lines” by using the ‘777’ data input records more than once. See 6.10.
- 4) The new parameter BEAKER allows capacity indices to be defined for turns in the simulation network as well as links. See Section 6.3.1.
- 5) Nodes not given co-ordinates may now have them worked out from the co-ordinates of their neighbours.

D.2.2 SATDB

- 1) The facilities to carry out “selected link assignment” have been considerably extended, e.g., to allow the analysis of trips crossing any one of a set of screen line links (as defined in **SATNET**) in addition to trips using a single link/turn. In addition a “selected trip matrix” may also be created and sector-to-sector trips may be printed.
- 2) A new “miscellaneous” option permits link and/or turn data to be read from an input “text” or “data” file, stored in the internal data base and from there stored in a UFS file (if required). This provides a relatively simple method for transferring data into a **SATURN** file, e.g., from another suite of programs.

D.2.3 P1

Although substantially re-written to make use of the “map network”, **P1** will appear much the same to users - although there has been a certain amount of “shuffling” of options between menus. In addition a number of new facilities have been added:

- 1) Terminal output (screen size permitting) now includes a text banner down the right-hand side with, e.g., a list of the parameters being annotated, origins and destinations from trees, etc.
- 2) Tree selection has been considerably enhanced and includes both isochrones, skimmed times and distances plus an “animated” link-by-link display of minimum routes.
- 3) “Interpolated routes” - see above - may be directly selected and displayed by nominating end nodes.

- 4) Link annotation “bandwidths” may now be “in-filled” and/or over-written with numerical values.
- 5) The format of the input device data file GRAF.DAT has been altered from 8.1; this also applies to **SATED**.

D.2.4 SATED

- 1) Two new methods of defining and editing data for a single simulation node are introduced:
 - (i) the data may be read entirely from a .dat file (e.g., as input to **SATNET**), or else
 - (ii) a buffer node in an existing UF file may be converted into a simulation node, making the maximum use of the information already coded within the buffer network.
- 2) The node graphics have been extended to allow the animated display of cyclical node profiles, e.g., the change in the queuing pattern over a single cycle of the traffic signals.

D.3 Changes in SATURN 8.3

For users who are upgrading directly from version 7 to version 8.3 directly, read appendices D and E first. **SATURN** 8.3 was first released in December 1991 (although many of the program changes reported below were actually incorporated in earlier releases but largely undocumented).

Basically **SATURN** 8.3 does not represent a major change from 8.2, it is more a continuous development with a number of specific new programs being added. Thus there are no changes in either data inputs or the structure of the various binary UF files (except in so far as new variables/records may have been added).

We first describe the three new programs added under **SATURN** 8.3, **SATEASY**, **SURI** and **MX**, followed by new features common to all (or most) programs in the Suite and by specific “major” changes to existing programs.

D.3.1 SATEASY

SATEASY is essentially the latest version of **SATASS** and will in time replace it completely. However for the moment both will exist in tandem.

The main extension in **SATEASY** is that it allows an elastic Wardrop assignment for one user class; e.g., assignment plus modal split. A number of notes describing the theory, options, inputs etc. are available on hard copy - please ask DVV for copies.

A further extension allows for multiple-user-class elastic assignment, so that you can model the differing reactions of work trips and shopping trips to increased congestion.

What **SATEASY** does not have is any sort of selected link analysis and therefore no PIJA analysis. My intention is to set up a new separate program, say **SATME1**, that will do the PIJA analysis based on the SAVEIT principle. It also does not allow “quantum assignment” which is now felt to be counter-productive for the reasons given in 7-4-5.

It does however also contain a new PARTAN option (which may be set as a parameter on the .dat files input to **SATNET**) which carries out “PARTAN” assignment as a variation on Frank-Wolfe for Wardrop equilibrium with a single user class. I have an article by Yazid Arezki and myself from Transportation Science which gives the theory and I can send that to anyone interested.

PARTAN may significantly speed up the rate of convergence and as far as I am aware (famous last words!) is bug-free. Try it and see if it works - I would be very interested to find out how it performs.

No documentation on PARTAN yet included - be patient.

D.3.2 SURI

SURI is a **SATURN-URECA** Interface program developed jointly by Leeds and WS Atkins. Unlike other programs in the Suite it is only available via an extra purchase from Atkins since only UK users will be interested.

D.3.3 MX

MX is a prototype matrix data base program which will do for matrices the sort of things that **SATDB** does for networks. The idea is to eventually include most of the functions now carried out by **M1** to **M7** within one, essentially interactive, matrix manipulation program, **MX**.

At the moment **MX** is all there but with very little documentation and a bit like a brand new house with a roof and all the windows in place but with the distinct possibility that if you switch on the hall light the loo may flush! New facilities are being continually added.

One totally new option is the facility to create a new matrix from one or more existing matrices using FORTRAN style equations. Hence it can be used instead of the ADD, DOT, etc. options in **M1**, as well as doing more complicated functions. For example if you wanted to set up a “deterrence function” matrix defined by $EXP(-B * C(I,J))$ then **MX** can do that for you.

Basic documentation is included in 10-9 and the help file is mostly done. In addition there is an **MX.bat** file so type **MX** or **MX I** and see how you get on. Ring DVV with any queries - or suggestions/requests!

D.3.4 New General Features

- 1) Link capacity restraint/speed-flow curves introduced on internal simulation links. This, for example, enables motorway-style links to be included within the simulation network. See 6.4.12.
- 2) A “MENU” parameter is included in the DOS.bat command files which allows you to run “batch” programs more easily. Thus the command:

M1 MENU

runs **M1** with interactive menu control - similar to typing “**M1 I**” followed by defining the control file as “TERM”. Same effect, just simpler. Documentation to follow. Try it.

- 3) An “automatic timer” option (nothing to do with ovens!) has been added so that when running interactive programs with KEY input (i.e., dummy terminal input) the program pauses for a fixed number of seconds between each screen. Documented in 14.7.1. It is essentially designed for demonstration purposes.
- 4) Equally a “break” facility has been incorporated into KEY files to allow you to transfer from the batch mode back to interactive. Useful for re-defining program defaults as local standards. See 14.7.2.
- 5) A (highly) prototype Geographical Information System (GIS) has been introduced whereby **P1** network plots can include background information such as political boundaries, rivers, place names etc. This is highly experimental at the present - my intention is to include it “properly” as a feature of **SATURN 9** at which point we have some form of mouse-activated input which will make it easy for the user to define the data that has to go into the GIS file. The current version is (even by my standards!) user unfriendly as I am still playing around with appropriate file formats and what

sort of features are desired by users. However I'm very keen on the whole concept so any suggestions are very welcome.

See Section 9.4.6 for reasonably comprehensive documentation.

- 6) At certain points in certain programs where the program has “paused” it is now possible to move immediately on to another output display by pressing a single key. For example in **P1** you may shift the window upwards by either pressing U or the cursor control up-arrow once the current plot is finished; previously you would have had to hit ‘return’ to get to the main menu and then request the “up” option there.

The facility is only (currently) used at four different points; in **P1**, **MX**, **SATDB** and **SATED**, but more will be added later. See Section 9-1-4.

- 7) **SATASS** and **SATLOOK** now provide summary statistics for total flows through penalised links or turns (as defined under the 44444 cards input to **SATNET**) in terms of total pcu-hrs/hr.
- 8) A third form of randomised cost distribution is now available under SUZIE; a value of KOB = 2 uses normal distributions where SUET now defines the coefficient of dispersion (variance to mean) as opposed to the coefficient of variation (standard deviation to mean) as under KOB = 1. Theoretically this has nicer properties, in particular for links ‘in series’. It may be used in **SATASS**, **SATLOOK**, **SATDB** and **P1**.

D.3.5 Specific Program Changes

SATNET

Link capacity restraint/speed-flow curves introduced on internal simulation links. This, for example, enables motorway-style links to be included within the simulation network. See 6.4.12.

SATLOOK & SATDB

New “files menus” included in both to provide greater flexibility in defining files. (N.B. These menus are designed to have the same “look and feel” as the files menu in **P1** although all three differ in details).

SATED

The node graphics provide an option to print out link data (e.g., flows) in addition to turn data for the selected node.

M1

- 1) The “stack” option now allows up to 10 single matrices to be stacked (the previous maximum was 4). In addition, under MS-DOS a new procedure “STACK” is provided to make stacking matrices easier. Type STACK for details.
- 2) A new “unstack” option now allows you to convert a stacked matrix into its constituent parts. See the parameter UNSTACK in 10.2. In addition, under

MS-DOS a new procedure "UNSTACK" is provided to make unstacking automatic. Type UNSTACK for details.

M6

New option 'NEWT' allows for the input of selected row/column totals instead of having to define them all.

P1

- 1) GIS (Geographical Information Systems) input files introduced. See Section 9.4.6.
- 2) A supplementary node co-ordinate file can now be input to update node co-ordinates; useful for correcting plots without having to go all the way back to **SATNET**. Accessed from the Files Option in **P1**; details under Help and in 9-4-8.
- 3) An option to interactively change node co-ordinates within **P1** has been added, entered either from the Files Option or - 386 users only - by typing E (for Edit) when closing a plot on the screen (an example of point 6 under General Features above). Sector-based co-ordinates may be defined at the same time. In addition the complete set of (new) co-ordinates may be "dumped" to a card image file suitable for direct inclusion in a network .dat file.
- 4) The matrix display facilities have been extensively updated and extended. For example you can now look at two matrices at once and select ranges of rows and/or columns to display. Using the latter facility it is possible to examine, in effect, individual matrix
- 5) The node display menu has been updated and various new options introduced.
- 6) Options to "force" the banner to appear either on the right or the top of the plot are now available - previously the program choose for itself where - and if - to put the banner.



D.4 Changes in SATURN 8.4

SATURN 8.4, first released in October 1992, does not represent a major change from 8.3, but (like 8.3 before it) is part of a continuous development with one major new program **P1X** being added. Thus there are no changes in either data inputs or the structure of the various binary UF files.

D.4.1 New General Features

- 1) The KEY and VDU facilities have been augmented by allowing the user to change the definition of these 'modes' by the use of AUTO and VDU records in a KEY file. See Section 14-7-3.
- 2) A third form of randomised cost distribution is now available under SUZIE; a value of KOB = 2 uses normal distributions where SUET now defines the coefficient of dispersion (variance to mean) as opposed to the coefficient of variation (standard deviation to mean) as under KOB = 1. Theoretically this has nicer properties, in particular for links 'in series'. It may be used in **SATASS**, **SATLOOK**, **SATDB** and **P1**. See 13-2-3.
- 3) Screen output (386/486 versions) now comes in colour - in particular the Help system should only be accessed by users wearing dark glasses!
- 4) More comprehensive simulation network summary statistics are provided in the output from **SATSIM**.

D.4.2 New Programs: P1X

P1X is an extended version of **P1** which includes not only the 'network graphics' features of **P1** but also the node graphics from **SATED**. In programming terms it is a fairly enormous program which possibly will not fit into all computers. It does however certainly work on 486 systems where it was developed.

It represents a major extension to **P1**, in particular by including the node graphical display of single nodes previously available within **SATED** but also much extended now.

Other new features include:

- a) Output ".PCX" graphic files - see Appendix Z.
- b) More turn data available, e.g. V/C ratios;
- c) An option provided to "round off" annotated link data.
- d) GIS file formats now specified; see Appendix Z.
- e) An option is provided to define an "alternative device", e.g., useful to jump quickly from an image on the terminal to hard copy output without going through a whole series of menus.
- f) Selected link assignment (as in **SATDB**) plus display now available directly in **P1X**.

- g) Link “selection” may now be based on data being annotated (previously this could be done but only be “re-creating” the same data within the Select Menu)
- h) Bandwidths on hard copy output device may now be “in-filled” by a set of parallel lines 1 mm apart.
- i) An option has been added so that, when numerical annotation is included with a bandwidth, it may be either inside or outside (i.e., on top of) the bandwidth.

D.4.3 Specific Program Changes

SATSIM

The output summary statistics, e.g., total vehicle-kms., are given more comprehensively by including both figures for the time period simulated plus estimates for any queued traffic, as well as being disaggregated by type of flow (e.g., buses, user class) and by capacity index (if used).

SATED

The node graphics are considerably improved (as well as being included within **P1X**; see above). In particular the flexible band-widths or “tubies” for displaying turn data is a major improvement. In addition:

- 1) Stage diagrams may be “inserted” at the top of the plot.
- 2) **SATLOOK**-style numerical output now directly accessible from the graphics menu.
- 3) Salford PC versions now include an option to “define” node data via “windows” which are superimposed on a node graphics plot.

SATLOOK

The convergence statistics summary tables are a bit more “clever” in that they exclude parameters which cannot be measured under certain options.

SATME2

- 1) Selected elements within the trip matrix may be “fixed”.
- 2) Constraints need no longer be “equality” constraints; counts may be interpreted as upper or lower limits.

N.B. The current version of **SATME2** was previously available under the name “**SATME3**”; it now replaces **SATME2** as the new facilities have now been sufficiently well tested. Data files previously used may need minor alterations to conform to the new input conventions and/or variable names.

D.5 Changes in SATURN 9.1

SATURN 9.1, first tested on an experimental basis in May 1994, contains a number of major changes from 8.4, but at the same time is part of a continuous development. Thus the basic structure of both the network and matrix ASCII data input files and of the various binary UF files is essentially unchanged and files created under 8.4 or before should still be largely compatible with 9.1 (although the converse is not true - files created under 9.1 will almost certainly not run with 8.4 programs.) The formats of some of the “minor” data files however have changed as, inevitably, will the exact order of inputs in “key” files.

The program structure has undergone some modifications. Thus the program **MX** has been extended to include virtually all the functions contained in programs **M1** to **M7** so that these programs, although retained in 9.1, are being gradually phased out. Secondly **P1X** has incorporated many routines from **SATDB** and **SATED** and the trend is very much, as with the matrix programs, towards creating one all-singing all-dancing interactive analysis program. Thirdly a new program **SATALL** has been created which brings together **SATASS** and **SATSIM**; see Section H.7.

The documentation has been updated to reflect these changes and, where appropriate, new document references are given in the following notes.

D.5.1 New General Features

- 1) Certain operations now use mouse controls, for the moment in **P1X** only. See H.8.1 below for specific details and Section 9.1.7 for general principles.
- 2) Equally data in some circumstances may be defined using a screen editing or window-style environment, in particular within **P1X**, **SATDB**, **MX** and **SATED**. Notes under these specific programs give details. A more general description of the principles involved is given in Section 9.1.6.
- 3) The use of “comments” in data files has been introduced. These appear in a number of different file formats with the common feature that a ‘*’ is used to indicate that the text following is a comment. See Section 15.29.

In particular comments are used in:

- a) Namelist input records; see appendix A, notes 13 and 14.
 - b) Comments may be included in KEY files by including lines with a ‘*’ in column 1. These lines are ignored when a key file is being read but they will appear on the screen. See Section 9.1.3.
 - c) Comments are allowed in GRAF.DAT.
 - d) All input .dat files (will eventually) allow comment lines, but for the moment some of the more obscure data file input routines have not been modified. Most importantly they may be used freely in network .dat files.
- 4) The conventions used to define “namelist” parameters have been generally extended to include new features such as the comments mentioned above

as well as the ability to define time period-specific parameters described in H.3 below. Appendices A and B have been revised to reflect these changes.

- 5) The use of “key strokes” to choose the next option has been increased, particularly in **P1X** in conjunction with the display of the available options in the banner. Thus depressing the ‘1’ key may take you directly into option 1 as opposed to typing <enter> to obtain the menu display followed by ‘1’ <enter> to select option 1. See Section 9.1.5.

In addition key strokes - or their numerical ascii equivalents - are entered into LOG files so that you can make use of key strokes and still have a LOG file that can be turned into a “useable” KEY file. Equally mouse-based input is also recorded into the log file so that interactive jobs involving both single key strokes and mouse input may be repeated via key files. See 14.7.5.

- 6) As a general rule a response of Q for “quit” in most replies within interactive programs will have the effect of returning you to the previous menu. However it can probably never be made into a universal rule since there are always circumstances when you are halfway through an operation and there is no way of getting back to your starting point.

Equally when asked to define a filename a response of “quit” will also (sometimes!) get you back to the previous menu; useful if you accidentally get into the wrong option.

- 7) Extra file opening and checking options have been introduced. Thus:
 - ◆ When opening a new file programs now check whether or not that file is already “open”, in which case it will request another file. Previously this resulted in a fatal error.
 - ◆ If the file requested is not found a (Dos) directory listing is generated with up to 16 apparently suitable filenames from the home directory.
 - ◆ An option to automatically over-write existing output files has been introduced (previously you were asked whether or not you wished to overwrite that file). This makes the use of key files easier but a bit more dangerous in that you may overwrite important files without realising.
- 8) Text/filenames may be defined via namelist and are passed via the UFS/A files etc. Thus you may define the trip matrix filename when defining an input file to **SATNET** so it need not be re-defined for **SATASS**. More usefully if you want, for example, to do a select link analysis in **SATDB** or **P1** the program “knows” the trip matrix it requires.

In addition a number of other “useful” filenames such as a GIS file name are stored on .ufs files and accessed when needed.

- 9) All UF* files now contain a “Version indicator” which is printed out to the LP files indicating, e.g., that this file was produced by a version 9.1 program. At the moment this is for information only but in the future it will be used to aid in the correct reading of out-of-date files.

- 10) The number of multiple user classes has been increased to 32 from 10. To accommodate the extra arrays needed in UF files a system of “extended” Dirck Access codes has been created; see 15.21.1.
- 11) The interactive programs **P1X** and **SATED** now require mandatory namelist-based parameter definition files in order to define default values for internal parameters. For example if you want node numbers to be displayed by default by **P1X** you may set a relevant program variable to 1; if it is 0 node numbers are not displayed. Files may be saved from within the programs once you have modified the menus to your own requirements so that from then on the program will have been “customised” to your specifications. See Sections 9.7.3 and 9.9.2.
- 12) Ascii data “sub-files” have been introduced whereby a sub-file might contain the complete set of bus route data as normally contained with a full network .dat file - hence a “bus sub-file”. Sub-files may be “called” from a network file using a \$INCLUDE option described in Section 15.30 within SATNET. The use of .xy files in **SATURN** 8.4 is an early example of a subfile

Sub-files may be created in the usual ways with an edit program or alternatively some may be created interactively within **P1X**; see 9.4.12.
- 13) Matrices with greater than 1,000 rows may now be read as standard without generating a programming error, although not all programs can necessarily handle matrices of this size. For example the standard acceptable matrix size in **MX** is 600 x 600. As always larger-dimensioned programs are available on request for those willing to part with additional licence money!
- 14) The conventions by which array dimensions are defined has been altered such that multipley-dimensioned array lengths such as (3,3000) are now coded as (3,(3000)) in order to simplify re-setting maximum network dimensions. This is only of interest to programmers who will no doubt be wondering why I am so obstinate in not using “parameters” - old habits etc. etc.
- 15) Both **SATDB** and **P1X** now match links which are, e.g., simulation in one network but buffer in another or vice-versa. Thus if you convert a buffer network into simulation it is now possible to compare flows in the two networks either graphically or in tables.
- 16) A series of tutorial or “how to” batch files has been set up in order to demonstrate specific features of **SATURN** interactive programs. For example, there is a How procedure to demonstrate how to obtain a Selected Link Analysis within **P1X**. See 9.1.8.

D.5.2 GIS Files

The functions and contents of **SATURN** GIS files have been considerably extended within **SATURN** 9.1, as have the number of programs which can make use of the data contained within.

In particular data contained in GIS files are now used by both network- and matrix-based programs and the name of the GIS file associated with either a network or trip matrix is now stored on the ufs/ufm files so that, if required, the correct GIS file

can be opened and accessed when and as required. Thus, for example, **SATLOOK** now has access to the link and node name information held on GIS files and prints this information out as appropriate. To enable this to happen new (character) parameters GISFIL have been added to the Namelist parameters read from .dat files by **SATNET**, **M1** and **MX**. See Sections 6.3.4 and 10.2.3.

Data encoded within GIS files has been extended to include the following:

- ◆ Node, zone and/or sector alphanumeric names;
- ◆ Link names.
- ◆ Co-ordinates for links which are “curved” as opposed to straight lines. (See section 9.4.2.7)
- ◆ X,Y co-ordinate data (identical to that input to SATNET)

Unfortunately it has been necessary to modify the GIS file formats from those previously set up under **SATURN** 8.4 to accommodate the new features. Full specifications are given in Appendix Z. It is however possible to re-format old files with a bit of programming or clever use of spreadsheets; Mike Hall or Dirck Van Vliet can advise.

It should also be noted that GIS files may now be set up relatively painlessly using mouse controls within **P1X**; see 9.4.6.2.

D.5.3 Time Period Modelling - PASSQ Options

The facilities which allow **SATURN** to carry out “quasi-dynamic” assignment, the use of PASSQ and linked time periods, have been considerably simplified by the introduction firstly of “.ps” files and secondly by the option to define data for several time periods within a single network data file. These options are described in Sections 15.2.3 through 15.2.6.

The ultimate objective is to make it as convenient to run and to analyse linked time periods as it is to run and analyse static or single time period networks. However certain programs (see **SATSUMA** in 15.2.6) are still not completed so that full facilities will be included in **SATURN** 9.2.

D.5.4 SATNET

- 1) Default speed-flow curves as identified by the capacity index may be defined within the 3333 buffer network data. This facility removes the need to code speeds and capacities more than once for similar buffer links. See Section 15.9.4.
- 2) Capacity indices for simulation links may be included on the mid-link capacity restraint records. See Section 6.4.1. They may also be used in conjunction with the default speed-flow curves coded under the 333 records to define simulation mid-link speed-flow or capacity-restraint data. See the specification for Record Type 2B in Section 6.4.1 plus Sections 6.4.12 and 15.9.4.
- 3) The “SHANDY” option allows input link distances to be checked against crow-fly distances calculated from node co-ordinates and zero-coded

distances to be replaced by crow-fly distances. See 15.10. This option applies both to buffer links and simulation links.

- 4) Comment cards are now permitted throughout the input .dat files following the convention that a "*" in column 1 denotes a comment card; see Section 15.29.
- 5) The logic by which the terminating '99999' records are detected has been "improved" so it is possible that certain existing files will no longer be correctly interpreted. Thus a 9 in column 1 followed by blanks is a valid 99999 record. This avoids problems under the DUTCH options whereby node numbers > 99999 could lead to confusion.
- 6) Simulation centroid connectors may now be defined as going to a single node, although this will be interpreted as a set of links either to or from that node. See the notes added to Section 6.5.
- 7) Coding bus route has been made considerably simpler by removing the need to specify the "number of nodes" entry and by allowing free format entries of the node numbers (i.e., the nodes need not be in fixed columns). This option is controlled by setting a parameter 'EZBUS' to .TRUE. See Note 4, Section 6.9
- 8) An \$INCLUDE option in the input .dat files switches input to a sub-file within the 44444, 55555, 66666 or 777777 data records. See Section 15.30.
- 9) The formats used to define X,Y co-ordinates on the 55555 data records may now be user defined via a parameter XYFORM - see Section 6.3.4 and note (7) under 6.8. This option is very useful for networks whose X,Y values are taken directly from Ordinance Survey data bases whose "standard" widths exceed 5 digits or are most easily expressed with a decimal.
- 10) Extra information/messages is now included in the summary table of errors using text contained in the file SATTIT.DAT. Thus if, say, error 115 has occurred 26 times a message will appear saying that error 115 is caused by "making bad jokes" or whatever so that users will not need to search through the lp file to find out what 115 is all about.
- 11) The name of the .UFS file being updated may be set within an input .DAT file as an alternative to setting it within the call to the bat file or procedure. See 6.1.

Equally the filenames of the trip matrix and GIS file associated with the network may be defined under &PARAM. The names of these files are then carried forward within the .ufs file structure so that they may be automatically opened and used by later programs as required. See Section 6.3.4.

- 12) A new parameter DEFCAP sets the default road capacity per link on out-bound external simulation links. This has no effect on simulation results or delay calculations but may effect graphical listings of capacities or V/C ratios. See parameter DEFCAP in Section 6.3.3.

- 13) Under certain circumstances the output binary file from **SATNET** is now given an extension .UFN rather than .UFS so as to avoid confusion with the output files from **SATALL** and/or **SATURN**.
- 14) Bus names may now be “alpha-numeric” as opposed to pure numbers as previously. This means that the manner in which they are referenced, e.g., in **P1X**, has changed in that they are now referred to by their SEQUENTIAL number.
- 15) An “informative title” may be included after the 77777 record (but on the same line) to give a title for, e.g., the set of screenline counts that follow. However the name is not used in very many displays as of yet.
- 16) A new parameter NUCMIN introduced to set a lower limit on permitted values of NUC. See 6.3.2.
- 17) A new parameter BUSKER allows a complete set of bus route data with every node included to be output to a “network.bus” file.
- 18) Bus route names are now stored as “alpha-numeric” rather than as pure numbers. Existing dat files are still acceptable; the differences only become evident in the way in which bus routes are selected, e.g., in **P1X**. See 6.9.

D.5.5 SATEASY and SATASS

SATEASY and **SATASS** continue to co-exist in 9.1 with virtually all of the functions of **SATASS** now contained in **SATEASY** (with the exception of PIJA calculation). The intention is to phase out **SATASS** as quickly as possible and replace it by **SATEASY** (although the program name may revert to **SATASS** for continuity). Some of the changes noted below refer to only one program; if not so noted they apply to both.

- 1) Output statistics from the assignment now have a higher level of disaggregation by, for example, capacity index.
- 2) A parameter has been included (SEED) which, if FALSE, excludes the calculation of PIJA's if the corresponding element T_{ij} in the trip matrix equals 0. This can result in considerably smaller UFP files (which can be HUGE!) and reduced cpu time to run **SATME2**. See Section 7.6.2. (**SATASS** only)
- 3) A check is included that the zone names on the trip matrix file are identical to the zone names on the network file; if not a warning message is given.
- 4) A list of the 10 worst converged links between assignment and simulation is now given in line printer output as an extra indication of where any lack of convergence between simulation and assignment is based. (**SATEASY** only)
- 5) The batch procedure **SATURN** has been modified such that, for pure buffer networks, the final output file is now a .UFS file, not .UFA so as to be similar to the output from a simulation network. The “intermediate” file output by **SATNET** is renamed as “.UFN”.
- 6) Elastic options in **SATEASY** calculate an approximate elasticity for the trip matrix as a whole and print warning messages if the values get too large.

D.5.6 SATSIM

- 1) Fuel consumption statistics per simulation link as calculated within **SATSIM** are now stored as a Dirck Access array 1503 in UF* files in units of total litres within the time period.

Equally the numbers of primary and secondary stops per turning movement are stored as arrays 1523 and 1533, and the mean simulation link delay in seconds per pcu is stored as array 1513.

Thus all 4 are now available for, e.g., graphical display within **P1X** or for manipulation within **SATDB**.

- 2) Output simulation statistics explicitly differentiate between totals which are accumulated WITHIN the time period simulated and those which occur in the next time period due to queues at over-capacity junctions. These are stored within the UFS files so that the same data may also be displayed by **SATLOOK**. See Section 15.1.4.

D.5.7 SATALL

The new program **SATALL** in effect combines the programs **SATEASY** and **SATSIM** into a single program as well as carrying out a full convergence loop between the two. Thus the output file contains both converged assigned flows plus the corresponding simulated delays.

By combining two programs into one **SATALL** should be both faster and, ultimately, “more clever” in terms of the steps that can be automatically introduced in order to improve the rates of convergence. However at the time of writing **SATALL** simply follows the simple logic of the **SATASS/SATSIM** loops.

Documentation is contained in Section 18.

- 1) **SATALL** features better screen report formats, including loop convergence statistics from the assignment-simulation loop as well as convergence statistics from each procedure individually in a format that does not “scroll off” the screen before you can read it.
- 2) It also requires an input file (from **SATNET**) with extension UFN rather than UFS and outputs a final file with standard extension UFS even if the network is pure buffer. (N.B. The renaming of the output file from **SATNET** from .UFS to .UFN is taken care of within the bat procedure.)
- 3) Convergence statistics comparing simulation totals between successive simulations are included within the **SATALL** line printer output and provides another method for gauging the overall convergence of the assignment-simulation loops.
- 4) The statistics for comparing flows between successive assignments (in addition to “ISTOP”) now include a mean GEH statistic, relative mean absolute difference and relative standard deviation. The GEH statistic also appears in the new screen report mentioned under 1 above.

D.5.8 P1X

- 1) A large number of input and/or choice operations may now be executed via the use of a mouse (see Section 9.1.7). In general these are entered through the key stroke M following a standard network plot; subsequent choices are indicated by the menu in the banner. In particular the mouse may be used to:
 - a) change XY co-ordinates
 - b) re-define the window
 - c) define a cordon (and produce a control file for SATCH)
 - d) select nodes for graphical display
 - e) request select link re-assignment
 - f) define bus routes (for output to a file)
 - g) define joy rides
 - h) define counts (for output to a file)
 - i) display trees, forests, etc.
 - j) create/edit GIS files
 - k) request link or node based information for display in the banner.

Further information on these options is best obtained by direct experimentation; some help menus are being prepared but if they are not available, please be patient!

Note that option M is only displayed if the mouse option is “activated” within the system/device menu (option 15); the default setting on/off is controlled by a parameter set within P1X0.DAT which may be customised by users.

- 2) The manner in which annotated link data is handled has been brought into line with the concept of a data base as used in **SATDB** with the consequence that the majority of options from **SATDB** are now included in **P1X**. Hence **P1X** and **SATDB** have been effectively merged.

For example data may be viewed in a tabular format on the screen or dumped to the line printer file, statistical tests may be carried out, etc.

Link annotation data, as selected from a menu, may now either be stored in the “permanent” data base or, under a “pick and plot” option, it may appear directly in a plot without being permanently saved. This saves a good deal of time if you are simply “browsing” through the data by reducing the number of instructions necessary to get data up on the screen. In addition, if you are happy with the data, you may ask to have it permanently stored in the data base.

- 3) In a similar manner the “node graphics within P1” options have been extended such that many of the options within **SATED** may now be accessed from **P1X**. For example you may now “edit” simulation nodes from



within **P1X**, although for the moment this may only be done on an “experimental” basis - options to permanently save changes will be added as time permits.

- 4) More options now use data stored on the GIS files in addition to there being a greater variety of data on the GIS files themselves; see H.2 above. Thus **P1X** can now display:
 - alphanumeric names for links
 - node names
 - curved roads
 - more “IKONS”: Church, car park and hospital
- 5) Options have been added to update existing network .dat files by adding, via the mouse, new bus flows and/or new count data. Thus **P1X** complements the use of **SATED** to update the simulation network data within a .dat file. The intention is that eventually a single graphics-based program will be able to update/create all sections of a network .dat file working solely with mouse and/or screen editing facilities. Equally a .gis file may be updated or created from scratch; see 9.4.6.2.
- 6) Sub-files containing bus, count and xy data may be created directly within **P1X**.
- 7) A wider range of node data, e.g. V/C ratios, is available within network plotting.
- 8) An “overlay” option has been added within the tree menus such that successive trees appear superimposed upon the same plot with each tree appearing in a different colour.
- 9) Desire lines for matrices may be plotted, i.e., lines directly linking an origin and destination whose width is proportional to the trip matrix element. Options also exists to direct the line via an intermediate point so that a trip matrix representing trips through an interview station will actually pass through that point. Enter the matrix option menu for further explanation.
- 10) When matrices are displayed it is possible to “filter out”, say, rows/columns with very low values to avoid “cluttering up” the display.
- 11) Stacked matrices may be displayed (but only a single level can be selected at a time).
- 12) A number of additional methods to highlight “selected” links have been added, largely replacing the use of “zig-zag” lines by solid in-filled bands.
- 13) Similarly the width and/or colour of a link may be determined by its link capacity index; e.g., motorway links may appear as solid blue lines, etc. Default widths/colours may be entered in the default parameter file P1X0.DAT or edited interactively using a screen edit window.
- 14) Data annotation may be requested only on selected links.

- 15) Data from two networks could previously only be annotated by, e.g., 2/1 ratios; now they may also be annotated “in reverse” as 1/2, etc.
- 16) More options have been added in order to “force” annotation to appear.
- 17) Mid-link capacity has been added to the list of “standard” data items such that information on such links may be more easily obtained.
- 18) A further standard data entry is the difference in link flows between successive assignments (runs of **SATASS**) plotted as a GEH error statistic. This allows the user to help to identify those sections of the network where the **SATASS/SATSIM** convergence is poor.
- 19) Numerically annotated link data, as well as appearing as numbers parallel to the link, may now also appear “horizontally” within “data boxes” which are joined to the centre of a link by a “twig”. This removes some of the problems associated with poor resolution of numbers on the screen when written at an angle.
- 20) Demand/accept flows are now distinct options for annotation to avoid the previous confusion.
- 21) Simulation link arrays may be selected for annotation using their DA code, not just assignment links.
- 22) The mouse-based cordon selection may also be used to blank off selected areas; e.g., mouse cordon.
- 23) Plots may be overlaid by grid lines, either at fixed intervals or a fixed number per side
- 24) Plot titles may now be up to 76 characters long (the previous limit was 40).
- 25) The default parameter file P1X0.DAT has been set up in order to allow users to “customise” default options; see 9.4.10.
- 26) A parameter in P1X0.DAT determines whether or not you start with a full network plot or go straight into the first menu.
- 27) As a consequence of the new methods for handling annotated data the two scratch files 3 and 4 are no longer used; non-programmers will notice no difference whatsoever!
- 28) A simple option to reverse the selection has been included; e.g., if you select all links above 500 pcu/hr you can “toggle” to those below.
- 29) Turn-based data held in the (**SATDB**) data base may be displayed either as “turn data” within a network plot or as part of the node graphics.
- 30) Nodes to be annotated may be selected by their node type; e.g., traffic signals only.
- 31) An option to obtain scatterplots of one variable data column in the data base against another (e.g., modelled flows versus counts) may be obtained through the STATISTICAL ANALYSIS options shared with **SATDB**.



D.5.9 SATED

The role of **SATED** has changed significantly. Originally it was very much a program that could only be run AFTER a full run of **SATURN** in order to experiment with alternative simulation node definitions. Gradually options were introduced so that the experimental changes could be stored in either the UFS files or (partial) network data files.

The latter function has been extended so that **SATED** may now be used essentially as a **SATURN**-specific editor to prepare network data files prior to input to **SATNET**. This is done via a series of screen-editing window-based options in which correctly formatted node data files may be created on-line or existing data files may be edited. Both functions are entered via option 5 in the master menu. It is hoped that this function will be of great use to users who have to prepare simulation node data for a large network.

More specific changes include the following:

- 1) A bug in previous versions whereby simulation link speed-flow data was not output by **SATED** has been corrected and full facilities to set and/or edit such data are included.
- 2) If a distance is changed for a link (A,B) it is also changed by default for (B,A)
- 3) Simulation node co-ordinates may be set/alterd within **SATED**.
- 4) An option has been added to allow the user to automatically loop over all entry links at a node/all turns from a link when in "edit mode".
- 5) A default parameter file SATED0.DAT is required in order to allow users to "customise" any default parameters.
- 6) The master menu now offers explicit sub-menus for both Files and Parameters.
- 7) Three new options have been added for signal optimisation (although the three new ones are basically research only and should probably be avoided) and maximum stage lengths may be specified (in addition to minima) for the "standard" option. In addition the choices are now made within a menu.

D.5.10 Graphics (SATED and P1X)

- 1) Node graphics plots may now (optionally) include a title and the banner may be excluded (as in network plots).
- 2) Hard copy graphics devices which do not allow "in-fill" options, i.e., pen plotters, now are programmed with a fairly crude in-fill option using closely spaced lines.
- 3) An option has been included within the screen/device graphics menu (accessible from both **P1X** and **SATED**) to allow an existing .pcx file to be read in and therefore displayed on the screen. See 9.4.7.
- 4) Output to HP laser jet devices is now (we think!) possible; see GRAF.DAT for documentation on how to set appropriate data in GRAF.DAT.

- 5) Up to 20 separate devices may not be listed in GRAF.DAT.

D.5.11 SATDB

- 1) A major change is to introduce a screen--edit function within the “view data on the screen” option, thus allowing users to change data within **SATDB** rather than having to export it to a different program, e.g., a spreadsheet or editor.
- 2) One of the “create new data column” options allows you to “transfer” data either from a link to its exit turns or from all turns to a link, e.g., to aggregate turn data and to store it as link data. Thus one could aggregate turn delays to produce a total link delay, or divide link flow between its turns. This opens up a range of operations which previously could only be done by “programming”.
- 3) An option has been introduced to automatically loop over multiple user classes within selected link assignment.
- 4) Multiple data columns may now be read from input .dat files instead of just a single data entry with the data read in free format; see 9.8.3.
- 5) Non-defined links under miscellaneous input may now be set to a default value, e.g., 0, instead of being assigned missing values.
- 6) Alphanumeric link names from a GIS file may be set up as a “data column” in the link data base.
- 7) Option 8 under the Assignment/Tree Build option calculates turning volumes at buffer nodes, stores them (not very usefully) in the data base and (more usefully) prints turn matrices at selected nodes or for all nodes to the line printer.
- 8) This option does not “sit very comfortably” within **SATDB** so that it will reappear elsewhere in due course.
- 9) Both counts and the associated count set number may be read in simultaneously.
- 10) Statistical analysis may be disaggregated BY values in another data column, e.g., disaggregated by capacity index or by count set number.

D.5.12 SATLOOK

- 1) Options have been introduced to allow users to skim generalised costs in cost units as opposed to effectively forcing them to appear in units of generalised time as previously.
- 2) Skimming “forests” as opposed to skimming “trees” is now allowed; see Section 15.27 for a full description. This is now option 9 so that the old option 9, the very early version of **SATDB**, no longer exists. Any facilities there are now much be more easily handled within **SATDB** itself.

D.5.13 MX

MX has been greatly extended under 9.1 so that not only does it incorporate a number of entirely new functions, it also includes virtually all of the functions previously carried out by the individual programs **M1** to **M7**. Thus, although the latter programs are still included within **SATURN** 9.1, they are only there to provide continuity and users are advised to migrate to **MX** whenever feasible. It is intended, at a later stage, to produce a set of “**M1** etc emulation” bat files which have the same format as the current **M1**, **M2**, etc, bat files but will actually work by calling **MX** with a relevant key file.

- 1) A screen-edit/window option to interactively change data is now included as a sub-option available from within the “display on the screen” option. In addition to editing an existing matrix on a cell-by-cell basis this also means that you can create a matrix entirely “on screen” without first producing a correctly formatted .dat file. This should be of great benefit to users producing either small matrices from scratch or making minor changes to larger existing matrices.
- 2) The internal matrix file within **MX** may now be built directly from an input .dat file, not just .from ufm files. This enables **MX** to perform the essential operation, previously only handled within **M1**, of creating a .ufm file from a .dat file. In addition a wider range of input data formats can be handled, thus making the job of accessing matrix data from other suites potentially easier.

Alternatively a “flat” matrix can be created with equal values in each cell as a starting point.

- 3) **MX** now can dump output ASCII files in the form: I J Tij with one record for each non-zero matrix element. The same format is also allowed for input. The precise format may be user-set. This should improve transferability of data between SATURN and other similar suites of programs.
- 4) Row and column totals are now included as the last row/column in ij print-outs.
- 5) Any screen listing of matrix elements now goes to the line printer file as well as to the terminal.
- 6) **MX** now reads from a GIS file associated with the matrix. In particular alpha-numeric zone names are read from an input GIS file and these are included in the print out of row and column totals.
- 7) New trip ends for matrix furnessing may now be set up using a screen edit or window-style input format.
- 8) A new unified format has been created for the input .dat files used in **M6** matrix furnessing to define new trip ends; see Section 10.9.4.2. This includes, e.g., both definitions of row and column totals directly plus row and column changes; previously different sorts of information were contained in distinct files. Equally an option has been created which outputs trip end totals in the same “standard” file formats.
- 9) The STACK and UNSTAK options from **M1** have been included in **MX** under option 15 from the Master Menu.

- 10) The functions to compress and/or re-code matrices as previously provided by programs **M3/M4/M5** are now included under the ufm output options. In each case an input .dat file must be prepared which follows with minor exceptions the control files previously used by **M3/M4/M5**. Format specifications are given in Section 10.9.4.
- 11) Trip length distribution option (from **M1**) is included as an option under "STATISTICS" from the Master Menu.
- 12) Most print formats have been adjusted to allow for 5-digit zone numbers - although their use is not particularly recommended as it leads to complications elsewhere.

D.6 Changes in SATURN 9.2

SATURN 9.2, first released in May 1995, contains a number of minor changes from 9.1, mostly in graphics and mouse-based facilities, but at the same time is part of a continuous development. Thus the basic structure of both the network and matrix ASCII data input files and of the various binary UF files is essentially unchanged and files created under 9.1 or before should still be compatible with 9.2 (although the converse is not true - files created under 9.2 will almost certainly not run with earlier programs.)

The exact order of inputs in “key” files is likely to have changed.

The following sub-sections describe, firstly, general new features of 9.2, followed by a description of new programs included in 9.2 for the first time and concluded by a note of changes to individual programs.

As with all new software releases there is always a greater chance of bugs appearing in new components than old. Most of the new features listed below have been adequately tested and many of course are relatively simple such that either they work or don't work. However others have either only been introduced very recently or are the sort of code that, from painful experience, works 99.99% of the time but fail under very specific or unusual circumstances. Bugs in the latter category may take years to emerge.

Therefore new features which we feel may be somewhat “dubious” are indicated by the symbol ⊗ below. This is not to say that we do not recommend their use, indeed we would positively encourage users to try them and to alert us to any problems that arise.

References are made to sections in the Documentation where full details may be found.

D.6.1 New General Features

- 1) Missing or “unfindable” control and help files no longer generate fatal errors but only non-fatal errors. In the event of a missing control file all default values are taken (as would normally result if the control file were simply a “dummy” file).
- 2) Generally speaking these errors occur when the files exist in a sub-directory where, for one reason or another, the program does not search “rights” so that the solution may be to change an “APPEND” or equivalent definition.
- 3) The contents of the essential file SATKEY.DAT has been extended so that certain universal parameters applicable to all programs may be user set, for example the number of lines on the VDU screen or a pathname “prefix” for help files which may also help solve problems in locating help files stored in standard directories. See Appendix Y.
- 4) HELP files are now set up as “direct access files” which gives the advantage of considerably faster access. It does however mean that the .hlp files from earlier versions are no longer valid (since they are not direct access) and that the current versions occupy more memory.

In addition if you wish to modify any help files for local conditions you must ensure that the edited file is a correctly formatted direct access file. A DBOS facility, MAKEDA77, is included on your DBOS disc - type MAKEDA77 and follow instructions.

See Section 9.1.2.

- 5) Fuel consumption equation coefficients may now be user set via namelist parameters input to **SATNET**, see 15.32.
- 6) Bat files MXM1, MXM2, etc. duplicate the original functions of **M1**, **M2** etc but use **MX** - see 10.1.5.
- 7) In order to provide compatibility between runs of 9.2 and previous runs a logical variable PRE92 is introduced. If TRUE this “de-activates” a number of new features introduced in **SATURN** 9.2, e.g., any new checks on recently discovered potential bugs.

Note that this does not guarantee that you will get 100% strict agreement with previous runs (and equally the results might well not differ even with PRE92 = FALSE); the use of new compilers and/or new machines also has an effect.

This is intended to become a standard feature with each new release. Thus a PRE93 parameter in 9.3 will similarly de-activate any new code in version 9.3 when released.

- 8) An option to automatically optimise green times at **all** signalised junctions has been introduced into **SATED** to complement **SATOFF** which optimises offsets. This is a much requested feature, but one which should be used with caution as its repeated use may well give unrealistic results. See 15.31. Try HOW6.
- 9) The number of “HOW” tutorial files has been extended; users are strongly encouraged to try it out! Type “HOW”. See 9.1.8. Where specific HOW files have been created in order to demonstrate near features of 9.2 these are indicated below.
- 10) Extremely rough ‘n’ ready estimations of standard emissions - CO, CO₂, NOX, hydrocarbons and lead - are now provided; see 15.33.
- 11) Standard pc versions are now compiled under version 3.0 of Salford FTN77 and also user version 3.0 of DBOS. You will therefore need to install the new version of DBOS.
- 12) The format of GRAF.DAT has changed (although old versions are still compatible) and a new option to allow “proper” infilling on devices such as laser printers has been included. See GRAF.DAT itself for details.

D.6.2 New Programs

SATPIJA + SATME3

SATPIJA is a new program which produces a UFP file from an existing UFS (or UFA) file created with SAVEIT = T. It therefore duplicates the role of **SATASS**

and (see I.4 below) means that all functions of **SATASS** are now carried out by either **SATEASY** or **SATPIJA** (plus other functions of course).

However the exact form of the new UFP files differs from those produced by **SATASS**; hence an upgraded version of **SATME2**, called **SATME3**, is provided to be used in conjunction with **SATPIJA**. Otherwise **SATME2** and **SATME3** are indistinguishable.

See 11.7 for a full description of both programs.

SATSUMA

SATSUMA combines together a series of .ufs files from successive time periods run using the PASSQ option in order to produce a new form of UF file, a .uft file, in which, for example, the flow record gives a suitably averaged flow, the summary totals add together each time period without double counting any effects due to vehicles queued at the end of one time period, etc.

It is hoped that this program, along with the easier options for running multiple time periods introduced in 9.1, will make applications of PASSQ far more user friendly, and that a quasi-dynamic version of SATURN will more accurately reflect some of the detailed behaviour of time-varying flows in peak periods. See 15.2.6.

SATNET

- 1) An increased range of namelist parameters has been provided, most of which are “carried forward” and used in later programs. These include:
 - ◆ Elastic assignment parameters MCGILL, etc; see 6.3
 - ◆ PCNEAR; see 8.7.1.
 - ◆ Wardrop assignment stopping criteria UNCRTS, XFSTOP and FISTOP; see 13.5.1.
 - ◆ Fuel consumption coefficients; see 15.32
 - ◆ PARTAN; see 13.5.7.
 - ◆ PRE92; see I.1 above
 - ◆ SIGOPT; see 15.31.
 - ◆ ERTM; see 6.3.1.
 - ◆ WINDY; see 6.3.1.
 - ◆ Emission coefficients; see 15.33.

Additional file names may be defined under namelist including (see 6.3.4): CIJFIL, a file name for the cost matrix used under elastic assignment

D.6.3 Assignment Programs

- 1) The old assignment program **SATASS** has now been virtually totally replaced by **SATEASY** which carries out all the functions of **SATASS** apart

from PIJA analysis which is now handled by **SATPIJA** (see I.2 above). Thus the 9.2 **SATURN** bat file calls **SATEASY** rather than **SATASS**.

- 2) All elastic equilibrium parameters such as MCGILL may now be defined within **SATNET** and transferred via the .ufs files through to **SATEASY** including a character variable CIJFIL that pre-defines the cost matrix file name (see I.3 above).
- 3) The stopping criteria for Wardrop equilibrium may now be user set; see 10.1.5.
- 4) A new parameter ASHORT has been introduced in order to optionally replace the assignment statistics listed at length within the output line printer file by a much briefer summary table at the end. See 6.3.1.
- 5) A logical option, ERTM, to allow negative T_{ij} to be assigned has been created but is definitely not recommended; see 6.3.1.

D.6.4 Simulation Programs

- 1) Link delays (i.e. on links with speed-flow curves defined) are included as a separate component in output statistics.
- 2) Upper limits have been introduced on the delays both within the time period simulated (MAXDTP) and to permanently queued traffic at the end of the time period (MAXQCT); see 8.4.1.
- 3) Bat files produce different messages for assignment/simulation iterations which “converge” (i.e. satisfy ISTOP) and those that are “terminated” on maximum iterations.
- 4) A number of changes have been made to the way in which delays are calculated at simulation turns. Some, mostly minor (see I.12), are related to delays at zero or near zero flows and will have little practical effect. Others relate to give way turns sharing lanes with non give-ways and may be more substantial.

Preliminary results suggest that these changes **may** improve the convergence of simulation-assignment loops in previously badly behaved networks, but on **SATURN** it is notoriously difficult to generalise.

These changes may, if desired, be de-activated with the PRE92 parameter - see note 6 in I.1.

D.6.5 SATALL

- 1) The length of the LP output file may be significantly reduced by making use of summary tables for assignment statistics by iteration via the new parameter ASHORT described above.
- 2) By setting a parameter SIGOPT = T it is now possible to automatically optimise signal stage green times once within each simulation. This is still very much an experimental research-only facility but it is available; see 15.31.

- 3) The convergence measure of “flows within 5% of their previous value” has been changed such that the 5% is now a user-set parameter PCNEAR; see 8.7.1 and 6.3.3.
- 4) New convergence statistics have been added to the window displays; see 18.4.

D.6.6 SATED

- 1) Nodes may be edited using full graphical display and with instructions in the banner, in particular signal stages may be so defined and stage inserts appear as they are created.
- 2) A choice of stage length signal optimisation algorithms is now available; see 15.31.

D.6.7 SATDB

A preferences file SATDB0.DAT has been introduced; see 9.1.9.

D.6.8 P1X

- 1) The way in which GIS files may be either created or extended has been made more “random access” in that the various sub-sections may be amended in any order or more than once. The banner display has been generally improved as well.
- 2) Options to cancel all current link annotation added.
- 3) There is a new facility to store/recall former window definitions including the previous window definition; see 9.4.2.1. It is planned to extend this facility such that useful window definitions, once created, can be permanently stored, e.g. as part of the preferences file.
- 4) There have been minor changes in GIS file definitions:
 - ◆ Add a zone number plus title to polygons
 - ◆ Line widths can be in units of “metres on the ground”
 - ◆ See Blocks 1 and 2, Appendix Z.
- 5) An “Information” option has been included within the mouse-based options in order to obtain detailed information listed within the banner on either nodes, links or zones. Try HOW5.
- 6) Scattergrams of, e.g., flows vrs counts are available through the statistics sub-menu of the database options. Try HOW4.
- 7) Histograms of matrix frequencies and trip length distributions are available via the matrix display options. Try HOW7.
- 8) A “node selection” menu has been added which allows, for example, node data to be displayed only at signalised junctions. Try HOW8.

- 9) A limited number of options from **SATLOOK** are now available via an option (27) within the main text-based menu.
- 10) An option to output an updated .ufs file which can include modifications to simulation nodes introduced via the node graphics has been introduced. (Previously you could “edit” nodes but could not “save” the results.)
- 11) An option to issue a “DOS” command from within the graphics system/device menu allows you to, e.g., print files without exiting from **P1X**.
- 12) An explicit left-hand margin has been added for better printing for bound reports (within the General Display Menu).
- 13) Output devices may be connected via ports COM1 to COM4 or LPT1 to LPT4 (within the System/Device Menu).
- 14) Rectangular plots may be “centred” within the plot so that the full height/width is available for the banner.

D.6.9 MX

- 1) The options available to either dump .UFM files into ASCII files with user-set formats, or equivalently to read matrix input from ASCII files in non-**SATURN** format have been considerably extended. See 10.9.4.7.
- 2) Row/column sums may be disaggregated by level for stacked matrices.
- 3) A preferences file MX0.DAT has been introduced; see 9.1.9.
- 4) A new bat file, MXX.BAT, has been created with an easier format for multiple matrix input. Type MXX for information.

D.6.10 SATLOOK

- 1) Both assignment and simulation summary totals are optionally printed in both “F” and “E” formats, where E-formats are particularly useful for very small numbers which tend to otherwise be printed as 0.00 or very big numbers which appear as *****.
- 2) When producing cost or skimmed matrices from multiple user class networks it is now possible to produce stacked matrices directly with one level per user class. Useful for input to elastic multiple user class assignment using **SATEASY**.



D.6.11 BUGS

A number of “bugs” have been detected in the calculation of simulation delays in **SATURN** 9.1 and, by implication, in earlier versions. These range from the correction of extreme anomalies with few practical implications to what could most accurately be described as “silly errors”, particularly with respect to give way turns, which, under the most unfavourable conditions, can give quite significant changes in calculated delays. Overall, however, differences in, say, total simulated vehicle-hours between **SATURN** 9.2 and earlier versions are, generally speaking, not large.

One example of “anomalous delays” occurred at signals with shared lanes and zero or extremely small flows (e.g. 0.00001 vph) with reported delays of 5 or 6 figures. Since the product of flow and delay was either zero or near zero this had no effect on summary statistics, but still looked fairly dubious.

One positive result of the “tightening up” of delay calculations within the simulation is that the overall level of assignment - simulation convergence can be improved. Further information is given in I.5.

D.6.12 DOCUMENTATION

In addition to minor alterations throughout and new sections noted above the following sections and/or sub-sections have been added:

- 9.1.9 Preferences Files
- 10.9.4.7 Non-Standard **MX** Data Input
- 11.1.5 Convergence of Matrix Estimation and Assignment
- 13.1.5 Stopping and/or Convergence Criteria for Wardrop Equilibrium
- 13.2.5 The Convergence of Stochastic Assignment
- 13.5.7 Partan Assignment
- 14.7.4 Comments in Key Files
- 14.7.5 Ascii Keys and Mouse Commands within Key Files
- 15.1.4 Network-based Simulation Summary Statistics
- 15.27 Skimming Trees and/or Forests

As always readers of the hard copy, word processed documentation need to be aware that, since these are only released at intervals, the ASCII documentation files supplied on disk with the .exe files may well be more up to date. In case of discrepancies between the two believe the ASCII files!



D.7 Changes in SATURN 9.3

SATURN 9.3, first released in September 1996, contains a number of major changes from 9.2, in particular within **SATALL** and **P1X**. However the basic structure of both the network and matrix ASCII data input files and of the various binary UF files is essentially unchanged and files created under 9.2 or before should still be compatible with 9.3 (although the converse is not true - files created under 9.3 will almost certainly not run with earlier programs.) The exact order of inputs in “key” files is likely to have changed.

The following sub-sections describe, firstly, general new features of 9.3, next a description of new programs included in 9.3 for the first time and finally notes of changes to individual programs.

References are made to sections in the (latest) Documentation where full details may be found.

D.7.1 New General Features

- 1) Under DOS the .exe and .bat files have been restructured such that it becomes easier for programs to “find” files in other sub-directories or, if they are not in the sub-directory where they should be, in another obvious sub-directory, e.g. your home directory. In part this is done by storing full “pathnames” in addition to “filenames” in the .ufs files. Thus if you ran SATURN on a file “network.dat” in sub-directory C:\SATURN\WORK the resulting .ufs would store both network.dat and C:\SATURN\WORK\network.dat. If you later copied network.ufs to a different sub-directory or even changed its name programs should still be able to locate its original .dat file.
- 2) The “\$INCLUDE option” may now be used within Namelist; see Appendix A, Note 16.
- 3) A bat+key procedure **SATBUF** has been written which uses **SATDB** to convert simulation networks into “best fit” equivalent buffer networks on a link by link basis; see 15.8.2.
- 4) A new “Directory Enquiries” option using the Salford subroutine SELECT_FILE@ for directory listing which lists the acceptable files in a window is optionally available.

D.7.2 New Programs

SATPIG

A new program SATPIG produces a complete set of route flows output to an ASCII file, i.e., for every route used by (positive) ij trips the number of trips assigned plus the node-by-node definition of the route is given. This may be used, for example, to interface **SATURN** with various micro-simulation packages. See 12.6.



SATNET

- 1) The output UF file is now always a UFN file, not UFS, and both the program and associated bat files have been so modified.
- 2) All variables used under elastic assignment or simulation may now be defined within **SATNET** and “carried through” as defaults. Hence the list of variables in Section 6.3 is considerably longer. The intention is now to minimise the use of separate control files at later stages in the assignment/simulation loops by setting all parameters for a network with **SATNET**.
- 3) Equally all file names which are used in subsequent programs, e.g., the cost matrix file for elastic assignment, may now be defined as namelist parameters in **SATNET** and “carried through” via the uf* files; subsequent jobs require fewer parameters in the command line. For example, it is possible to run an elastic assignment with a command such as “SATEASY network” without having to specify any further file names. See 6.3.4.
- 4) Certain default parameter values have been changed to reflect current usage more accurately, in particular:
- 5) SAVEIT (F to T), MASL (5 to 15), NITA (10 to 20), NITS (6 to 10), ISTOP (85 to 90)
- 6) New namelist parameters has been provided, including:
 - ◆ MIN/MAXLSF: error checks on lane saturation flows
 - ◆ FRED: to set an estimated trip matrix for elastic assignment, see 7.5.3;
 - ◆ NFT: to choose old **SATURN** versions
 - ◆ COMPAS: to sort exit buffer nodes into clockwise order.
 - ◆ KERMIT: buffer distances and times are defined in units of KilometERs and MInuTes (Obvious really and quite inevitable!)
 - ◆ SATTIT; see note 8 below
 - ◆ TIJMIN; lower limit on trip matrix cell values to be assigned; see 6.3.3 and note 3 at the end of Section 4.
- 7) The data formats used for any data input section may now be user-defined within the .dat files themselves. For example if you wish to have co-ordinates or link counts defined in different columns from the **SATURN** standards you may do so by inserting an extra record with the required format. See 15.35.
- 8) The value of MAXZN is automatically increased in line with the maximum zone number actually coded so that, in effect, it has become a redundant parameter.
- 9) The supplementary file SATTIT.DAT is no longer mandatory; if it cannot be found then default DA titles are taken from the program. In addition a name

list parameter SATTIT has been included such that if SATTIT = F the file is not referenced at all.

- 10) If the trip matrix is defined within **SATNET** checks on its validity are carried out in **SATNET** in addition to **SATALL** such that possible errors, e.g. inconsistent number of zones, are picked up at an earlier stage.

D.7.3 Assignment Programs

The old assignment program **SATASS** has now been virtually superceded by **SATEASY**, and **SATEASY** in turn by **SATALL**. The **SATASS** exe file will continue to be supplied with 9.3 but its use is not recommended.

Within elastic assignment it is possible to specify certain Tij's to be inelastic (i.e. "frozen"). See 7.5.5

The use of SUZIE = T with SUET = 0.0 to do MSA for Wardrop Equilibrium has been formalised and an extended set of convergence statistics, including delta values, are included. See Section 7.11.8. It may be used to indicate a minimum number of iterations for stochastic assignment. It may also be used under multiple user classes.

Iteration costs stored under SAVEIT are now held in a separate file with a .UFC extension instead of being included as part of the ufs file. They are also calculated with DIDDLE = T and with elastic assignment; i.e., all the time when SAVEIT = T. Being held on a separate file there is no longer any upper limit to the number of iterations which can be processed in this manner (as opposed to previous versions where there was an upper limit of 99). See 15.23.

Aggregate assignment statistics are printed out subdivided by capacity index.

Tabulated values of the objective function Z and total costs are now normally given divided (normalised) by the total number of trips which should make them somewhat easier to digest.

D.7.4 Simulation Programs

- 1) Blocking back occurs on centroid connectors in addition to blocking back on upstream links. Hence the "knock-on" impacts of blocking back are far less, particularly in situations where large centroid connector flows could totally block a link. See 8.5. Queuing delays on links and on (blocked back) centroid connectors are distinguished within simulation summary statistics. See 17.8.
- 2) As with **SATURN** 9.2 (see note 4 in I.5) a number of minor changes have been made either in the simulation or in the simulation/assignment interface which might be described as a general "tightening up" of minor problems. The net effect, however, has been a further significant improvement in the convergence of the assignment/simulation loop, especially near full convergence. If required these changes may be avoided by setting NFT = 92 (but certainly NOT recommended!).
- 3) A new array (DA code 1543) has been introduced which stores, for each simulation link, the total delay in pcu-hrs experienced by traffic on that link

WITHIN the time period simulated (including delays, if any, on centroid connectors due to blocking back). It includes both transient delays plus queuing delays (but, again, only WITHIN the time period).

- 4) The Weston Gap - a method for introducing flow-dependent gaps has been included but, as it is still experimental, not yet documented. Essentially it allows you to reduce a minimum gap of, say, 5 seconds at zero cross flow to 3 seconds if the cross flow reaches 100% capacity. If you think you would like to try it contact DVV.

D.7.5 SATALL

SATALL is now the “standard” procedure for running simulation networks as opposed to explicit loops over **SATSIM** and **SATASS/SATEASY**. It contains all previously available simulation/assignment options and has been proved to be sufficiently robust.

- 1) The length of the LP output file has been significantly reduced by the inclusion of summary tables for convergence statistics.
- 2) A greater range of convergence statistics are now output, for example in line with the latest British requirements in the Traffic Appraisal in Urban Areas Manual; see 9.8.
- 3) Automatic green splits may be calculated within **SATALL** via the parameter SIGOPT (and works better than before); see 15.31.4.
- 4) The option to run elastic MUC now works. See 9.11.
- 5) Turning flows at buffer nodes are now calculated and stored on the output UFS file (if SAVEIT and REBBUF = T) where they may be printed using **SATLOOK**; see J.10 and 15.36.
- 6) A gap function is calculated under (Wardrop) multiple user class and elastic assignment.
- 7) A “hot key” to stop runs has been introduced, i.e.; typing Q terminates an iterative run at the next simulation. See 9.7.
- 8) DIDDLE works under both elastic and fixed trip matrix and answers every user's prayers for improved convergence. Trust me! See 9.4.
- 9) “Continuation” runs of **SATALL** are now possible; e.g. if you run 20 simulation/assignment loops and think you would like 25 you can run 5 extra loops without having to re-run from scratch. See 9.7 and 9.12.

D.7.6 P1X

- 1) **P1X** has continued to swallow up large chunks of **SATLOOK**, **SATDB** and **SATED** such that most of the first two programs are now available within **P1X** and the node graphics in **P1X** already covers much of **SATED**. In addition most of the cordon facilities in **SATCH** may also be accessed via **PIX**; see 11.13.

- 2) The facilities to either create or extend GIS files have been enhanced, for example GIS items may be added in any order.
- 3) Excess travel time (i.e. delay) is accumulated and displayed on joyride routes.
- 4) The control file GRAF.DAT is now optional; if not found for any reason an internal default version is set up. See 11.3.1.
- 5) Banner menu choices may be made by mouse if a parameter “mini mouse” is toggled to “maxi mouse” within the System/Device menu. See 11.1.7.
- 6) An “arboretum” option has been added to the tree options - basically an arboretum is like a forest without the repetitions so it displays each distinct route used by an O-D pair and its proportion. See 15.26.
- 7) An option to provide interactive bus information is available through the Analysis Options; see 11.8.4.
- 8) Contour isochrones with in-filling added to the tree-build options - “a glorious riot of colours” (The Guardian).
- 9) A completely new set of “edit” functions have been added; e.g. to convert buffer nodes into simulation nodes (similar to old routines to **SATED** but better). Both the .dat files and the .ufs files may be updated. See 11.9.
- 10) The options by which the window may be interactively set using the mouse have been extended to allow the user:
 - ◆ to “drag” the window
 - ◆ to scale the window
- 11) An input .pcx file may be used to set the “background” to a plot so that the **SATURN** plot can “over write” an existing map if desired. See 11.3.5.
- 12) A “union” of two networks can be created such that the links included on the screen contain all those EITHER in network 1 OR in network 2. See 11.4.3.1.
- 13) Links now have a default “bandwidth” (as opposed to being just displayed as lines), defined within the general display menu. See 11.6.4.
- 14) Data annotation to “curved” links - as defined using GIS data - now “follows” the curve, not the straight line joining the two end nodes. (But only, to date, for numerical annotation along the link, data in boxes (the “twig” goes to the mid point of the curved link) and data in variable bandwidths.)
- 15) Select link analysis may now either be carried out for a single user class (for multiple user class networks) or for all user classes combined together.
- 16) PCX output files and outputs to the “alternative device” may optionally exclude the banner menu choices which automatically appear on screen. See 11.3.5.

- 17) Annotated link data may be “selected” by specifying upper and lower limits for inclusion; e.g. don’t include zero’s. See 11.6.2.
- 18) Networks which are, e.g., long and narrow may now optionally be “centered” within the full available screen to avoid problems with the banner being “squeezed” along the shorter dimension of the plot so that full information is not given. See 11.5.

D.7.7 SATDB

- 1) An option to selectively assign trips relative to their distance from the origin, i.e., to differentiate cold starts, has been incorporated in SATRAP. See 15.37.
- 2) Turn data may be aggregated up into link data, either as a straight summation or as a flow-weighted sum. For example, you may add up stops per turn to obtain total stops per link.
- 3) The % green time per turn or link is available as standard data.
- 4) The option to read in miscellaneous input data from an ascii file will now (a) read centroid connector data (in the same format used to dump it from **SATDB**) and (b) not exit if it comes across any text in the file (such as namelist data). This provides an alternative, and in some respects more natural method, to “dump” data (using option 13) and to read it back again (e.g., post editing) via the miscellaneous facility. See 11.10.3.
- 5) Four columns containing the X and Y co-ordinates of the link A-node and B-node may be added from within the Miscellaneous Options; this is useful for passing link data into external GIS systems.
- 6) Various options now facilitate replacing missing values - either in existing columns or when created - by default numerical values, e.g. zero.

D.7.8 MX

Note that the traditional matrix manipulation programs **M1** to **M7** have been relegated to the **SATURN** reserve side and that **MX** now handles everything. The programs, however, still exist and may be obtained on request from either DVV or Atkins.

- 1) There are considerably more options available to deal with stacked matrices; e.g. printing multiple levels “inter-leaved” in a single ij cell, printing row and column totals by level, aggregating all levels into a single internal matrix. See 10.10.2 and 10.11
- 2) Limited graphics have been introduced - more to follow. See 10.12
- 3) Selection may now be based on “cell values” as well as “area”; see 10.6. Thus, for example, factoring may be selectively applied to ij cells based on their current values. See 10.7.1.
- 4) An option to include row/column totals on every screen, not just on the bottom/RHS screens, is introduced. See 10.10.1.

- 5) Greater use is made of alphanumeric zone titles from GIS files.
- 6) Interactive options added to set matrix dimensions/units and title for an output .ufm matrix. See 10.16
- 7) Row and column totals printed for several input matrices together (“inter-leaved”). See 10.11.
- 8) An external .ufm matrix may be read in as its transpose or by a series of zone re-definitions as in **M3/M4/M5**. See 10.4. Thus re-coding can be done either as part of the input or as part of the output.
- 9) Add an option under “M5” output to allow totally new and “empty” zones to be added into a matrix. See note 6, 10.16.3.
- 10) The internal matrix may be transposed internally as part of the “fortran equation option”. See 10.8.2.
- 11) Text names for sectors (if defined) are used in block listings and sector 0 is not included if it does not exist. See 10.10.5.
- 12) The factor options now include explicit options to factor by either row-specific or column-specific factors. See 10.7.3.
- 13) The cells displayed under the “view on the screen” option may now be “selected”; e.g., you may only display values > 10, all other cells are blank. See 10.6.
- 14) A transport specific option to add two cost skims via an intermediate (e.g. park ‘n’ ride) zone is introduced. See 10.8.4.

D.7.9 SATLOOK

- 1) Turning flows at buffer nodes may be displayed from within option 2, either at individual nodes on the screen or en masse to the line printer file; see note 4 under J.6 and 15.36.
- 2) Simulation summary statistics now include a breakdown into, e.g. total vehicle hours, within the time period and beyond the time period in terminal outputs (previously they were available in the LP file only), plus a new set of statistics which brings together totals for the simulation network with the equivalent totals from the buffer network. The latter provides a better single estimate of, e.g., total vehicle hours over the whole network, than was previously available from the assignment network summary statistics. See 17.9.

D.7.10 SATME2

While the matrix update program **SATME2** has not changed significantly the method of interfacing with **SATURN** has. In 9.2 a new program **SATPIJA** was introduced to provide an alternative method to **SATASS** to create a UFP file and, since the UFP files created by **SATPIJA** had a different format to those created by **SATASS**, an extended version of **SATME2**, **SATME3**, was also created. Since the new **SATPIJA/SATME3** route has now been successfully validated the old

SATASS/SATME2 option has been removed and, to maintain compatibility with long-standing program names, **SATME3** replaces **SATME2**.

Full instructions are given in the (re-numbered) Section 13.

D.7.11 BUGS

A separate list of bugs in 9.2, none very serious but as ever potentially annoying, is available and is routinely sent out via email.

D.7.12 DOCUMENTATION

In addition to minor alterations throughout and several new sub-sections covering new features noted above several sections have been re-numbered and the old section 7 on **SATASS** has been replaced by section 13 which covers **SATEASY**. The documentation supplied to users on computer files is now given as WORD 6 files instead of as ascii files as was the previous convention.

D.7.13 FEATURES IN PROGRESS

Very often **SATURN** programs as supplied contain a number of functions which are not fully tested and therefore undocumented, but still basically available if you know how. The "Weston Gap", note 4 in J.5, is a case in point. Others in 9.3 include:

- 1) System optimal assignment.
- 2) Shadow networks assignment.
- 3) Supplementary files defining capacity indices.
- 4) Blocking back based on maximum (as opposed to average) queues. (Possibly more realistic if using PASSQ).
- 5) A DA array on .ufs files to explicitly record tolls under road charging tests.
- 6) A perturbation technique to model peak spreading under PASSQ (as developed by KK Chin) can be applied with existing programs and key files.

If you would like more information about any of the above please contact DVV.

D.8 Changes in SATURN 9.4

SATURN 9.4, first released in March 1998, continues the developments made in 9.3, primarily within the interactive program **PIX**. New input facilities have been introduced in **SATNET** and a node data base facility has been added to **SATDB/PIX** to complement the existing link-based data base.

The basic structure of both the network and matrix ASCII data input files and of the various binary UF files is essentially unchanged and files created under 9.3 or before should still be compatible with 9.4 (although the converse is not true - files created under 9.4 will almost certainly not run with earlier programs). The exact order of inputs in “key” files is likely to have changed.

The following sub-sections describe general new features of 9.4 followed by notes of changes to individual programs.

References are made to sections in the (latest) Documentation where full details may be found.

D.8.1 New General Features

- 1) All .bat files for interactive programs such as **PIX** allow a “preference file” to be specified.
- 2) Namelist parameters may be set on the command lines of certain programs/bat files; See 14.6.
- 3) In very limited cases (see 10.14) it is possible to “append” (i.e. add) data to an existing file, e.g., in order to export data for several test runs to a spreadsheet.
- 4) The “command line” used to initiate a job is now detected by the program and recorded in the LP files; useful in determining “how” a job was set up.

D.8.2 SATNET

- 1) Separate sets of bus route 66666 definitions disaggregated “by company” are allowed. 6.9.
- 2) A new extra input data file, the “X-file”, has been introduced which allows link-dependent values of TAX and turn-dependent GAP values to be defined. 6.13
- 3) A new class of give way movements denoted by W for weaving segments, e.g. on motorways with slip roads, has been added. 6.4.2.5.
- 4) The following new parameters have been added and their functions described in 6.3:

KINKY;	15.38
MAXLSF	
QUEEN;	8.5
SATTM;	15.21

SHADOW; 7.11.10
SOWHAT; 7.11.9
XFILE; 6.13

- 5) A “history file”, basically an extended title, may now be included in the network.dat file and stored in the uf* files. See 6.2.

D.8.3 Assignment Programs

- 1) The technique known as “shadow networks” which is used to remove excess demand, an alternative to the use of elastic assignment, has been introduced and documented; see 7.11.10.
- 2) Equally “system optimal” assignments may now be carried out where a system optimal assignment minimises total network travel cost as opposed to individual driver trip cost. Its applications are more theoretical than practical. See 7.11.9.

D.8.4 Simulation Programs

- 1) Roundabout entry capacities may now be reduced by exit flows to the same arm using what are known as “K_s factors”; see 8.7.2.
- 2) Link-dependent TAX values may be set; see 8.2.3.
- 3) An alternative blocking back rule has been introduced based on maximum rather than average queue lengths over a link. See 8.5.
- 4) Several new time-based DA arrays are included in .ufs file, one consequence being that all simulation total statistics can be calculated by formulae involving only DA codes; see 17.11. Previously certain calculations, e.g. queued delays in future time periods, could only be calculated by programming.

D.8.5 SATALL

- 1) An option is now provided, primarily via the .bat file, to carry out one or more continuation assignment-simulation loops to an existing .ufs file rather than starting all over again from scratch. See 9.12.2.
- 2) The tricolour “window” display when the program is running now adds the file name at the bottom of the screen.

D.8.6 PIX

PIX has been extended and considerably altered in several respects. In particular the conversion of text-based menus into banner as opposed to graphically-based menus has been largely completed. Some text menus remain but only when they are much more convenient in that format. The network editing options have been extended and generally “tightened up”; more to come. In addition virtually all of the remaining “useful” components of **SATLOOK**, **SATDB** and **SATED** are now accessible from within **PIX**.

- 1) Data for turns may now be displayed as horizontal numbers within boxes and the choice of turn data has been extended, e.g. to include GAP values.
- 2) Simulation links may be drawn with a finite width and the lane structure illustrated as opposed to being simply single lines.
- 3) The size of the 1-way arrows may now be user set or suppressed entirely by putting the size to zero.
- 4) Mouse-based selections from a banner may be over-riden using a “hot key”, alt + a key. 11.1.2.
- 5) A new form of banner has been introduced, the “A-Z banner”, in both network and node graphics plots giving full information on what the current plot displays as both network and node graphics plots opposed to a banner indicating choices. 11.6.9.
- 6) The choices listed in the banner may optionally be suppressed from outputs to hard copy devices. 11.3.5.
- 7) Node-based data may be plotted as proportional “bandwidth” circles. In addition the set of available node-based data has been considerably increased. The options to select the nodes to be displayed have also been extended. 11.6.5.
- 8) Select link analysis may be carried out on centroid connectors as well as “real” links. 11.8.1.
- 9) A parameters sub-menu has been added to isochrone displays. 11.8.3.

D.8.7 SATDB

- 1) A variable number of decimals per output column may now be selected under the “Housekeeping” menu.
- 2) A node-based data base is included in addition to the traditional link-based and with all the standard options. See 11.10.5.
- 3) Selected links may be identified by a 0/1 in a new column.
- 4) Options to “unpack” simulation link and turn data have been added, e.g. to allow priority markers on lane restrictions per turn to be displayed.
- 5) A “parameters/options” sub-menu has been added to the terminal display to allow, e.g. lines with only missing data values or centroid connectors to be excluded from the listings.

D.8.8 MX

- 1) Ascii data files with “Spreadsheet-style” formats (values separated by commas) are now available for both output and input; 10.5 and 10.15.
- 2) The graphical-output facilities have been extended to include pcx files and scatterplots.
- 3) Most facilities previously available on a cell-by-cell basis, e.g. display on screen, are now equally available for sectors.
- 4) Matrix dumps to ascii files may now include only a subset of all elements, e.g. vertical strips to avoid very long record lengths per record. See 10.15.
- 5) Equally input from ascii files need not be based on full matrices so that the matrix may be input and/or updated in stages. 10.5.
- 6) Matrix totals (i.e. the sum of all elements) may now be “dumped” to an external ascii file. 10.14.
- 7) The FORTRAN-based matrix manipulation equations may now use row and column totals as variable names; this can be very useful in emulating trip distribution models. 10.8.1 and 10.19.1.

D.8.9 9.2 BUGS

A number of bugs have been found in 9.2 (as in earlier versions) and these are listed in ascii files BUGS.93 and BUGS.92 which are supplied with **SATURN** 9.4. Note that these do not necessarily occur in all released versions of 9.3 or 9.2 as errors are corrected in later releases. The vast majority of the reported bugs are relatively benign and only inconveniences; e.g. you try to do something and the program does not respond or crashes. A small number however can lead to incorrect results in certain (often unlikely) circumstances. It is a good idea to at least scan these lists.

It should also be noted that some of the bugs have in fact been around for years and not detected probably indicative of the fact that they are very rare and only occur in highly specific circumstances.

D.8.10 DOCUMENTATION

The documentation has been extensively revised throughout and issued as hard copy in ring binders by WS Atkins.

- 1) Sections 15.1 and 15.2 on queues and PASSQ have been put in a separate section, 17, and expanded considerably.
- 2) Documentation is now held as WORD 7 documents.

D.8.11 FEATURES IN PROGRESS

- 1) A singly constrained trip distribution model may be incorporated with single user-class assignments; more complex joint distribution - assignment procedures are being developed.

- 2) A new program PMAKE (strictly speaking PIX run from a different bat file) allows networks to be defined interactively on screen using the mouse to define nodes and links. For instructions how to use PMAKE (which is in fact included in 9.4) please consult Mike Hall or Dirck Van Vliet.

D.9 Changes in SATURN 9.5

SATURN 9.5 was first released in beta-test form in September 1999, and as a full release in March 2000. It is the first version of **SATURN** to be made available in both dos (16-bit) and 32-bit Windows versions, so it is now fully (or almost fully!) compatible with Windows 95, 98 and NT.

Compatibility with older versions of **SATURN**: as with previous new releases 9.5 binary files are no longer compatible with 9.4 and earlier versions of the programs, but binary files from old versions may still be read (within reason). Equally (ascii) data files from older versions may still be read by 9.5 but not necessarily vice-versa. Finally the exact order of inputs within key files may have changed.

Users are reminded that they may use the NFT parameter (6.3.2) to explicitly run previous versions of **SATURN**. However if they do wish to use the latest 9.5 version they will need to check that old explicit settings of NFT in existing network data files (e.g. NFT = 94) are updated to NFT=95 (or NFT = 0).

The following sub-sections describe general new features of 9.5 followed by notes of changes to individual programs.

References are made to sections in the (latest) Documentation where full details may be found.

D.9.1 Windows 95/98/NT 32-Bit Versions

- 1) The bat files used in the 32-bit versions use a different procedure to transfer command line parameters (i.e. the “net” in a command **PIX** net) into the programs. Previously these were included in a standard file look.ere which the program read; currently they are read directly from the command line by the program. The advantage of the new system is that it is less prone to confusion over which version of look.ere is which under multi-tasking; the disadvantage is that the users have less control over what the bat files do by being able to make their own changes.

Note however that the new bat files follow the same command line conventions as the old. If a program appears to “misinterpret” a command line please get in touch with DVV; some teething problems are inevitable.

It should also be noted that the new .bat files are incredibly simple - either they print the command formats to the screen or else they call the .exe file with the same command line arguments. So, apart from one extra keystroke there is no difference between typing:

	SATNET	mynt	(which calls the bat file)
and	\$SATNET	mynt	(which calls the exe file)

Those of you who are inclined to write your own .bat files, e.g. to set up long over-night runs, may wish to note that it is probably preferable to use the direct calls to the .exe's.

- 2) The 32-bit Windows version allows multi-tasking but with restrictions. Thus you can have two versions of, say, **MX** active at the same time but two

programs must not access the same files simultaneously. To a certain extent you can get around this problem by copying one file into another with a different name. However problems can still arise since, for example, network .ufs files generally contain the names of the .dat file from which they were created and the trip matrix .ufm file. These may be opened automatically by programs such as **P1X**; renaming the main file does not of course rename these sub-files.

- 3) Screen editing is handled differently under Windows. The good news is that it uses a proper edit window which is standard and much more flexible than the old-style 9.4 screen editing based on limited Salford functionality. The bad news is that it is not yet used as frequently as it was before but we are working on that one. See 19.9.
- 4) In certain instances text outputs may be directed not to the “screen”, i.e. into the master window, but to sub-windows which, like normal windows may be re-sized, moved about the screen, copied to the clipboard, deleted etc. This means that it is now easy to refer back to previous output information rather than having to try to remember it. See 19.10.
- 5) Interactive programs, largely **P1X**, now have a menu bar with pull down menus to complement the traditional **SATURN** choices from a banner menu. 19.5
- 6) At a technical level please note that the Windows versions no longer require the Salford DBOS memory manager to be loaded. They do however require various .dll files which are normally located in the same sub-directory as the .exe files when the programs are installed; once set up users need do nothing.

D.9.2 General Features

- 1) The concept of using symbols at the far right hand of menu items to indicate whether they lead to further menus (>), are logical variables which may be toggled (L), etc. has been extended from the graphical banner menus to include text menus.
- 2) We now have a web site - largely under construction; <http://www.its.leeds.ac.uk/saturn/index.html>. In particular the latest documentation files are stored there and should be accessed by users wanting the most up-to-date documentation.

Binary files, i.e. those with extensions .ufm, .ufs, etc., are now “zipped” which basically means that they require less disc space through, e.g. reducing a string of consecutive 0’s to essentially a single value of 0 plus appropriate pointers. The savings are particularly significant for very sparse matrices.

A consequence is that binary files are no longer backwards compatible such that files produced by 9.5 cannot be read by 9.4 or earlier programs; the converse, however, is not true.

- 3) The essential file is now - logically! - SAT95KEY.DAT; see Appendix Y.

- 4) A new definition of “vehicle classes” is introduced; see 5.8.2.
- 5) The parameter LEFTDR is now included under SAT95KEY.DAT as a “universal” parameter. See Appendix Y.

D.9.3 SATNET

- 1) Bus lanes may now be defined as part of simulation links by adding a B before or after the number of links entry per link. Thus 2B instead of 2 (or 3) implies 2 lanes for “normal” traffic plus one off-side bus lane; B2 is the same except that the bus lane is on the near-side. See 6.4.9 and 15.39.
- 2) “Bus route” inputs may now be used to define routes in a much more general sense; e.g. routes over which timed observations have been taken and which will be used for validation. Timing points are included within closed brackets after the relevant nodes. See 6.9.4.
- 3) A new parameter UPBUS allows (bus) routes which commence on a simulation link to start at the upstream end of the link as opposed to buses entering at the downstream end. Similar rules apply to the ends of routes. See 6.9.2, note (1).
- 4) Bus routes may now be coded “in reverse”. If you have a bus route which goes through slightly different nodes “out” and “back” you can define “back” with the same basic set of nodes as “out” rather than having to put them all in reverse order. See 6.9.2, note (7).
- 5) Data checking on input bus routes has been tightened up. In particular a long-standing “bug” whereby a bus route could execute a U-turn at a simulation node where U-turns were not permitted (i.e. any node apart from a type 5 roundabout) has been (correctly!) identified as a fatal error. Hence error-free networks under 9.4 may fail under 9.5. The quickest and simplest solution is to delete the offending routes; the recommended solution would be to redefine the route to avoid U-turns.
- 6) If a network has Fatal Errors, leading to an “Abnormal Termination”, a summary of the Fatal Errors messages is given at the end of the .lpn file and - 32-bit version - in a separate window.
- 7) The format of the 88888 data records has been modified to allow a “vehicle class” to be inserted in columns 6-7; see 6.11. This could create problems in existing data files if the matrix level, previously columns 6-10, was not right justified. Not very likely.
- 8) The default values of certain input variables, in particular DIDDLE, have been changed to reflect “best practice”; this may mean that old network files will give different results. In addition other variables have new default values “recommended” although not actually changed from previous versions. See 6.3.

D.9.4 Assignment Programs

- 1) The “simple” elastic options (i.e. T_{ij} is a function of C_{ij} only) have been extended to include MCGILL = 5 and 6 where the demand models are:

5: Nested logit model. See 7.6.2.

6: Single logit model (but differs from MCGILL = 2 in the way in which the trip matrix is defined).

These two models are characterised as being “share” models as opposed to “incremental” models in that the input trip matrix represents the full O-D matrix including, e.g. both road and public transport trips.

- 2) In addition a set of singly (origin) constrained distribution models have been introduced. See 7.10.1. These are of the incremental logit form:

$$T_{ij} = A_i T_{ij}^o e^{-\beta(C_{ij} - C_{ij}^o)}$$

where the balancing factor A_i guarantees

$$\sum_j T_{ij} = O_i$$

Furthermore these may be combined with the “simple” elastic logit models for MCGILL = 5 or 6 to provide joint distribution/modal split/assignment models. See 7.10.4.

Both these extensions were developed under a DETR-sponsored research project carried out by MVA and John Bates Associates in conjunction with DVV; their input gratefully acknowledged.

- 3) Estimated or empirical values of elasticities (disaggregated by user class if appropriate) are calculated within **SATEASY/SATALL** and printed both in the lpa/lpt files and within the network parameters output by **SATLOOK** (7.7.5 and 11.11.7).

D.9.5 Simulation Programs

- 1) A number of long-standing, apparently minor bugs have been corrected which collectively may, in some cases, lead to improved convergence rates.
- 2) A new feature is introduced for modelling roundabouts whereby the entry capacity for entry for an arm may be reduced in relation to the exit flow on that arm (i.e. flow that exits before the new flows enter) via “Ks factors”. See 8.7.2.

D.9.6 SATALL

An option to “continue” previous **SATALL** runs has been introduced. See 9.12.1.

D.9.7 PIX

- 1) The main menu now contains a “Validation” option which in turn comprises:
 - ◆ A comparison of modelled vrs. observed counts. (11.7.1)
 - ◆ An analysis of time-distance diagrams on selected routes. (11.7.2)

The latter is new in 9.5 and works on the principle that timed routes may be defined as a subset of the bus routes in which (a) the frequency is zero and (b) observed cumulative times to individual nodes are defined in the original .dat file input to **SATNET**.

Count validation is essentially the existing statistical analysis of observed vrs. modelled flows but with various options, e.g. demand or actual flows. (See also L.9, note 3.)

- 2) Node numbers may be annotated “offset” from their junctions independently of any annotation which traditionally appears “at” the junction.
- 3) Several other options permit time vrs. distance diagrams to be created; e.g. joy rides, bus routes, o-d trees, all under Analysis.
- 4) Select link analysis options have been considerably extended, e.g. to select actual, demand or queued up flows or to output selected trip matrices (which previously was only available within **SATDB**). Also flows to origins or from destination zones may be selected.
- 5) Bus route analysis may optionally include **all** of the first and last links; previously a bus route defined by A-B-C-- X-Y-Z began at the downstream end of link A-B and terminated at the upstream end of Y-Z; links A-B and Y-Z may now be included.
- 6) The Editing options have been extensively revised. See 11.8 and Section 18. In particular the PMAKE procedure which allows the “topology” of networks to be created interactively on screen and which has been “under development” for some time is now operational. The same procedures may also be used to edit network properties on screen and to create new scenarios for testing on network .dat files.
- 7) BMP outputs are now allowed under 32-bit versions. Technically the bitmap outputs have now become “generic” so that you may select whether a “PCX” output option produces a PCX or BMP file or, thirdly, output to the clipboard.
- 8) It is devoutly hoped, though not conclusively proved, that printing to external devices will be considerably simpler under WINDOWS 32-bit systems in that the drivers within Windows can be used. This also means that graf.dat can be essentially reduced to 2 devices, the screen and the printer.
- 9) A facility to “dump” the information on a network .ufs file into an equivalent (or nearly so) .dat file has been added. Useful if one of your colleagues (never you!) has been a bit over enthusiastic with the delete key!

D.9.8 MX

- 1) A new set of “Demand Calculations” has been added which effectively mirrors the elastic demand models available through **SATEASY** and/or **SATALL**. The latter programs calculate the cost of travel by road as part of the assignment program; within **MX** the road costs - and indeed any other cost matrices which are needed within the model - must be input .ufm files. Thus to carry out a simple modal split model input a trip matrix plus two cost

matrices, define the relevant parameters within **MX** and create a demand trip matrix. See 10.18.

- 2) Both input from and output to an external .dat file may now be “partial” such that only a part of the matrix is affected. These options are useful if, for example, it is desired to dump a **SATURN** matrix into a spreadsheet, e.g. EXCEL, for further manipulation but that program cannot accept a large number of “columns”, in which case one can dump and re-read the matrix in vertical “strips”. See 10.5.4 and 10.15.
- 3) New style screen editing is available under Furness options to define new trip ends etc, but not (yet) to edit individual cell or sector values.
- 4) Under Row and Column Totals, both listing (option 9) and dumping (option 12), the grand total of all matrix cells may be output on its own. In addition, when writing to an external file the data may be “appended” to an existing file which can be quite useful when collecting data from a series of runs under a batch procedure. See 10.14.
- 5) The options to print to alternative devices under matrix graphics has been extended so as to be comparable with standard facilities in **PIX**.
- 6) Editing of zones, e.g. adding or deleting rows and columns may now be done directly to the internal matrix "in situ" rather than applying the changes while copying from an external .ufm file. (Although we do cheat a bit by first copying the internal matrix to a “scratch” .ufm file and then re-copying as before). See 10.4.
- 7) Conversion options to and from EMME/2 have been created (although not extensively tested). Thus input from a .dat file may use a standard EMME/2 format; equally output to a .dat file may use the same format. See 10.5.5 and 10.15.

D.9.9 SATLOOK

- 1) Option 4, Simulation Summary Statistics, has been extended to cover not only buffer plus simulation statistics but also to output statistics for buffer-only networks. Option 5 - assignment summary statistics - becomes virtually redundant as a consequence.
- 2) Simulation statistics may now be calculated “on the hoof”, not using pre-calculated statistics from **SATALL** as stored in the .ufs files. This enables standard summary statistics to be calculated for only a set of **PIX/SATDB** - selected links.
- 3) Comparison statistics between observed and modelled flows are now much more flexible with options to distinguish e.g., actual or demand flows or counts on links or turns. See 11.7.1.

D.9.10 SATDB

- 1) An option, to be known henceforth as One Song to the Tune of Another, has been created whereby one trip matrix is assigned and loaded according to the routes and route proportions of another network (to which, presumably, a

different matrix had been loaded). An output .ufa file is produced and may next be simulated via **SATSIM**.

- 2) This represents a form of perturbation assignment whereby the impact of loading a (slightly) different matrix to fixed routes may be determined. See 11.10.6.

D.9.11 SATED (Node Graphics)

Nodes with arms at very low angles (nearly parallel) are “adjusted” such that kerbs do not meet at long distances from the junction centre. Previously this was done by adjusting their angles of approach; in 9.5 it is done by “pushing” them apart at right angles to their approach direction. This appears to better interpret the likely junction configurations in real life but there are bound to be a number of strange cases where further fine tuning to the algorithm used will be necessary. Please notify Dirck Van Vliet of any examples of node graphics which do not “look right”.

D.9.12 New Programs

A new program **SATDYSK** which carries out dynamic skims has been added; see 12.7. It should be stressed that this program is still under development and may well be modified over time.

D.9.13 Documentation

- 1) This has been extensively rewritten, in particular with Windows applications in mind, and is now produced using Office 2000. Illustrations of **SATURN** screen images are now included.
- 2) Note that the files are in 14-font and have margins set for alternate left - and right-hand pages. They are therefore best printed as two pages per A4 sheet “side by side”.
- 3) The files will be included with any releases but users are encouraged to download the very latest versions from our web site as these will be continuously updated. See note 2 under L.2.
- 4) Note in particular that a Beginner’s Guide to Network Coding has been introduced, section 5.6, plus two new sections: 18 which describes the new interactive network editing and building procedures and 19 which describes interactive procedures in general (formerly part of Section 11).



D.10 Changes in SATURN 10.1

SATURN 10.1 was first released in September 2000 and is the first fully 32-bit version of **SATURN** so it is now compatible with Windows 95, 98 and NT. The programs may however still be compiled as 16-bit executables (with slightly different functionality) and may be supplied if required.

As with previous new releases 10.1 binary files are no longer necessarily compatible with 9.5 and earlier versions of the programs, but binary files from old versions may still be read (within reason) by 10.1. There is (apparently) no problem in transferring files between 16 and 32-bit versions. Equally (ascii) data files from older versions may still be read by 10.1 but not necessarily vice-versa. Finally the exact order of inputs within key files may have changed.

However, given the relatively short time period between the releases of 9.5 and 10.1, there have been relatively few changes in formats so upgrades from 9.5 to 10.1 should not pose a problem. Your incompatible file is of course the exception to the rule!

The following sub-sections describe general new Windows features of 10.1 followed by notes of changes to individual programs. Where changes have been introduced following the general release version 10.1.5 in September 2000, the first version number is noted as e.g. [10.1.6]. Thus version 10.1.9 was released in January 2001.

References are made to sections in the (latest) Documentation where full details may be found.

D.10.1 Windows 95/98/NT 32-Bit Versions

- 1) Version 10.1 of **SATURN** is the first to be primarily programmed as a 32-bit program - and therefore suitable for use under Windows 98/NT/2000. In fact 10.1 is only being released as 32-bits, although a 16-bit version may also be compiled on request. See 3.4
- 2) There is therefore a continuing shift away from keyboard based inputs and text menus in the interactive programs such as **P1X** to windows-style inputs and graphical display banners.
- 3) In order to emphasise its role as a fully compatible Windows program version 10 is also released in parallel with the **SATWIN** "front end" program, which may be used to run **SATURN** programs without recourse to either Command Prompt or Dos. See 3.6.

D.10.2 SATNET

- 1) Fatal coding errors in **SATNET** are now sub-divided into "fatal" and "semi-fatal" such that semi-fatal errors prohibit the network from proceeding into **SATALL** but allow it to be processed by **P1X** so that the errors may be interactively corrected, 6.12 and 18.4.
- 2) The maximum length of a "pathname" which may be stored for a file is increased to 256 characters from 96.

- 3) A parameter FREEXY now allows X, Y co-ordinates to be input as “free format” under the 66666 data records, solving problems of, e.g. 5-digit zone numbers and co-ordinates with more than 5 digits. 6.8 [10.1.6].

D.10.3 Assignment Programs

- 1) A WIDDLE option (a variation on DIDDLE) has been added to allow assignments in buffer-only networks to be continued from previous assignments (see 9.11.6).
- 2) An extra parameter NITA_S to control the number of assignment iterations on the extra SAVEIT loop for elastic assignment has been introduced; see 15.23 [10.1.6].

D.10.4 PIX

- 1) Interactive network editing facilities, in particular the topological editing functions under PMAKE, have been extensively tightened up and extended. Try them! Section 18.
- 2) An auxiliary network plot is available to indicate, e.g. the location of the current window within the full network. See 11.5.2.
- 3) Parameters, e.g. height and width, of the “alternative device”, i.e. the printer, may now be set interactively during a program run; see 11.3.4.
- 4) Network-wide signal optimisation routines within **P1X** have been enhanced to allow the joint optimisation of both stage times (green splits) and offsets as well as the option to introduce a re-simulation loop. See 11.9.12 [10.1.6].
- 5) In addition the above optimisation may only cover selected nodes [10.1.6].
- 6) Trees may now be defined by the destination-end as opposed to origin only. See 11.8.3 [10.1.8].
- 7) The interactive editing of simulation nodes (or of buffer nodes converted to simulation) now allows bus-only links and/or turns to be defined more easily. [10.1.8]

D.10.5 MX

- 1) The demand calculations have been generally “beefed up” and made more user friendly such that they are now essentially functional rather than experimental. See 10.18.
- 2) A new form of stacked matrix by “blocks” as opposed to “levels” has been introduced. Its first application is to store trip matrices by multiple time periods within a single .ufm file. See 10.2.4 and 17.4.3.
- 3) Inputs from EMME/2 produced ascii matrices have been “tightened up” and made more reliable; 10.5.5 [10.1.6].
- 4) The option to read non-zero matrix elements off a single record now allows for a matrix level to be explicitly included in order to make it easier to update/define stacked matrices; 10.5.3 [10.1.6].

- 5) Zones may be added together (“compressed”) either from sequential blocks of zones or from “mixed” sets. See 10.4 [10.1.7].
- 6) The selection rules involving tests for EQ or NE now include an explicit plus/minus value. See 10.6 [10.1.8].

D.10.6 SATCH: Cordoning

Multiple user class matrices may now be cordoned over all levels, not just for a single user class. 12.1.6.

D.10.7 SATDB

An explicit GEH function is now included within the “FORTRAN equations” to calculate new data columns 11.10.8.

D.10.8 SATED (Node Graphics)

A new procedure for optimising signal green times has been introduced, basically a revised Mark II version of the **SATURN** equi-saturation algorithm. See 15.31.3.

D.10.9 SATLOOK

Count vrs modelled flow comparisons now include explicit output statistics for three validation criteria as recommended by the UK DETR. 11.7.1.

D.10.10 Multiple Time Period Modelling

Facilities for multiple time period modelling have been improved, first by introducing “blocked” matrix files (10.2.4) which contain trip matrices for several time periods within a single .ufm file and secondly by introducing demand algorithms based on the incremental logit model proposed in a PhD at Leeds by KK Chin. The latter algorithm appears both as a pure matrix manipulation model within **MX** (10.18.2) and as a new program **SATKK** which allows a joint equilibrium model of time plus route choice to be formulated and solved using an iterative procedure similar to Frank Wolfe. See 17.12.

While the new program **SATKK** has been included within **SATURN** 10.1 its documentation verges on the non-existent. However it does seem to work and has been successfully run during a **SATURN** Intermediate Workshop at Leeds; interested users are advised to contact DVV.



D.11 Changes in SATURN 10.2

SATURN 10.2 was first released in September 2001.

As with previous new releases 10.2 binary files are no longer necessarily compatible with 10.2 and earlier versions of the programs, but binary files from old versions may still be read (within reason) by 10.2. There is (apparently) no problem in transferring files between 16 and 32-bit versions. Equally (ascii) data files from older versions may still be read by 10.2 but not necessarily vice-versa. Finally the exact order of inputs within key files may have changed.

The following sub-sections describe general new Windows features of 10.2 followed by notes of changes to individual programs. Where changes have been introduced following the general release version 10.2.8 in September 2001, the first version number is noted as e.g. [10.2.9].

References are made to sections in the (latest) Documentation where full details may be found.

D.11.1 Windows 32-Bit Updates

- 1) The continuing process of converting from text- to windows-based interfaces within the main interactive programs **P1X** and **MX** has continued. In general terms virtually all of **P1X** has been converted with the exception of the **SATDB** and **SATLOOK** sub-programs (which are not planned to be changed), whereas only limited changes have been made to **MX** as noted below.
- 2) The format of **KEY** and/or **LOG** files have been altered when used to record choices from **P1X** banner menus such that the letter selected is recorded as well as its pixel position. This removes the problem with transferring key files between computers with different pixel resolutions or between networks where, for whatever reason, items in a banner menu appear at different locations. Using Key files should therefore be more "robust".
- 3) The Windows front-end program **SATWIN** has had a number of minor bugs corrected, particularly those related to file selection for lesser used options and modules. The Batch files used have also been modified to ensure the correct sequential operation of modules under multi-tasking operating systems like NT.
- 4) **SATWIN** has also been extended to allow spaces in folder names, which was strictly disallowed in the previous version. This should allow it to be installed under 'Program files' if required. The file Editor as before uses NotePad or WordPad by default but users can now also select their favourite editor from the Tools |Menu if desired.
- 5) Other extensions include quick access to modules through a right click on the event log, selective deletion of items from the event log (hold down CTRL key, click on lines to be deleted and Clear Selection); and an option to highlight and re-run a selection from the event file (as for delete but click on Run Selected Items).

- 6) Both the **SATURN** Introduction slideshow and User Documentation can be viewed through **SATWIN**.
- 7) Finally, the **DRACULA** demo is loaded automatically for access through the Module option in the toolbar. If the full **DRACULA** is purchased, it installs and is accessible under **SATWIN**.

D.11.2 SATNET

The default values for MAXDTP and MAXQCT have been changed to the “sensible” values of 10 and 60 respectively. If you have not previously used these parameters - which you should be doing! - then re-running old jobs will give different answers unless these parameters are explicitly re-set to their old default values of 0.

D.11.3 Simulation Programs

A small number of long-standing and extremely rare bugs within the simulation have been corrected; these may produce relatively small differences in the outputs from certain networks.

D.11.4 Assignment Programs

The MCGILL values have been redefined such that the “incremental” demand models and the “shared” demand models have distinctly different MCGILL values. Thus MCGILL = 1 ... 4 remain the same but values 5 and 6 (nested logit and logit) have been renumbered as 10 and 11. It is intended to further extend the set of functions catered for so that 5 will eventually be re-used (probably for Box-Cox)

D.11.5 PIX

- 1) Link annotation display now allows geometrical displays to use a variety of colours dependent upon the numerical values which are being annotated e.g. flows of 0-200 in red, 201 to 400 in blue, etc. etc. 11.6.3.4.
- 2) The “Variable Intensity” display now allows the maximum intensity value to be set to zero, in which case all displays are at maximum intensity so that all link data is displayed as a solid bar of fixed width, full length. So it only really makes sense to use it when you are also using variable colours! 11.6.3.2.
- 3) Tree-based analysis has been extended such that trees based on routes used in networks other than network 1 may also be displayed provided that the “other” network is structurally identical to network 1. (To be extended to allow for structurally different networks “soon”.) 11.8.3.3.
- 4) Plot windows may now be defined by explicitly defining the values of the min/max X and Y co-ordinates within 32-bit windows.
- 5) The set of plot window definitions as used in a particular run may now be saved and stored in an external “.wxy” file which may subsequently be read within another run such that “standard” windows may be re-created. 11.5.2.
- 6) The process of selecting a sub-set of selected nodes has been redesigned and, in particular, now allows the user to select nodes by clicking on them with the mouse.

- 7) Multiple node data may be displayed graphically within “boxes”. 11.6.5.
- 8) All “text” menus have been removed as alternatives to banner menus while a large number of windows-based selection and edit boxes have been introduced.
- 9) In addition forests may be displayed for more than one network at the same time or with the differences between two networks displayed. 11.8.3.3
- 10) The number of standard items of link annotation which may be selected from (text) links has been extended and now provides options to select flows, times etc. by user class or time period explicitly (rather than having to resort to DA codes).
- 11) A new option has been introduced into the Windows Menu Bar (under Back) which takes you back directly to the master (i.e., top-most) menu
- 12) An extra parameter has been added to the set of parameters which control the appearance of plots on the screen or printer; thus the “shift correction” corrects a potential problem whereby alphanumeric output which is rotated from the purely horizontal or vertical is incorrectly shifted upwards or downwards on some devices. The “annotation shift” provides an empirical correction. 11.3.4.
- 13) The cordon options within **P1X** now allow an output cordoned trip matrix to be a stacked matrix for multiple user classes (as is also available within **SATCH** with ALLUC = T).

D.11.6 PMAKE (Network Editing)

Although PMAKE is effectively a sub-component of **P1X** we list separately those new functions available within network editing.

- 1) A new output option, “Rebuild”, allows a .ufn file to be constructed from the internal .dat file which is created/manipulated by PMAKE. In effect this introduces **SATNET** as a sub-procedure within **P1X**. 11.9.2.
- 2) The range of data entries which may be graphically edited has been considerably extended to include, e.g., the counts data section and other components such as bus routes have considerably more functionality.
- 3) Most forms of editing now allow screen edit options to directly alter the .dat file within particular sub-sections (e.g. you may screen edit the coding of simulation nodes). In addition the .dat file may be screen edited as a whole; 11.9.14.
- 4) Signal settings from simulation nodes may now be dumped into special .rgs files which may most usefully be used to “transplant” a set of signal settings from one network into another. 11.9.16.
- 5) A set of options allow two networks to be compared node by node and tables produced to indicate, for example, when a node is coded identically in both networks apart from, say, its signal timings, etc. 11.9.15



D.11.7 MX

A number of minor changes and additions have been made. For example the procedures to define new zones have been extended and, hopefully, made more intuitive.

D.11.8 Path-based Assignment Algorithms

A totally new set of assignment procedures has been introduced which explicitly stores flows on O-D paths in addition to flows on individual links. This is based on research carried out at ITS Leeds by Dorota Kupiszewska and Dirck Van Vliet with the original C-code having been translated into Fortran. Path-based algorithms offer the possibility of improved convergence rates, alternative elastic assignment algorithms and much simpler analysis for certain operations. A set of papers is available from Dirck Van Vliet. Full documentation will (eventually) be included in a new section of the manual, 20.

D.11.9 New Programs: SPATULA

SPATULA converts outputs from the **DRACULA** Suite into a **SATURN**-compatible network binary file - specifically .ufd files - which may then be read by **P1X** such that the various analysis options therein may be used to view **DRACULA** outputs.

D.11.10 SAT10KEY.DAT

The standard identification file has been re-named from SAT95KEY.DAT to SAT10KEY.DAT; see Appendix Y. Note, however, that for the time being SAT95KEY.DAT files will continue to be accepted.



D.12 Changes in SATURN 10.3

SATURN 10.3 was first released in Beta version in April 2002 and as a full release (10.3.9) in October 2002.

As with previous new releases 10.3 binary files are no longer necessarily compatible with 10.2 and earlier versions of the programs, but binary files from old versions may still be read (within reason) by 10.3. Equally (ascii) data files from older versions may still be read by 10.3 but not necessarily vice-versa. Finally the exact order of inputs within key files may have changed.

The following sub-sections describe both new general features of 10.3 (e.g., new Windows 32-bit features) and changes to specific programs. Where changes have been introduced following the general release version 10.3.9 in October 2002, the first version number is noted as e.g. [10.3.10].

References are made to sections in the (latest) Documentation where full details may be found.

N.B. The order of items within each section is not based on relative importance but, roughly speaking, on the chronological order of development.

D.12.1 General Updates

- 1) The problem of text which is written at an angle (specifically numerical link annotation in **P1X**) appearing (sometimes but not always) at the wrong position and the wrong orientation on (some!) hard copy outputs larger than A4 has been solved by substituting an optional set of "DIY" fonts. 11.3.8.
- 2) All text and edit box etc. windows now allow Cut, Paste and/or Copy operations as appropriate.
- 3) The .bat files are now more "clever" in that you may input file/pathnames directly as in P1X net1 net2.ufs instead of P1X net1 S 2 net2. 14.2.1.
- 4) Namelist now accepts the input of subscripted arrays; see note 12, Appendix A.

D.12.2 SATNET

- 1) The KNOBS facilities has been extended in several ways (15.14), both in terms of inputs (described here) and applications (notes 2 and 3):
 - ◆ They may be included in the 333 records on the same line as the link to which they refer as opposed to being a second record which must always appear (parameter KONAL).
 - ◆ The data may be input as part of a separate input file (defined by the namelist parameter KNBFIL).
- 2) Tolls may be explicitly defined within the 44444 records in monetary units as opposed to equivalent time units and also defined through the KNOBS inputs. 20.3.

- 3) The extra time spent by buses at bus stops along links may be explicitly defined using KNOBS data. 15.44.
- 4) New namelist variables NOXYC and NO333C allow zones to be distinguished by their absolute value rather than using a C in column 1 (useful in converting existing data sets). 5.1.6, 6.6 and 6.8.
- 5) The output .lpr file now gives the line number in the input .dat file any time that it reproduces that a data line. This makes locating errors in the .dat file much simpler.
- 6) Certain input fields (e.g., link times or speeds) on either the 11111 or 33333 data sets which are implicitly integers may now be input with decimal places for greater accuracy if required. 6.4 and 6.6 (Note 10).
- 7) Bus lanes may be explicitly defined as parts of simulation links for the exclusive use of buses. They are coded by adding the letter B to those columns on a link data record which define the number of lanes. 15.39 and 6.4.9.
- 8) The SHANDY option has been extended so as to “suggest” correct values for XYUNIT if the input link distances disagree consistently with those calculated from crow-fly distances, e.g., by a factor of 10 implying that XYUNIT is out by a factor of 10.

D.12.3 Simulation Programs

- 1) A complete set of simulation plus buffer summary statistics including summations for penalties and tolls is included at the end of every run of **SATALL** plus, optionally, at the end of each loop. See also D.12.10.
- 2) A new facility to model the “weaving” effect between in-bound and exit ramps on motorways has been introduced. 15.40
- 3) The lane choice on links where merging traffic enters has been altered to allow for traffic on the major road to avoid the lane where the merging will take place. This therefore reduces the delay to and increases the capacity of merging traffic and means that the 10.3 simulation gives significantly different results from previous versions. However it is possible to use the old rules by setting a parameter APRESV to 0.0 or by NFT = 102. 8.8.3.
- 4) Merging movements may now be defined in “pairs” to represent, e.g., the situation where two motorway links come together in a “Y” junction. 6.4.2.3 and 8.8.3.

D.12.4 Assignment Programs

- 1) The effect of monetary charges (including parking charges, road charging etc.) is now explicitly included within the assignment and elsewhere. Tolls are input in monetary units (e.g., pence) and converted into generalised time units along with “real” time and converted distance in order to determine both route choice as well as the more general demand functions. Previously tolls could be modelled but had to be first converted into the equivalent time units by the user. 20.2.

- 2) When the output .ufc (SAVEIT) file is based on a final re-assignment rather than the “actual” assignment (as happens with, e.g., DIDDLE) and therefore use of the SAVEIT-based analyses is only approximate a table of statistics comparing the “true” link flows and the “SAVEIT” link flows is produced within **SATALL**. The same data may also be accessed from within **SATLOOK** (main option 8) and in **P1X**. 15.2.
- 3) The total number of trips assigned (total and disaggregated by user class where appropriate) is now stored on the output .ufs file and are reported within the output simulation/buffer statistics by **SATLOOK** etc. A useful output statistic under elastic assignment. 17.9.
- 4) The elasticities calculated for shared demand functions (e.g., logit models) where MCGILL > 10 are now done **after** the assignment using output road costs rather than pre-assignment using essentially guesstimates of the road costs; the two methods may give quite different values and the new method is more appropriate. 7.7.6.

D.12.5 **SATALL (Assignment / Simulation Convergence)**

- 1) The stopping condition for the loop between simulation and assignment within **SATALL** may now require that the stopping criteria are satisfied on more than one successive loop via a parameter NISTOP. 9.1.
- 2) Flow convergence statistics between successive assignment / simulation loops for multiple user classes are now disaggregated by user class and printed both within the .lpt files as well as within the summary statistics produced by **SATLOOK** and/or **P1X**. 9.11.
- 3) The distribution of the %FLOW and %DELAY statistics which monitor convergence of the assignment / simulation loops are now given for variable values of the critical difference (PCNEAR, in effect) as well as the traditional single value for fixed PCNEAR. 9.9.1.

D.12.6 **PIX**

- 1) Geometric link annotation (e.g., bandwidths) allows a full choice of colours based on link values through, e.g., user-set ranges. 11.6.3.4.
- 2) Link annotation may consist of fixed width bars with variable colours to denote ranges of values; e.g., links whose speed is 0-10 kph will be in one colour, 10-20 kph in a different colour, etc. 11.6.3.5.
- 3) Node annotation can be displayed within “boxes” such that more than one data property can be annotated. 11.6.5.1.
- 4) An option has been added to the Windows menu bar to return directly to the “top” menu from anywhere in the program and/or to further directly select any of the standard “top” choices. E.g., you can go directly to the Analysis menu from anywhere within P1X. 11.2.
- 5) Select link analysis allows multiple user class stacked matrices to be output in a single run. 11.8.1.

- 6) Select link analysis now outputs a table showing the demand flows from all possible entry points to the first node to all possible exits from the final node. 11.8.1.
- 7) The node bandwidths displays may be in multiple colours; e.g., set by range bands, positive vrs negative, etc. 11.6.5.2.
- 8) Pen colours for the secondary device (i.e., printer) may be defined internally in the same way as the standard pen colours may be defined for the screen. 11.3.7.
- 9) The log files produced by P1X - which in turn become key files - have been "tightened up" and are less prone to random crashes.
- 10) A selection of links and/or nodes (in the sense of selecting a sub-set of links for display) by pointing and clicking with the mouse. 11.6.1 and 11.6.5.3.
- 11) With multiple user classes the annotated link data may either be selected for a single user class or for all classes. 11.6.2.
- 12) The definition of devices has been tightened up so that now the "primary" device is always the terminal screen and the "secondary" device is always a printer accessed using the Windows drivers. This further reduces the importance of the graf.dat file in that you may still select various devices from graf.dat but the only information taken on board is information relating to device dimensions (e.g., distinguishing an A4 from an A0 printer) etc. so that there is no difference for example between a "PLOTTER" and a "LASER PORTRAIT FILE". 11.3.2.
- 13) A problem with Windows List Boxes (e.g., menus) has been corrected whereby scroll bars sometimes appear on even very short lists with the final item "off the bottom". By optionally adding an extra blank line on the bottom the problem disappears. 19.7.
- 14) It is now possible to include/exclude links from the plots by virtue of their capacity index, a sort of halfway house between "link selection" and "link display". 11.6.1.4.
- 15) O-d desire lines are still restricted to a maximum number of 502 but now, if there are more than 502 possible entries, the 502 maximum values are included. 11.6.7.
- 16) Bitmap background displays "move" as the network window "moves". 15.43.
- 17) A "routes file", similar to that produced by SATPIG, may now be produced for a cordoned network (with a view to passing it on to a micro-simulation framework such as DRACULA; see next point). 11.13.2.
- 18) A short demonstration of the DRACULA micro-simulation program may be run either using the cordoned network or node graphics. 11.13.7.
- 19) The Information options have (a) been added as one of the choices from the "master menu" (and also retained under Analysis) and (b) been extended to include most of the convergence and/or error summary statistics available from SATLOOK.

- 20) The choice between Network and GIS editing is now made within the Master Menu rather than one sub-menu removed.
- 21) An extra option under Display allows direct control of bitmap files used as background. 11.6.10 and 15.43.
- 22) The secondary device (i.e., printer) dimensions may now be set automatically by defining the device as, e.g., A0 or A3. 11.3.4.
- 23) An option under Information allows the user to “monitor” the user co-ordinates of points within a plotted window by pointing with the mouse; the co-ordinates appear in the banner. 11.8.6.
- 24) A DRACULA micro-simulation demonstration of flow patterns of traffic at a single junction is available under Node Graphics. 11.12.?
- 25) A new option to “mark” the various network parameters and to print warnings of any apparently “weird” choices (as judged by DVV and MDH!) is available under Information.
- 26) When using the mouse, e.g., to define a “window box”, the co-ordinates of the current mouse position generally now occur within the banner as a guide to the point to be selected.

D.12.7 PMAKE (Network Editing)

Although **PMAKE** is effectively a sub-component of **P1X** we list separately those new functions available within network editing.

- 1) A rebuild facility has been added - effectively incorporating **SATNET** within **P1X**. 18.2.6.
- 2) All 8 data segments including the 44444 and 88888 data records may be edited directly.
- 3) Simulation centroid connectors to links may now be converted automatically into connectors to a new priority node created in the middle of the link. 11.9.4.
- 4) Files referenced via \$INCLUDE records may now be input and edited and also re-created at the end of the edit procedures. 18.2.3.
- 5) Screen editing (via standard Windows edit boxes) is now available for all data segments. 11.9.16.
- 6) Bitmap files used as background for tracing networks now require co-ordinates to be defined. 15.43.
- 7) Signal settings from one network may be transferred to another via “.rgs files”. 11.9.14.

D.12.8 MX

- 1) Spreadsheet (comma separated CSV) input now allows zone names and/or sequential numbers to be optionally included on each “row” record. (Previously they could be output but not input.) 10.5.4.

- 2) Errors in editing the zone structure have been corrected and more options included for compression/renaming. 10.4
- 3) The identification of intra-zonal cells has been “tightened up” for stacked matrices so that the totals printed under row and column totals are improved. 10.11.
- 4) An option under Matrix Manipulation allows the log-sum of two or more cost matrices to be created; e.g., for application within hierarchical logit models. 10.8.5.

D.12.9 Path-based Assignment Algorithms

These are now included as standard and (will be) documented.

D.12.10 SATDB

- 1) **SATCOBA** allows a sub-network with the specifications required by COBA (e.g. 2-way links appear only once) to be created from a **SATURN** network and a correctly formatted data file including flows from multiple time periods to be output. 15.42.
- 2) Options have been added to allow link or turn data to be aggregated by node. 11.10.5 and 11.10.8.4.
- 3) The aggregation of, e.g., turn data to links or link data to nodes may be based on maximum or minimum values in addition to straight forward summations or averages. 11.10.8.4.
- 4) The option to do an all-or-nothing assignment also now calculates a delta function value as would have been done within the original assignment itself. 11.10.7.3.
- 5) A new DA array numbered 4053 has been added and represents the average link speed including - for simulation links - the flow-weighted average delay at the downstream junction.
- 6) The “rules” for calculating reverse link values, in particular those to obtain two-way flows from one-way flows, have been “tightened up” to cope with one-way links and to better satisfy what would be required under the **SATCOBA** facility mentioned above. 11.10.8.2.
- 7) An option has been added under “dump to a text file” to include a blank C-node entry for links under CSV format (in effect an extra comma). Thus both links and turns have three initial identification entries prior to the data proper. 11.10.9.
- 8) In addition the “width” of the individual records dumped to a text file has been increased so that up to 24 data items may be dumped. 11.10.9.

D.12.11 SATLOOK

- 1) A new .bat file plus internal operation **SATTUBA** outputs the time, distance, and monetary tolls (as required) matrices in the format required by the latest evaluation program Tuba. 15.41

- 2) The output tables which include both buffer and simulation summary statistics (e.g., total vehicle-hours) now also include totals for time penalties (input under the 44444 records) and for all monetary charges. 17.9.
- 3) The output tables under Error/Convergence Stats now include the summary table from **SATALL** which includes, e.g., the average absolute difference between flows from one loop to the next as well as the table which gives the “ISTOP statistic”. That table has itself been extended to include the Relative Average Absolute Difference (RAAD) as required by DfT validation procedures. 11.11.8 and 9.9.1.

D.12.12 SATCH

- 1) Several “bugs”, both in **SATCH** on its own and in cordoning within **P1X**, have been corrected.
- 2) A “spine” option, similar to that already in **SATCH**, has been added to the cordon options within **P1X** so that, e.g., a section of motorway may be “cordoned off” and the matrix of all trips entering/exiting along that stretch of motorway calculated. 11.13.5.
- 3) Within **P1X** the cordoned trip matrix may optionally be printed to a window while output to a .ufm file is also optional. 11.13.6.
- 4) A “routes file” similar to that produced by **SATPIG** (except that **SATPIG** runs for a full network) and intended for input into **DRACULA** may now be output within **P1X**. 11.13.7.
- 5) A demonstration run of the **DRACULA** micro-simulation model over the cordoned sub-network may be generated automatically from **P1X**. 11.13.8.
- 6) The cordon may now be interactively set in **P1X** by a rectangle set by “rubber banding” (similar to the “box” option under windowing).

D.12.13 SATPIG

- 1) **SATPIG** now produces an output “.kp” file in addition to the .lpg file containing the route data. 12.6.
- 2) The route data file has an extra (.trp) format suitable for direct input into **DRACULA**.

D.12.14 DOCUMENTATION

- 1) The manual has been fully updated to include the new facilities reported above. In particular one new section, 20 on tolls, has been included and several other subsections have been extensively revised, e.g., 15.14, or added, e.g., 15.40 to 15.45.
- 2) Previous appendices D to N which contained details on improvements from **SATURN** 8.1 up to 10.2 have now been aggregated into a single Appendix D and denoted D1, D2, etc. up to the current section D12.

D.13 Changes in SATURN 10.4

Date of last Update: 05 December 2003

SATURN 10.4 was first released in Beta version (10.4.3) in March 2003 and as a full release (10.4.10) in October 2003.

D.13.1 P1X

- 1) The Validation options have been extended to allow a set of summary tables for each route with timing points to be printed automatically to the .lpp file and to a window with appropriate statistics for the goodness of fit between observed and modelled times included. Statistics include a test for the DfT criterion of +-1 minute or 15%. 11.7.2.3
- 2) GEH statistics comparing observed and modelled flows under Validation may now have a "sign" added; i.e., positive or negative depending on whether the observed flows are greater or less than the modelled flows.
- 3) The choice of turn annotation data has been extended to include input turn count data and error statistics such as GEH which compare modelled and observed counts.
- 4) Turn goodness of fit statistics (e.g., GEH as above) may also be displayed under Validation in addition to (/instead of/without) link validation statistics.
- 5) The turn annotation choice menu is entered directly if numerical data is selected.
- 6) Cordoned trip matrices may be "Furnished" in order that the new origin / destination totals at the new crossing points correctly equal the assigned flows at those points (correcting for approximate routes). This also applies to **SATCH**. 12.1.7.
- 7) A confirmation "OK" box has been added once a select link choice has been set. E.g., if you make a mistake setting a sequence of nodes you can "cancel" rather than having to go through the full SLA calculations.
- 8) Outputs under DUTCH are improved by checking for maximum node length actually used rather than allowing for 8 columns and restricting the remaining data output (e.g., GEH stats under count comparisons)
- 9) U-turns at external simulation nodes may be printed under Information options and/or displayed as plotted node data. 11.8.4.5.
- 10) The format of the Graf.dat file has been altered to allow extra parameters such as the "rotational shift" to be entered as user-set defaults. 11.3.4.4.
- 11) An option under the Window Menu to return to (up to 10) previously selected windows (whether or not the windows have been specifically "saved") has been added. 11.5.3.
- 12) The co-ordinates of any point within the on-screen network may be "monitored" to show the user-defined X,Y. 11.8.4.2.

- 13) An option is provided under editing to “examine” the various network parameters for values which, in the opinion of Dirck and Mike, look a little fishy. 11.9.11.
- 14) Zonal sector numbers are now included as a standard node data item to be displayed.
- 15) **P1X** is now more “robust” against the program crashing when more than one application is running at the same time and the same “non-essential” file (e.g., a trip matrix) is required by more than one application.
- 16) Re-creating a .dat file from a .ufs file has been improved and various “glitches” repaired. However, it needs to be borne in mind that the facility does not necessarily cope with all the most obscure options available within network coding (particularly the most recently added features) and that a “perfectly cloned” .dat file may not always result.

D.13.2 MX

- 1) The bat files MXM5 and MXM7 which were included in SATURN versions prior to 10.3 have been resurrected.
- 2) The options to edit the zone structure of a matrix have been extended and generally tightened up so that it is easier to edit stacked matrices (although not necessarily recommended).
- 3) The matrix build batch file MXM1 now allows the input “data” file to have any extension, not just .dat, although .dat remains the default. Thus the command “MXM1 trips.kp” will read from the file trips.kp.
- 4) The batch file mx.bat now includes an extra keyword “OUT” to define the output .ufm matrix and the options which may be used in conjunction with “MX I” have been extended to include all standard keywords, e.g., including OUT. 10.16.
- 5) A CSV input option is included under the M5 option for .ufm outputs. Appendix W.3.
- 6) The maximum array dimensions for rows and columns have been modified such that the maximum number of columns permitted is 3 times the maximum number of rows. This means that, with the maximum number of zones for your **SATURN** level, a matrix with three stacked levels may be processed by **MX**.

D.13.3 SATNET

- 1) A new parameter ILOVEU allows U-turns at external simulation nodes connected to buffer nodes to be either fully accepted or banned (as far as possible). Previously U-turns were always banned, although not with a 100% guarantee. 18.9.
- 2) Extra checks have been included on signal settings/lane choice that may impede convergence.

- 3) Zones for which sectors have not been explicitly defined are now assigned to sector 0. (But only when some sectors have been defined; if no sectors are defined all zones default to sector -1.)
- 4) The rules concerning the definition of Y-merges have been tightened up to avoid confusion between entry ramps on a motorway (for which a single M is advised) and the merging of two motorways (for which 2 M's are allowed).
- 5) Namelist input is checked as to whether the same variable "name" appears more than once and a semi-fatal error generated if so. (In fact the check is done automatically for all namelist inputs but is only semi-fatal in **SATNET**.) Note 17, Appendix A.
- 6) The pre-load input file may now either a .ufs file (as before) or a text-based file containing link identification and flows. In other words it is no longer necessary to set up the pre-loaded flows via a **SATURN** run, they may be obtained directly from some other data source. 15.5.4 and 14.4.4.
- 7) Both the UPDATE and PASSQ options may be used simultaneously and a new input &OPTION parameter PQFILE has been introduced in order to define the PASSQ input file (in addition to UPFILE for UPDATE).
- 8) Minimum and maximum green stage lengths (as used during signal optimisation) may now be defined within the network .dat files and/or edited within **P1X**. See 6.4.13 and 15.31.

D.13.4 SATALL

- 1) A new option "AUTOK" has been introduced which removes the need to set KOMBI in advance and which appears to considerably improve the convergence of the assignment-simulation loops. AUTOK automatically selects the "optimum" weighted average of two successive loops as opposed to KOMBI which uses a fixed 50:50 average whether or not it is actually required. 9.3.2.
- 2) New default values of the blocking back parameters set at the start of each new simulation are based on the previous blocking back factors plus latest assigned flows in order to reduce the time taken to calculate blocking back factors and to improve convergence when the changes to the assigned flows are small (as occurs under AUTOK).
- 3) The transfer of delays between the simulation and the assignment, i.e., the creation of new cost-flow curves following each simulation, has been "tightened up" in a number of relatively minor ways which, in some cases, allows improved convergence.
- 4) A potential (and hopefully rare) problem of using the REDMEN option in conjunction with frozen cells (ICING = T) has been spotted and dealt with. 7.5.6.
- 5) A measure of the strength of the relationship between (aggregate) network travel times and trip matrices which conforms to the parameter "g" as used by VaDMA (paragraph 4A11 in Appendix 4A) is now calculated at the end of

every assignment. It is printed out in the .lpt files and may also be accessed via the “Convergence etc.” statistics in **SATLOOK/P1X**. 7.11.11.

- 6) A new “convergence” table has been introduced into .lpt files which shows the 10 biggest changes in blocking back factors from one loop to the next

D.13.5 SIMULATION

- 1) APRESV, as used to control lane choice for merges, is now handled slightly differently. i.e., it’s improved and has more impact!
- 2) A new turn-based variable has been added which, for signalised junctions, monitors the ratio of delay with signal co-ordination to signals without co-ordination. This is also one of the “tightening up” measures referred to in note 4 under **SATALL** which can lead to improved convergence.
- 3) X-turns at signals (i.e., traffic which gives way to straight ahead opposing flows in the same stages) are handled differently when the opposing traffic is being blocked back from its exit link. Previously it was assumed that the opposing traffic flowed continually across the junction at its maximum rate and did not leave any gaps for the X-turners. 10.4 assumes “yellow box conditions”, i.e., that the opposing traffic only crosses the junction when there is space downstream and that therefore it leaves gaps for the X-turners. 8.5.2.

D.13.6 ASSIGNMENT

- 1) The total U-turn flows through external simulation nodes is now recorded and stored on the .ufs files. 18.9.
- 2) Output Tij matrices from incremental elastic assignment (i.e., MCGILL <10) now include input intra-zonal trips unchanged. 7.4.4.
- 3) Uncertainties regarding what happens under elastic assignment for O-D cells which have positive trips input but which are unconnected have been resolved. Thus (as with intras above) they are included in the output trip matrix at their input values under simple incremental demand models. See 7.5.7.

D.13.7 SATDB

- 1) The minimum number of data columns has been increased from 5 to 8.
- 2) **SATCOBA** now accepts a control file as input which allows a choice of certain options and/or parameters to be set. 15.42.2.
- 3) Turn data may now be aggregated to link data by their exit link as well as their entry link, i.e., turn A-B-C is added to link B-C as well as A-B.
- 4) New “skimming” .bat files SKIMTIME, SKIMDIST and SKIMTOLL have been created in order to automatically skim average time, distances and tolls from a network .ufs file. 15.27.4

D.13.8 SATME2

- 1) “Frozen zones” may now also be defined as “frozen sectors”; similarly frozen i-j cells may also be defined at the sector level. 13.2.2.
- 2) Table numbers have been inserted in the output .lpm and are cross-referenced within the Manual.
- 3) A new parameter ODXMAX is introduced which in effect frees the o-d balancing factors from the upper/lower limits set by XAMAX. However, if you need to use it, it probably means that you need to look more carefully at your inputs. 13.3.1 and 13.3.2.

D.13.9 SATPIJA

A new option PIJAKP allows the PIJA factors to be output as a text file (default extension .kp) in addition to the .ufp file output. The option is useful if it is desired to transfer PIJA data to another suite of programs or, e.g., EXCEL.

D.13.10 SATOFF

A new parameter MANOFF (MAster Node for OFFsets) has been introduced (12.2.3) which “fixes” the offset for a particular signalised node such that all new optimised offsets are taken relative to that point. The change is purely cosmetic and does not affect the simulation.

D.13.11 SATWIN

- 1) A direct link to the **SATURN** Website has been included on the **SATWIN** interface.
- 2) Dropdown boxes have been introduced for the various Settings choices, allowing, for instance, users to select previously used Working folders more conveniently. An edit function also lets users delete previously used folders from the lists. The default file editor may also be changed through the Settings option.
- 3) Lines in the ‘Events Log’ window may now be edited directly to change or correct commands.
- 4) Any command may be typed directly into the ‘Events Log’ and executed immediately. This can include functions such as Notepad for network editing eg. Notepad LIV10.DAT
- 5) A direct call to **DRACWIN**, the **DRACULA** front-end, is available to users from the main **SATWIN** Toolbar.



D.14 Changes in SATURN 10.5

Date of last Update: 11 November 2004

SATURN 10.5 was first released in Beta version (10.5.1) in November 2003 and as a full release (10.5.10) in October 2004. The following new features are to be noted. (Note as well that the documentation has been extensively updated to take account of these new features and references to the relevant sections of the manual given.)

D.14.1 P1X

- 1) Arrows added to bus lanes in node graphics.
- 2) An option to define the default title as filename + date in addition to network title + date added.
- 3) Link data for annotation sub-divided into 5 sub-sets and the order of items rationalised (plus several new items added). 11.6.2.1.
- 4) Maximum transient queues by links, turns and lanes added within **SATLOOK** simulation node analysis options.
- 5) Various improvements/bug fixings have been added to **PMAKE**; for example:
 - ◆ giving warnings when negative co-ordinates are generated;
 - ◆ making sure that new nodes without connections do not disappear when the plot is refreshed;
 - ◆ making sure that altered junction types appear correctly on refresh plots
 - ◆ creating new nodes outside the min/max boundaries of the current network and/or windowed plot;
 - ◆ ensuring that text Namelist parameters are not repeated in output .dat files;
 - ◆ making it easier to convert external simulation nodes to full internal simulation nodes;
 - ◆ when a simulation link is deleted any associated centroid connectors are edited interactively rather than automatically;
 - ◆ newly created buffer centroid connectors are assigned a capacity index of 0;
 - ◆ adding and deleting centroid connectors within the simulation network (i.e., the 22222 data records) which has its own sub-menu may now be done (partially - to external simulation nodes only) within **PMAKE** Add/Delete Links (18.7);
 - ◆ curved links (as per GIS files) may be immediately defined as new links are added (see also note 15 below);

- ◆ GIS files may be created at the same time as new networks are being created and the user is prompted to save such files before exiting;
 - ◆ Duplicated curved links are reported if and when a new definition is initiated and, when inputting from a GIS file, the first definition is always used by default.
- 6) The list of the 10 worst converged simulation nodes from **SATALL** is now also given within the standard convergence statistics in **P1X** and/or **SATLOOK**.
 - 7) An option under “Select” for either link or node display allows either the “top ten” (i.e., the 10 links or nodes with the maximum property) or the “bottom ten” (minimum property) to be selected for display. 11.6.1.1.
 - 8) Link data under node graphics has been (a) “re-organised” into different sets and (b) had extra data sets added; e.g., it is now possible to display all the data contained in the data base. (Useful for examining multiple networks where you can, e.g., look at link flows in all networks simultaneously by first adding them to the data base.
 - 9) The lines used for node shapes (e.g., circles for roundabouts) may now be assigned a “width” which makes them stand out better with bitmap backgrounds.
 - 10) The colours used to display zones may be set according to zone sector numbers to make it more obvious which zones are in which sectors. 11.6.5.1.
 - 11) **SATURN** users who are also **DRACULA** users may now either run the demo versions of **DRACULA** or their own full versions from within network cordoning and node graphics.
 - 12) At the end of any **DRACULA** run (either full or demo) the user may choose to view any of the standard text output files from that run within text windows.
 - 13) Simulation centroid connector (22222) data sets may now be screen edited under network editing. 11.9.4.
 - 14) The “intensity” of background .bmp files can be reduced in order to make the **P1X** display more prominent. (Especially useful within **PMAKE**.) 15.43.6.
 - 15) GIS editing is now more closely integrated into the network editing options so that, for example, curved links may be defined within **PMAKE** / Link Edits, either for existing links or, in particular, when a new link is first created. 18.6.1.
 - 16) Nodes converted from buffer to simulation under **PMAKE** may now have extra records representing link capacity restraint added automatically based on the buffer link properties. This allows a “quick and dirty” conversion which is not necessarily recommended. 11.9.12.
 - 17) Lane turning arrows in **P1X** node graphics are assigned a user-set width.

- 18) GIS curved links may now be drawn as the partial arc of a circle by defining a centre of curvature as opposed to a set of explicit points. An extension is to define a set of links which constitute a closed loop as a full circle, e.g., to correctly represent roundabouts which have been broken down into a series of sub-nodes. 5.7.3.
- 19) The edit options to optimise signals and transplant signal timings are now “grouped” into a single “Global Operations to Signals” sub-menu which has been extended to include the “update” option described next.
- 20) Signal stage times and/or offsets may be “updated” from the .ufs file to the internal .dat file under Network Editing, specifically so that changes made in **SATALL** by using either SIGOPT or SATOFF parameters or in **SATOFF** may be transferred into a .dat file.
- 21) The set of available bus-based link flows for annotation has been increased to include, e.g., entry flows upstream and downstream.
- 22) Isochrones may now be output much more quickly by plotting different coloured circles at zones and/or nodes in order to denote equi-distant bands from the origin or destination. 11.8.3.4
- 23) Link flows at the downstream stop line, both demand and actual, have been added to the standard list of link annotation choices. These may be used in preference to the existing link flows which, in the case of simulation links which are “bridged” by centroid connectors, are the mid-link flows.
- 24) Namelist parameters changed via **P1X** network editing (e.g., changing ISTOP) may (optionally) now be included on an output .ufs file. Useful for changing parameters prior to doing a continuation run with **SATALL**, for example. 11.9.11 and 9.12.2.
- 25) A “select” option has been added to the turn annotation based on the node selection in force. 11.6.5.3 and 11.6.6.
- 26) Select Link Analysis of Screen Lines has been extended in two ways. Firstly, the screen line may be defined using a 7777 input data set or as the currently selected links (as also available within **SATDB** SLA) and also as an input (free-format) file. Secondly, the “selection” criteria in the event of multiple crossings may be set either to a minimum or an exact number of crossings and the critical number of crossings may be varied. 11.8.1.8 and 11.8.1.9.
- 27) Under the choice of link annotation (flows) the first three user classes are explicitly listed for both actual and demand flows. 11.6.2.1
- 28) The “line drawings” of simulation nodes as included within a network plot have been re-scaled so that the lane widths etc. at the junction are at the same scale and line up with the lanes plotted on the links. See also #37 below. See 11.6.4 (7) and 11.6.5.1 (4).
- 29) The format of the .rgs files has been changed such that the cycle time is included as well. 11.9.14.

- 30) The bandwidth colours for one plotted variable, say flows, may now be set with reference to a second variable, say speed. 11.6.3.4.
- 31) The numerical value printed **outside** a bandwidth now takes the same pen colour as the bandwidth plot.
- 32) If, say, the differences in flows between networks 1 and 2 is being plotted and a link in network 1 is not present in network 2 it is now possible to define a default flow for the missing link, the obvious value being zero. Previously no data at all was plotted for the unmatched link. 11.6.2.4.
- 33) Saved Windows co-ordinates (as in .wxy files) may now have a text name of up to 28 characters recorded on creation to assist in later identification. 11.5.2.
- 34) The Information menu prints comparative simulation summary statistics for either multiple networks or multiple time periods (as already available in line printer or terminal output from **SATLOOK**). 11.8.4.4.
- 35) Count validation statistics of multiple count sets (“disaggregation”) may now be applied to a single set only. 11.7.1.
- 36) The positions of the pop-up windows which are used, e.g., to set device parameters, are now centred better by taking account of the screen resolution.
- 37) The angles of the arms as used under basic node graphics are now determined by the initial directions of any curved links defined within GIS files, not simply as “crow fly” to the adjacent node. 11.6.5.1(4).
- 38) The preferences file P1X0.DAT has been reformatted with one entry per line and with an explanatory text added as a comment at the end of each line (or **some** lines – work in progress!). 11.4.3.
- 39) If a timed route has been included within the 66666 routes which is **not** a bus route (i.e., it has a frequency of zero) and it uses one or more links with bus lanes then the times/delays on those links taken within a joy ride are now the “car” times/delays rather than the bus lane times/delays as was previously assumed.
- 40) A new “menu entry” has been added at the top level, “Convergence”, whose objective is to display data relating to the convergence of the assignment-simulation loops. To a certain extent it contains the same information as given under option 8 in **SATLOOK** or the convergence option within **P1X** Information, but broken down into smaller chunks. However it also contains a number of new convergence indicators such as 42 below as well as a useful short summary table of the main convergence indicators for one or all of the input networks. 11.15.
- 41) The definition of the blocking back factor BBF displayed as link data has been “reversed” so that it is now 1.0-BBF that is plotted (as a percentage) instead of BBF. Thus if a link is not blocking back, in which case BBF = 1, a value of 0 is displayed; but if a link is strongly blocking back, say BBF = 0.2, then a “positive” value of 0.8 (80%) is displayed. This makes it much easier to identify those links that are blocking back.

- 42) A table listing the 10 biggest changes in blocking back factors over the final two assignment-simulation loops is included both within the Convergence Statistics within Information and within the Convergence Menu (#40 above). The same table appears in the .lpt files.
- 43) The KEY and VDU commands on the command line may now be combined into a single keyword KEYVDU such that “KEYVDU X” is equivalent to “KEY X VDU X”. Useful if the command line is near its maximum number of entries. 14.5.1.
- 44) Select Link Analysis may now be based on a network other than the “base” network 1 provided that the second network is structurally identical to that on network 1. 11.8.1.7.
- 45) A (normally hidden) message has been added whenever you go from the graphics screen to the text screen (e.g., when entering **SATLOOK**) such that, if the text screen is automatically maximised (as it should be), the message is hidden; if not, the message tells you to maximise it yourself.
- 46) The “rubber band” rectangle which indicates the choice of a new window under Boxes now has a 2 mm width if there is a background bmp file (so that it is more prominent).
- 47) Links which have been selected as part of a screen line under Select Link Analysis may be “de-selected” by clicking on a link which has already been selected.
- 48) Cumulative penalty times (i.e., 44444 data) and tolls are now included in the joyride tables in the .lpp files as well as being listed in the banner.
- 49) The list of link properties which may be annotated has been extended to include:
 - ◆ Blocking Back Factors from the previous assignment-simulation loop;
 - ◆ The differences between the last two sets of blocking back factors;
 - ◆ The previous set of assigned demand flows;
 - ◆ differences between the last two sets of demand flows.

All of these are useful in assessing assignment-simulation convergence.

D.14.2 MX

- 1) If sectors are used and certain zones are undefined (sector = -1) then an option is added to convert their sector definitions to 0 (which, post **SATURN** 10.4, is the standard default value for undefined sectors).
- 2) However it may be somewhat difficult to have undefined (-1) sectors in the first place since any input values of -1 (presumably from pre 10.4 network files) are automatically converted to 0 on input in order to conform with what **SATNET** does.

- 3) A new batch file MXWEIGHT has been added to take a weighted average of two .ufm matrices (as opposed to MXAVER2 which always takes a 50:50 average). 10.20.12.
- 4) The control (text) file used to input Furness trip ends may be in CSV format as well as fixed format to avoid any problems with the number of decimal places being limited. (In fact all numerical inputs into **MX** should now not be restricted in this way.) 10.7.5.
- 5) The options to “dump” to ascii/text files now explicitly includes Tuba Formats 1, 2 and 3 (but with some limitations). 10.15.

D.14.3 SATNET

- 1) Extra warnings have been added to deal with the improper use of the parameter KINKY (i.e., setting KINKY = F is bloody dangerous!)
- 2) Warnings identify the situation where a namelist variable name is correctly identified but the wrong data type is used; e.g., a text parameter is assigned an integer value.
- 3) The rules whereby bus routes are allowed / not allowed to make U-turns have been made (hopefully!) more realistic. This may also affect the way in which routes are interpolated between non-adjacent nodes.
- 4) An explicit check has been added on the maximum number of KNOBS, 8.
- 5) FORTRAN read errors encountered when processing extra KNOBS data lines within the 33333 records are now semi-fatal errors.
- 6) A new parameter (FREEKY) has been added to allow KNOBS data to be read in as “free format”, e.g., in CSV format.
- 7) Extra error checks are incorporated when reading 33333 KNOBS data, e.g., that there are not multiple entries in a single block of 10 columns. (Which may happen if the record being read is in fact a new link record, not a KNOBS record.)
- 8) Users may wish to note that 5-digit zone “names” are now permitted – and, in fact, have been for some time although not documented. 5.1.6.
- 9) The extra line input following a simulation link record to define a link speed-flow or capacity-restraint function may now explicitly code an ‘S’ or ‘T’ in column 29 to indicate whether the two data fields in columns 11-15 and 16-20 are speeds or times. If blank the parameter SPEEDS decides. This means that buffer network 33333 link records may be copied directly for this purpose without worrying about whether they use the same conventions about speeds/times as simulation link records. 6.4.12.
- 10) Completely blank lines in network .dat files are now explicitly detected and treated (mostly) as comments. Previously they were read as blanks (doh!), i.e., one or more zeros, which might cause fatal or semi-fatal input errors, for example if they were link count records which had to contain non-zero A-node and B-node entries. The one exception to this rule is KNOBS data contained on a separate line following a buffer link, in which case a full set of

zeros is a legitimate input. (Previously blank lines were explicitly detected and ignored under 33333 records only.) 15.29 and 15.14.5.

- 11) The rules concerning capacity-restraint data on links from an internal simulation node to an external node which have been coded within **both** the 11111 and the 33333 data segments have changed such that the 11111 data is **always** used independent of FIFO. 6.15
- 12) The option to “UPDATE” using a previous network has been improved such that a much better initial simulation-assignment convergence may be obtained using UPDATE. See also D.14.7 (3). 15.3.
- 13) A new semi-fatal error has been introduced if, with multiple user classes, a user class definition does not appear within the 88888 data records (or if, less likely, the same user class appears twice).
- 14) An error check (Serious Warning 139) has been introduced to detect X priority markers at priority junctions which have apparently been coded on the **wrong** arm and which can cause a straight ahead major movement to give way to opposite turning traffic. The results can be catastrophic! (And found to occur in real networks which have been apparently well validated.) See 6.4.2.2.
- 15) A further error check has been introduced (Serious Warning 137) to detect inconsistent saturation flows per lane (e.g., a left turn been given a saturation flow of 2,000 and the straight ahead being given 1,500 which might indicate that the numbers have been swapped around). The “rules” are essentially arbitrary but it is hoped that they will help to detect “gross” coding errors. See 6.4.6.3.
- 16) The default values of certain namelist parameters have been changed from their “historical” to their (previously) “recommended” values. The reason why they had not previously been changed was to ensure upwards compatibility with older versions of the programs. However, given that 10.5 is unlikely to give **exactly** the same results as previous versions (see, for example, D.14.5) it seemed to be a good moment to make these somewhat overdue changes. The parameters affected and their old and new values are listed below:
 - ◆ BEAKER from F to T
 - ◆ SHANDY from F to T
 - ◆ ISTOP to 95 from 90
 - ◆ MAXDTP to 10 from 0
 - ◆ MAXQCT to 60 from 0
 - ◆ NISTOP to 4 from 1

D.14.4 SATALL

- 1) The table printed at the end of each assignment-simulation loop listing the 10 turning movements with maximum differences in delays has been

updated to include current and previous capacities and cross-referenced to the **SATURN** manual.

- 2) Maximum transient queues per link and turn are now calculated and recorded for every simulation node.
- 3) An extra line has been added at the bottom of the “on screen” window during execution listing the values of MASL, NITA, etc.
- 4) An improved method for including signal optimisation stages (either SATOFF or SIGOPT = T) within the simulation / assignment loops has been introduced. The new method carries out a fully converged assignment / simulation loop before optimising the stages and/or offsets and repeating the “outer” loop. The process may be repeated a small number of times (as controlled by a new parameter NIPS). 9.12.2
- 5) Setting ICING = T but failing to define an input frozen trip matrix (which can be done either using FILICE in the .dat file or FREEZE on the command line) is detected as a fatal error. Equally if both FILICE and FREEZE are used the file set by FREEZE is used and a message to that effect is given in the .lpt file.
- 6) Flows which enter and leave simulation links at “the wrong ends”, for example bus flows when UPBUS = T, are more tightly controlled, avoiding potential reporting errors with link flows.

D.14.5 SIMULATION

- 1) Minor improvements made to the “yellow box” rules whereby X-turners at signalised junctions are opposed by traffic which is blocked back. See 8.5.3 and point 3 under Simulation in Appendix D-13.
- 2) A number (but not all) of the new simulation options introduced in 10.4 may now be excluded by setting NFT = 103.
- 3) The internal convergence of priority junctions with shared lanes has been improved in certain (probably not very common) situations where there is a local “surge” in arriving traffic, due, for example, to traffic signals very near upstream.
- 4) Blocking back rules have been changed in a number of ways to deal with situations where what is, in effect, a single link is coded as a series of links through 2-arm nodes (e.g., by including mid-link pedestrian crossings). Firstly, if the node at the upstream end of the “full” link is an external node then no blocking back is modelled at the downstream end. Secondly, if the “full” link ends at another internal simulation link then the stacking capacity considered is the **sum** of the stacking capacities of all the links in series. 8.5.4.
- 5) A potential problem in the lane-sharing sub-model has been corrected (see note 24 in the list of Bugs in 10.4) and will lead to marginally different results between 10.4 and 10.5 (as do points 1 to 4 above as well).

- 6) Random delays may now be applied to both “give-way” or “minor” turning movements as well as “major”, although the overall impact on existing networks is likely to be small. See 8.6.2.
- 7) An error in the calculation of delays has been detected under networks with $PASSQ = T$ for turning movements which share lanes. Thus if there is an initial queue at the start of the time period within the shared lanes **and** the relative proportions of turns within the shared lane(s) has changed from the previous time period then the over-capacity delay component may differ (possibly significantly) between turns whereas, since the queue is a common queue, the delays should be equal. The greater the change in proportions, the greater are the differences in delays. This has been corrected by calculating **all** over-capacity delays in shared lanes based on the shared queue and a common V/C ratio.
- 8) For networks where $PASSQ = F$ the V/C ratios should be identical for shared lanes so that the effects should be minimal. However small differences on early iterations, where the simulation convergence is less than perfect, may affect the overall “convergence path” and lead to small differences in the final results.
- 9) As a consequence of 7 and 8 the rules governing simulation turns which share lanes and are over capacity have been tightened up to insure that all turns in the shared lane(s) have exactly equal V/C ratios. Equal V/C ratios has always been the objective in such situations, but certain (fairly rare) circumstances have been identified in which they do not and small inequalities which were previously tolerated have been corrected.
- 10) The net consequence of changes 7, 8 and 9 is that the simulation in 10.5 gives slightly different – and, in principle, “better” - results from previous versions. An extra logical parameter Q105 has been added to allow the old rules to apply if $Q105 = F$ and, the new rules, if $Q105 = T$. 8.4.7.
- 11) A new set of parameters has been added to measure the convergence of each internal simulation node in terms of its **IN** profiles (i.e., the “between-node” convergence) in addition to the traditional convergence of **OUT** profiles (which measures both “between-“ and “within-node” convergence). 8.3.3.
- 12) The calculation of flow-delay curves has been tightened up for turns which (a) are heavily over capacity in the current time period and (b) have very large initial queues from $PASSQ$ such that $MAXQCT$ is invoked in both. The objective is to ensure that the delays calculated by the simulation and by the assignment agree. This can improve the convergence between the two sub-models. See also point 2 under D.14.7 as well as 8.4.6.
- 13) A new parameter $NITS_M$ has been introduced to set a **minimum** number of simulation iterations. This may be used to help to obtain very high assignment-simulation convergence levels which are otherwise limited by the simulation converging after only 2 or 3 internal iterations as the overall process nears convergence. (This applies particularly under OBA; see D.14.6.) 6.3.2 and 8.3.



D.14.6 ORIGIN-BASED ASSIGNMENT (OBA)

A major innovation in 10.5 has been the inclusion of the so-called Origin-Based Assignment (OBA) algorithm as developed by Hillel BarGera as a PhD student of Prof. Dave Boyce at the University of Illinois at Chicago in the late 1990's. His work has revolutionised traffic assignment in that his methods solve for Wardrop Equilibrium solutions to an accuracy limited only by the numerical accuracy of the computer and within comparable cpu times to existing algorithms such as Frank-Wolfe as traditionally used in **SATURN**.

OBA first became available in **SATURN** 10.5 through a collaboration with Hillel BarGera and the University of Chicago but with additional licensing requirements. Background papers are included in Appendix G and instructions for running OBA within **SATALL** are given in Section 21.

OBA is particularly efficient relative to Frank-Wolfe (the algorithm normally employed within **SATURN**) in assessing the impact of small "schemes". If the assignment is less than perfect then the change in, say, total vehicle-hours due to the scheme may be totally masked by the intrinsic "noise" in the with- scheme and without-scheme solutions. By making the assignment extremely accurate OBA allows the impact of even very small changes, such as the addition of a single lane or changes to signal timings, to be accurately measured.

D.14.7 ASSIGNMENT

- 1) A new parameter NITA_M has been introduced which sets a **minimum** number of iterations within the standard assignment methods. This may be used to help to obtain very high assignment-simulation convergence levels which are otherwise prevented by the assignment itself converging after only 1 or 2 internal iterations as the overall process nears convergence. 7.1.5 and 9.5.1
- 2) The use of MAXQCT to limit queuing delays in the simulation has also been introduced into the assignment so that the upper limits on delay are taken into account in working out route choice. This also potentially improves the convergence between the assignment and the simulation. 8.4.6.
- 3) The number of assignment iterations on the very first assignment-simulation loop when using an UPDATE network has been (potentially) increased in order to take full advantage of the potential benefits of UPDATE. See also D.14.3 (12). 15.3.
- 4) An extra demand-based convergence parameter for elastic assignment has been added, TxCij-AAD, which is based on the absolute differences between current o-d trips and the corresponding values calculated from the o-d costs and weighted by trip costs. It is very similar to an existing convergence parameter, TIJ-AAD, which, however, is unweighted. The new parameter is effectively the same as that used by DIADEM. 7.5.5.

D.14.8 SATLOOK

- 1) The list of the 10 worst-converged simulation nodes is now included within the standard convergence statistics.

- 2) An extra skimming batch file, SKIMPEN, has been added to SKIMTIME etc. in order to skim time penalties as set under the 44444 records (and which may have been used in the past to model tolls). 15.27.4
- 3) Various messages have been added for simulation links where the cycle times are different at the upstream and downstream nodes such that any signal co-ordination is lost. E.g., 17.7.
- 4) The various components of the calculation of a simulated delay (e.g., delay spent in cyclical flow profiles as opposed to over-capacity queues) may now be explicitly printed under node data. 11.??

D.14.9 SATDB

- 1) The link numbers as used for setting up a COBA network may now be created with the Miscellaneous Data Input Menu and also displayed using **P1X**. 15.42.4
- 2) When reading data from an external ascii data file an additional data column may be created which stores the line number for each input link. This may be used, for example, to display the data in the same order as input (by sorting on the line number column in ascending order).
- 3) An option has been added when inputting a DA column from two input files to automatically create a third column equal to their differences. This makes it quicker to look at, say, flow differences without having to explicitly create a differences data column.

D.14.10 SATOFF

The batch file satoff.bat may now automatically run **SATSIM** after running **SATOFF** in order to update the simulated cost-flow curves in order to make repeated loops with **SATALL** simpler. 12.2.4. (But see also point 4 under **SATALL** above for an alternative method of linking the two procedures.)

D.14.11 SATME2/SATPIJA

- 1) Extra documentation has been added to Section 13 of the Manual to give (we hope!) useful advice on common problems encountered in using **SATME2**; e.g. starting from a “good” prior matrix (13.1.9), what sort of counts to include (13.3.9), etc. The added warning messages (see below) reflect this new advice.
- 2) Warning messages are included in the **SATME2** LPM file if the flows from the input trip matrix differ “significantly” from the counted flows; i.e., if the prior matrix is a poor starting point and needs to be improved.
- 3) Equally warning messages are included in the **SATPIJA** LPJ file if the set of counts used appears to have problems.
- 4) A check is introduced as to whether the input prior trip matrix has been produced by **SATME2** in order to try to prevent users continually updating matrices through multiple loops through **SATME2**. Doing so is now a fatal error (although it **may** be allowed by explicitly setting a parameter ENCORE to T in the namelist parameters). 13.3.5.

- 5) A new set of (subscripted) **SATPIJA** control parameters SET777() allows certain sets of input counts contained within separate 77777 data sets on the network .dat file to be easily included/excluded from the .UFP files and hence from **SATME2**. 13.2.1 and 13.3.8.
- 6) Useful data from a run of **SATME2** (e.g., XA balancing factors) is dumped onto an ascii data file (extension .me2) which may be read by **P1X** to provide extra insights into what has happened within **SATME2**. 13.8 and 11.8.5.
- 7) Link flows as input on a **SATPIJA** control file are read essentially as free format, not – as before – as integers within 5 fixed columns. 13.2.1.
- 8) Counts may now be combined together (e.g., from parallel roads, over a screen line, etc.) such that the constraint is on the total flow over all links, not on individual links. 13.1.8.

D.14.12 SATCOBA

- 1) An option to add together the link flows from two or more input “networks” (presumably different time periods during the same day) and output a single weighted flow as opposed to the full set of multiple flows is now available. 15.42.2. (In fact this was the original intention of **SATCOBA** and what the manual says it does!)
- 2) An extra table of link turning proportions (COBA KEY 082) has been added. This is useful for generating accident statistics. 15.42.1
- 3) Extra documentation describing how to display the link numbers generated by **SATURN** for cobra links within **P1X** has been added. 15.42.5
- 4) Link flows on simulation links which are “bridged” by centroid connectors may now either be defined as mid-link flows or (the recommended default) as stop-line flows at the downstream end (i.e., to include entry flows from centroid connectors). Parameter MIDLF. 15.42.2
- 5) The necessary “knobs” data to define user-specified link numbers may now be input directly to **SATCOBA** rather than through **SATNET**. 15.42.3
- 6) Documentation explaining how to use a common system of link numbers for both, e.g., “do-minimum” and “do-something” networks using KNOBS data has been added. 15.42.4.



D.15 Changes in SATURN 10.6

DATE OF LAST UPDATE: 16 JANUARY 2006

SATURN 10.6 was first released in Beta versions during 2005 (with temporary version numbers 10.6.1 thru 10.6.12) and as a full release (official 10.6.14) in March 2006. The following new features are to be noted. (Note as well that the documentation has been extensively updated to take account of these new features and references to the relevant sections of the manual are given.)

Items added after the original release of 10.6.14 are given in italics.

D.15.1 P1X

- 1) An option to select from multiple count fields added in the plotting options under Validation/Counts
- 2) Select Link Analysis may now be undertaken for "All OD pairs", i.e., with no test on whether or not an OD pair should be included;
- 3) The width of a lane (which defaults to 3.75 m) may be altered with the effect of making the roads appear wider when plotted with explicit lanes; the same effect applies to junction line drawings. 11.6.4(8).
- 4) Various options to calculate and display the "worst" O-D paths in terms of having the maximum cost in excess of the minimum have now been added. These help to identify where convergence problems are arising
- 5) Options have been included under Node and Link Information to list all the link data currently stored in the data base.
- 6) The input format of curved links on .gis files (77777 data) has been modified such that it is no longer strictly necessary to include blank records at the end of links where the number of X,Y points is a multiple of 4. This may make it easier to import data from external data sources such as Mapinfo files, etc. Appendix Z, BLOCK 7.
- 7) The convergence options will now print the standard convergence tables 1 and 2 for **all** input networks (if more than one).
- 8) Enclosed polygons in GIS files may now have a line width associated with them. Appendix Z, Block 1.
- 9) The "intensity" of a .bmp may now be defined within its .xyb file. 15.43.6.
- 10) Plotted count data under Validation/Counts may now be selected by the 7777 set number in the same way that selection may be done under "Go".
- 11) The "link selection rules" may now be applied to the analysis of counts under Validation/Counts.
- 12) Links selected under Information may now either be 1-way or 2-way; in the latter case, once selected, the properties of both directions of a link are given.

- 13) Link information now lists all bus routes which go through that link.
- 14) An Appendix I.1 has been added which lists (or will eventually list when it is finished) all the various link data items available in **P1X** with a potted explanation of what each contains. Similarly Appendices I.2 and I.3 list node and turn data respectively..
- 15) Extra simulation link data is provided, for those links with capacity-restraint speed-flow curves defined, to differentiate delays associated with the link capacity restraint, those associated with turning movements at the stopline and the sum of the two. Previously what was being plotted when was somewhat ambiguous in that situation (it was actually the sum although it was misleadingly titled “delay at jcn”).
- 16) A negative link width by capacity index implies that links with that capacity index will not be plotted. The negative values may usefully be input via the preferences file to automatically suppress the plotting of certain classes of links. 11.6.4, note 4.
- 17) Under Node Graphics it is now possible to output some of the numerical **SATLOOK**-based tables (E.g., the table of turning flows and delays) directly to windows which may be cut, pasted etc.
- 18) Hard copy plots are now scaled to use 100% of the plotter paper if required. Previously only 95% was used. This is probably only important if a .bmp background file is being printed as well since, previously, the .bmp file was scaled to 100% and therefore came out 5% larger than the network plots.
- 19) As mentioned above, 18, hard copy outputs may now include .bmp background files to the correct scale. 15.43.4.
- 20) The main Window bar choice “Back”, which previously had two pull-down sub-menus for either going “back” one level or going directly to an option in the “master menu”, now appears as two separate items in the Window bar – “Master Menu” and “Up1”. Up1 is equivalent to “Return” or “Quit” in the banner and has the advantage that it always remains in the same position to make multiple returns simpler.
- 21) *Three extra link data items have been added under “Times” in P1X in order to display the value of CLICKS per link, the extra time penalty per link due to CLICKS and the cruise speed with CLICKS included. 10.6.16.*
- 22) *Improvements have been made to prevent the “Master Menu” and/or “Up1” options on the Windows command bar line from being “greyed out” when they need not be. 24/05/06*

D.15.2 MX

- 1) The outputs obtained from dumping “Grand Matrix Totals” have been extended, particularly with multiple matrices with multiple levels
- 2) New “batch” procedures UFM2CSV etc. have been introduced in order to easily “dump” .ufm matrix files into “text” or “ascii” with a number of standard formats; e.g., UFM2CSV creates a CSV file for transfer into Excel, UFM2SATL dumps into the standard “long” SATURN format, etc. 10.20.13.

- 3) Equally CSV2UFM automatically builds .UFM matrix files from a CSV text input such that, by combining with UFM2CSV, it becomes much easier to transfer SATURN matrices to and from, e.g., EXCEL. 10.20.14
- 4) The number of decimal points used to “dump” matrices to text files under Tuba formats 2 and 3 is now user-defineable. The number may also be set by default in the MX preferences file mx0.dat (using namelist parameter name NDPS). 10.15.2.
- 5) Equally matrices may now be “text-dumped” with E-formats (e.g., 0.602E+02 as opposed to 60.2) and a user-set number of decimal points with most output formats (i.e., not just Tuba formats). The advantage of E-formats is that all output numbers have the same “precision” independent of their absolute value.
- 6) Explicit options to read in text files with Tuba formats 1, 2 and 3 are now included. 10.5.6.
- 7) The standard “batch” procedure MXM1 (aka M1) will now read data files in which the standard header records are combined with cell values given in CSV formats (which therefore includes Tuba Format 1). This facilitates the direct input of matrices from other suites of programs such as EXCEL. 4.4. This option uses a new Namelist parameter KROPT (to be documented eventually within 10.5.1).
- 8) The “automatic” batch procedures such as MXFACTOR, MXSTACK, etc. have been modified to be 100% background. Previously they would open a terminal screen and write file details to it; they now create a file dummy.vdu instead so that they function in the same way as KEY + VDU. N.B. Similar changes have been made to batch files using **SATLOOK** and **SATDB** etc.
- 9) The facilities to create a .ufm file by reading a text file with one record per line have been improved, in particular to allow stacked matrices to be created in this manner with the level explicitly input. 10.5.3.
- 10) An option to allow “lines” of row and column zone names to be embedded within the screen display during screen editing (as opposed to only appearing at the edges of the display) has been introduced. Equally buttons to shift the screen edit area up, down, left and right have been added. Version 10.6.15 07/03/06.
- 11) *The batch file MXSTACK will now accept up to 8 input matrices to be stacked; previously the (unstated) maximum was 7. May 2006.*
- 12) *New batch files STACK and UNSTACK have been added with consequent changes to MX. UNSTACK automatically unstacks a stacked matrix mat.ufm into square matrices mat1.ufm, mat2.ufm, etc. while STACK does the opposite, i.e., creates a stacked matrix mat.ufm from mat1.ufm, mat2.ufm. This avoids having to explicitly name the sub-matrices. Both require the 10.6.17 version of MX. 03/06/06. 10.20.11 and 10.20.12.*
- 13) *The “internal” unstacking option within MX now offers three options for naming the output unstacked matrices: (1) fully interactive (as now); (2) mat1.ufm, mat2.ufm ... where mat.ufm is the matrix being unstacked, or (3)*

root1.ufm, root2.ufm where “root” is defined independently of current matrix names. 03/06/06. 10.17

- 14) *An “XCL” option has been added within MX whereby an eXtra Command Line can be added to the MX batch files to enable more than 9 arguments to be called on the command line. Section 14.8. 25/05/06.*

D.15.3 SATNET

- 1) Extra arrays in the output .ufn/.ufs etc. files contain a list of all link tolls (as opposed to previous versions where only the tolls entered under 44444 were explicitly stored). This means that a number of analysis options such as Joy Rides in P1X now give complete summations of link tolls en route.
- 2) A new semi-fatal error has been introduced whereby, if the network and the trip matrix have the same number of zones and the zones in each are “named” (i.e., they have non-sequential numbers), the same zone name appears in different positions in both. For example, if the network zones are 1,3,4,5 ... and the matrix zones are 1,2,3,5... then zone 3 appears as either the 2nd or 3rd zone. Highly suspicious! 5.1.6.
- 3) If UPDATE is set to .TRUE. in &OPTION but no update file is explicitly set (either via UPFILE or the command line) then the program looks for a .ufs file with the same root; i.e., after ‘SATNET net’ it seeks to update the file net.ufs. This ensures that if a network data file net.dat is being continually edited each new version will be updated with the results from the last run of **SATALL** with (hopefully) reductions in the subsequent **SATALL** run times.
- 4) A new option WSTART (for Warm START) has been included within &OPTION to enable the first assignment to be a “warm start”, i.e., one which commences from a previous assignment solution. In addition the documentation and advice relating to warm starts has been enhanced and users are strongly recommended to read Section 22.
- 5) Networks may now be built under ATLAS = T with only 55555 X,Y node co-ordinate data included (i.e., no simulation or buffer links at all) in order to prepare a network to be edited under PMAKE – presumably from an existing data base consisting of node names and co-ordinates. 18.5.2.
- 6) Setting an XFILE which cannot be opened (for whatever reason) is now a semi-fatal error, not a non-fatal error.
- 7) Coding the first turn from a link at signals as an X-turn rather than the last turn (i.e., the left turn as opposed to the right turn under drive on the left) is now a semi-fatal error.
- 8) BUSKER now uses a different “compressed” format for very long bus routes in order to fit them within the maximum allowed 20 records. 6.9.2, note (10).
- 9) An option to define variable maximum free-flow speeds by user class, code name “Clicks”, has been introduced. This allows, for example, heavy lorries to have lower speeds (and therefore higher times) than cars on high-speed motorway links. In turn this may influence their assigned route choice. 15.47.

- 10) The total number of error checks (in addition to the specific check noted in 2 above) has been increased. Thus Warnings 80 to 85, Serious Warnings 41 to 48, Non-Fatal Errors 63 to 65 and Fatal Errors 74 to 84 are all new. Users are strongly encouraged to check out these errors in particular in the .lpr files. In addition, since the fatal errors have been extended, it is quite possible that network data files that previously “passed” will now “fail” and the necessary corrections will need to be made before that network will run under 10.6.
- 11) Checks have been added for negative weights (e.g., PPM, PPK, etc.) used under 88888. 02/06/06
- 12) Extra error checks have been added for potential problems reading default speed-flow curves under 33333 with DUTCH = T. The problem is that if you do not include the extra columns required under DUTCH the speeds etc. get misread and it is possible that all default speed-flow curves are missed out with no error message printed. This one has been around along as the default speed-flow curves under 33333 have been. Corrected in 10.7.1 only. 09/06/06

D.15.4 SATALL

- 1) The convergence rules for terminating the assignment – simulation loops have been extended to include both gap values and total cpu time. 9.2.3.
- 2) The SAVEIT assignment for a single user class now automatically uses the PARTAN option (7.11.7) which should provide a more accurate assignment and therefore better post-assignment analysis of route flows. 15.23.4.
- 3) A “morning after pill/procedure” **SATUFC** based on **SATALL** has been created which will build a new .ufc file containing a new set of assignment routes under SAVEIT. This can be useful if, for example, the original SAVEIT assignment was not accurate enough or was not carried out at all (SAVEIT = F). 15.23.5.
- 4) CODMIN = T (as set in the network .dat files) automatically generates a matrix of O-D minimum costs at the end of the assignment.
- 5) Frozen cells may now be used with incremental distribution (i.e., ICING = T with MCUBC = 1).
- 6) The WSTART (Warm Start) option now allows the very first assignment within **SATALL** to be based on the flows from a previous assignment, leading to potentially major improvements in convergence and cpu times. Section 22.
- 7) Related to WSTART, assignment solutions may now be stored as “UFO files”, a description based on OBA methodologies which enables warm starts to be carried out even if the network and/or the trip matrix have been modified. Section 22.3.
- 8) Multiple corrections have been added under WSTART as per Appendix E.4, note 7. 10.6.15 onwards.

- 9) Multiple corrections have been added under CLICKS as per Appendix E.4, notes 10 and 14. 10.6.15 onwards.

D.15.5 SIMULATION

- 1) Print-outs of blocking back factors now differentiate between whether the link is the first in a chain of links which block back or somewhere after the first. This may be useful information to analyse non-convergence of blocking back patterns.
- 2) Minor modifications have been introduced into the simulation of roundabouts to deal with an extremely rare possibility that the capacity of an arm could go to zero and cause divide-by-zero crashes. A bi-product of these changes is an improvement in the rate of internal convergence. The "old" form of simulation may be retained by setting an &PARAM parameter RB106 to F. 8.7.3.
- 3) The rules by which turning movements which are green in two successive stages are assumed to be continuously green during the inter-green have been extended to **exclude** double-phasing at pedestrian signals and the rather unusual case of X-turns which are green in all stages. 6.4.3.
- 4) Various changes have been introduced in the simulation from 10.6.15 thru 10.6.17 to prevent program crashes; see item 11 in Appendix E.4. It is expected – although not guaranteed – that these changes will not have any effect on networks that currently run happily, only on those that currently crash

D.15.6 ASSIGNMENT

- 1) A new form of distribution is introduced for stochastic assignment defined in very general terms via a "cumulative density function". For example, one may use this option to define a gamma distribution, a log-normal distribution, etc., etc. See 7.2.3.
- 2) The upper limits on NITA and NITA_S have been increased to the minimum of 1001 and 4004/NOMADS so that clearly the second restriction will only apply if the number of user classes (NOMADS) is five or greater. In addition this restriction should only really affect NITA_S since the values used for NITA should be much smaller than these limits anyway.
- 3) If both AUTOK = T and NIPS > 0 so that the assignment-simulation loops are repeated with updated signal settings the AUTOK averaging is not applied on the first loop post updating. May 2006. 9.12.2

D.15.7 SATLOOK

- 1) Total network statistics such as total vehicle-hours, vehicle-kms, etc. are now printed disaggregated by user class for buffer-only networks.
- 2) Joy ride statistics as printed to the .lpl file (but not to the terminal) now include total penalties and tolls.

- 3) Forest skims output as text files (Tuba Formats) may now be optionally written in E-formats and/or with a variable number of decimal points for maximum precision.
- 4) The definition of “costs” either for building trees or for skimming has been extended to explicitly include monetary tolls. This applies to be both “forest skims” and to single minimum cost paths (options 9 and 14 respectively). Later versions of 10.5 may contain the same facilities.
- 5) The output menu for simulation nodes now includes an option to print all capacity-reduction factors associated with motorway link weaving. 15.40.8.
- 6) GO4IT has been added to SATLOOK0.DAT to make it easier to avoid problems with key files and whether or not new files are automatically over-written. 10.6.17. See also notes 3 and 4 under D.15.8 which make it less necessary to worry about GO4IT.
- 7) Explicit options have been introduced to include/exclude 44444 penalty times and/or extra CLICKS time in the definition of skimmed “time”. (See item 13 in Appendix E.4.) May 2006. 15.24.4 and 15.27.7.

D.15.8 Key Files

- 1) The command line parameters KEY and VDU have been combined into a single parameter, KEYVDU, such that, e.g., MX matrix KEY X VDU X may be written as MX matrix KEYVDU X. The main advantage is that it can save two parameters on a command line which, given that the upper limit is 10, can sometimes be useful. See 14.5.1.
- 2) More rigorous checks for KEY files which terminate prematurely have been introduced in order to remove potential problems of programs hanging. 10.6.15.
- 3) New checks have been included on incorrect key files where a file to be opened does not exist and therefore there is no question “Do you want to over-write this file?” but the key file contains a Y response to say Over-write. See 14.5.9. Non-fatal error. 31/05/06
- 4) Similarly the fatal error that trapped the converse Key File error where a Y line was needed (“Yes I want to over-write an existing file”) but not included is now a Non-Fatal Error. See 14.5.9. 31/05/06

D.15.9 SATCOBA

- 1) The order of links at priority junctions used to output turn proportions may now be optionally adjusted such that the first two links are, in order, major and minor. Parameter MAJORM, 15.42.2
- 2) Flows from (up to 3) multiple user classes may now be output. Parameter MUC, 15.42,2

D.15.10 SATME2 / SATPIJA

- 1) As with SATNET a new fatal error has been introduced such that, if the network and the trip matrix have the same number of zones and the zones

in each are “named” (i.e., they have non-sequential numbers), the same zone name appears in different positions in both. For example, if the network zones are 1,3,4,5 ... and the matrix zones are 1,2,3,5... then zone 3 appears as either the 2nd or the 3rd zone. Highly suspicious! See 5.1.6

- 2) New statistics listing the maximum / minimum changes by O-D pair / origin / destination are given under Table 14. These may be compared with values of input parameters such as XAMAX.

D.15.11 SATCH

- 1) A new parameter INTRAS has been added such that, if INTRAS = T, any intrazonal trips from the input trip matrix are included in the cordoned trip matrix. 12.1.4, note (14)
- 2) The cordoned bus routes “respect” the use of FOZZY in that, if the nodes in the “full” network are not consecutive but require intermediate nodes to be interpolated, the intermediate nodes are also excluded from the cordon routes. 12.1.4, note (15).
- 3) Potential problems associated with using either GONZO or explicit user-class factors within the 88888 records have been identified and corrected. See 12.1.6 and 12.1.7. The basic problem is that it was possible to “double count” the effect of GONZO by including it both (explicitly) within the cordoned network .dat file and (implicitly) within the cordoned trip matrix.

D.15.12 Documentation

- 1) The Manual has been extensively upgraded and extended to cover not only the new options listed above but also to explain in greater detail existing features of SATURN. See, in particular, sections 4.4, 8.4.8, 9.2, 9.5, 11.15, 15.3, 15.4, 15.23, 15.27, 15.46, 21.3, 21.8, 22 and Appendix E, in addition to specific sections above.

D.15.13 SATPIG

- 1) Route data is now output only to the .trp (or .kp etc.) ascii text file, not to the .lpg file, in order to save creating two potentially very large files when only one is really necessary.

D.15.14 SATDB (DBDUMP)

- 1) A new batch file dbdump has been introduced in order to automatically dump data from a SATURN .ufs file into an ascii text file. For example, the command:

```
Dbdump net flows.txt 4503
```

automatically dumps the demand flows (DA code 4503) from net.ufs into a file flows.txt. Various options are provided to control the “format” etc. of the output file. 15.46.

D.15.15 SATTUBA

- 1) *SATTUBA has been extended to treat individual user classes under MUC.*



D.16 Changes in SATURN 10.7

DATE OF LAST UPDATE: 8 JULY 2007

SATURN 10.7 was first released in Beta version from July 2006 (with purely temporary version numbers 10.7.1, 10.7.2 etc.) and as a full release (official 10.7.8) in February 2007. The following new features are to be noted. (Note as well that the documentation has been extensively updated to take account of these new features and references to the relevant sections of the manual are given.)

D.16.1 P1X

- 1) “Default” link capacity-restraint records may be defined for simulation links under Network Editing. I.e., you define simply a capacity index and the parameters of the speed-flow curve are taken from a “default” (D) record defined under the 33333 data records. 20/06/06.
- 2) Link travel times and/or speeds as calculated by **P1X** during tree building and/or joyrides and displayed in the banner now (optionally) include the effect of CLICKS. 10.7.1 09/06/06
- 3) Options added within **P1X** network editing of simulation nodes/links such that a default speed-flow curve (i.e., one based only on the capacity index and curves defined under 33333) can be created for a simulation link rather than explicitly setting a free-flow speed, capacity speed, etc. etc.. 10.7.1 14/06/06
- 4) Banned turns displayed within **P1X** as “blocked arrows” previously only included turns with zero saturation flow as coded under 11111 but not any turns for which a banned movement was defined under 44444. The latter turns are now included as well. 16/08/06
- 5) Filenames as listed under “Show A-Z” now contain up to 24 characters on 2 lines in the banner if necessary. 24/08/06
- 6) The (text-based) options within **SATDB** to input data (e.g., flows) for ALL user classes now allow the total number of user classes to be greater than 4 and data for ALL classes are added to the data base. 06/10/06
- 7) Nodes may now be “marked” or “highlighted” with a small circle to indicate where either (any) warnings or certain **specific** warnings, etc. have occurred during the network processing in **SATNET**. This can therefore act as a guide to locating nodes where particular errors have occurred so as to make it easier to correct those errors through Network Editing. See 11.6.5.4. 30/10/06
- 8) The use of the “mouse” has now been effectively turned off when **P1X** is run with both KEY and VDU options on so as not to interfere with the use of the mouse by any other currently running windows. 01/11/06
- 9) The number of scatter plots and tables within windows which appear under the Validation of Counts disaggregated by count sets is now strictly limited

since, with up to 120 different count sets now permitted, the number of active windows created becomes prohibitively large.

- 10) The total number of individual Warnings, Serious Warnings, etc. etc. generated within **SATNET** along with informative titles may be displayed in a window as an option under Information. A summary table of warnings etc. by data input segment is also included. 11.8.4.9. 06/12/06
- 11) The option under Information to display “Convergence errors etc.” has been replaced by a shorter option that simply list CPU times and other miscellaneous network data such as elasticities etc. since Convergence statistics are provided within their own main menu and the error messages are now given separately under #10 above. 11.8.4.8. 07/12/06.
- 12) User Class Flows may now be optionally annotated in units of vehicles per hour as opposed to PCUs per hour provided that: (a) the user class has been assigned a vehicle class and (b) that that vehicle class has a value of VCPCU different from 1. N.B. This option does **not** apply to total flows where, for certain components such as PASSQ flows, it is more difficult to establish PCU factors. 16/12/06
- 13) Extra link and turn data annotations have been made available, for example the average queue lengths associated with V>C queuing may now be displayed in addition to the total average queue length previously available. Full lists available in App. J. See also D.16.3 (3). 28/01/07.
- 14) A new set of options has been added under Tree Building to identify the “Worst O-D routes”; i.e., those paths where the difference between the path cost and the minimum O-D cost is maximised. Identifying such paths may help to pin-point the sources of convergence problems. 11.8.3.4.
- 15) The default “user class” for SLA has been set to zero so that, for multiple user classes, all user classes are analysed. For a single user class it defaults to 1. Also added as a parameter MADSLA in the preferences file. Similar changes are made in **SATDB**. 10.7.8. 17/02/07.

D.16.2 MX

- 1) The MXM5 options now allow zones to be deleted from an existing matrix. (Or, strictly speaking, the documentation makes it a bit more clear how to do it.) See Appendix W.3. 03/06/07
- 2) MXM5 permits newly created zones to have user-defined row, column and intra values set; previously all new zones had their cell values set to zero. Appendix W.3.
- 3) MXM5 will now operate on both “simple” square matrices and stacked or blocked matrices. Appendix W.3.
- 4) The “interactive” zonal editing options within **MX** now allow you to create an equivalent input file for MXM5 to make it easier to repeat the same editing operation on other matrices. 10.4.1.
- 5) The numerical Trip Length Distribution options have been extended (a) to allow more options (e.g., include/exclude intra-zonals) and (b) to output

directly to an external ascii file or to a window to make accessing the results easier.

- 6) An option to dump data from more than one matrix to an ascii text file has been added but only under the specific formats of Tuba-3 or “one IJ record per line”.
- 7) Dumping SATURN .UFM files to EMME-2 formatted text files previously excluded any output for matrix rows which contain **all** zeros. 10.7 adds a text record consisting of only the row origin in the case of all-zero rows. 18/12/06.

D.16.3 SATNET

- 1) Bus routes are now allowed to make a U-turn at **all** types of simulation nodes, not just simulation type 5 roundabouts or buffer nodes as before. The U-turn is treated as a “free turn” with no delay added. See note (10), section 6.9.2.
- 2) Bus routes are now allowed to exit the network at one external node and re-enter at another (where an “external node” in this context may be either an external simulation node which does not lead into the buffer network or a buffer node which exits only to a zone. This will probably have more applications within cordoned networks where routes in the main network may snake in and out of the cordoned network. See note (11), section 6.9.2.
- 3) If a parameter WRIGHT is set to T then certain existing warnings, serious warnings and/or non-fatal errors may be upgraded to semi-fatal (NAFF) on the basis that there is no conceivable reason that could explain these errors even though **SATURN** can manage to run with them included in the network coding without crashing. At the moment only a small number of Serious Warning (139 and 140) and Non-Fatal Error 227 have been so identified but the number will increase. N.B. The default value for WRIGHT has been set to .TRUE. in the release version 10.7.8: attention! 6.12.2. 09/10/06
- 4) All warnings, serious warnings, etc. that occur at nodes are now cross-classified by node numbers so that the final error summaries in the .LPN files not only list the number of times a particular error occurred but also the nodes at which those errors occurred. The information is also added to the .uf* files for display in P1X under Information. 26/10/06
- 5) Links which appear in more than one set of 77777 counts are now recorded as appearing in **both/all** sets and will appear as such within the Validation etc. summary statistics in **P1X**, **SATLOOK** etc. However links which appear twice within the **same** count segment are still errors. 30/10/06
- 6) The maximum number of individual 77777 count sets has been increased from 20 to 120. 12/11/06
- 7) Setting ERRYES(437) = F converts a Semi-Fatal Error for an unidentified link within the 77777 records into a Serious warning 269 such that the assignment stage may still be invoked. 11/11/06

- 8) A logical namelist &PARAM parameter CROWCC has been introduced to control whether zero-distance buffer centroid connectors are assigned a non-zero crow-fly distance. See E.4, # 29 and 15.10..3 03/12/06
- 9) The number of individual Warnings, Serious Warnings etc. generated within **SATNET** are now stored on the output .uf* files and may be displayed in **P1X**. See D16.1 #10. 06/12/06
- 10) A summary table giving the number of Warnings, etc. by input data segment (i.e., 11111, 22222 etc.) is now included near the end of the .LPN files and is also interactively printed on request in **P1X**. 09/12/06
- 11) A new option “UNIQUE” has been introduced to minimise the double-counting of V>C delays in buffer networks in certain circumstances. Consider a series of links A-B-C-D... in the buffer network such that traffic on A-B can only exit to C (ignoring U-turns to A), traffic on B-C can only exit to D, etc. etc. Hence all links will be assigned the same demand flow V. At the moment if, say, all links have the same capacity C and $V > C$ then the same queuing delay will be imposed on all links – “double-counting”. However, if UNIQUE = T, the extra delay is imposed at only **one** of the links (that with the minimum capacity which therefore represents the “bottleneck”). This option is useful if, say, an existing buffer link A-C is split by a mid-link node B with no other changes and the same link properties apply on both A-B and B-C. See 15.48. 01/02/07.
- 12) Default speed-flow curves by capacity index under 33333 may now be defined directly in terms of COBA-10 speeds and flows such that the best-fit value of the power n is calculated by **SATNET** rather than being input directly by the user. 15.9.6 10/02/07.

D.16.4 SATALL

- 1) The simulation summary statistics such as total pcu-hrs etc. may differ marginally from those calculated previously due to a bug discovered in previous releases. See Appendix E.4, #26. 14/11/06.
- 2) .The CLICKS option to allow differential speeds by user class has been extended to allow CLICKS to be disaggregated by link capacity index. As selected by setting an &PARAM parameter KLUNK = 1. 15.47.2. 03/12/06.
- 3) The number of simulation data arrays stored by **SATALL** on the .ufs file has been extended to include:, e.g., queues due to V>C per simulation link and/or turn. These new data arrays may be viewed within **P1X**. Many of them make use of the extra space available for DA codes in 10.7 as noted D.16.9 below. 28/01/07
- 4) The rules for using a stacked trip matrix under MUC have been tightened up so that if, for example, the trip matrix has 5 levels but the network has only 3 user classes or if one of the levels of the trip matrix is not selected by any of the user classes it is a fatal error. Check the definitions of matrix levels in the 88888 records of the network .dat file.

D.16.5 SIMULATION



- 1) The procedures by which delays are calculated for X-turns at priority junctions which share lanes have been revised slightly in order to remove a possible discontinuity in the outputs which was adversely affecting the assignment-simulation convergence. 02/07/06.

D.16.6 SATLOOK

- 1) Comparison statistics between modelled flows and input counts may optionally **not** appear on the terminal screen in otherwise interactive modes but only in the LP files. This can be useful when there are a very large number of counts and/or count sets. 12/11/06.
- 2) The tests for DETR-compliance have been (correctly) extended to include the separate category of counted flows above 2700 and the default is now for DETR compliance to be **included** by default (but this may be changed, if desired, via the preferences file). 21/11/06
- 3) A number of other improvements have also been made to the comparison of observed and modelled flows, particularly when the counts have been divided into multiple count sets under the 77777 network data. In particular a CSV file containing "headline statistics" for each input count set has been introduced and which contains a summary of all the most important statistics in a CSV format. 03/12/06
- 4) It is possible to carry out count comparisons using an **input** file of count data rather than relying on counts input under the 77777 data records in the original network .dat file. See 11.11.13. 04/03/07
- 5) Extra options which indicate when and how much the link capacity, as defined on a link speed-flow record, "actively" restricts the junction stop-line capacities. See 8.4.4. 23/12/06

D.16.7 SATTUBA

- 1) New versions of the batch file sattuba0 and sattuba3 added to request output files in .ufm format or tuba-3 format respectively. 15.41.4.3 15/08/06
- 2) Files for **all** user classes may be output from a single command by using "UC *". 15.41.4.2. 27/08/06

D.16.8 SATME2/SATPIJA

- 1) A new method to "freeze" cells has been introduced whereby a matrix of frozen cells may be input in much the same way that frozen cells may be introduced into the elastic functions within **SATALL**. 13.1.6. 26/11/06

D.16.9 SATWIN

- 1) The initial SATWIN start-up screen as been replaced by a new menu to select the various versions of SATURN Executables installed on the machine. See 3.6. 18/02/07

D.16.10 DA Codes

- 1) The conventions by which DA codes represent different styles of data have been extended such that “real” data (i.e., numerical data which includes decimals) can be stored in codes ending with an **8** as well as a 3. Effectively this doubles the number of available codes and the number of data arrays that can be stored. See 15.21. 28/01/07

D.16.11 SATDB

- 1) An alternative method of representing bus route data in the data base has been introduced whereby the new data column stores the **order** of the link or turn in the route, i.e., the first link in the route is 1, the second is 2, etc. etc.. The old method simply stored the route number. This option is useful if you wish the data display on, e.g., the screen to appear in route order.
- 2) SATRAP (full multiple route re-assignment) now allows a sub-matrix of O-D trips to be specified in terms of sectors in addition to zones. This permits one to calculate, in effect, a “forest” of loaded trips between two sectors. 10.7.4. 15/12/06
- 3) If there are more than six columns of data to be displayed to the terminal screen then Left and Right control buttons have been added to the menu bar. Equally a Formats button has been included to directly change the format (number of decimal places) of an individual column. 10.7.8. 21/02/07

D.16.12 Documentation

- 1) The Manual has been extensively upgraded and extended to cover not only the new options listed above but also to explain in greater detail existing features of **SATURN**. Note, in particular, Appendices I and J, which document what is contained in DA codes and what P1X annotation consists of, and Appendix K, a list of all available batch files, has been added.
- 2) The Manual is now in A4 PDF format and is updated on a regular basis – typically every quarter – and is available for download from the SATURN website.



D.17 Changes in SATURN 10.8

DATE OF LAST UPDATE: 21st JUNE 2009

SATURN 10.8 was first released in pre-Beta version in March 2007 (with purely temporary version numbers 10.8.1, 10.8.2 etc.) and as a full Beta release (official 10.8.12) in December 2007. The first full release was version 10.8.15 in March 2008 followed by a (limited) release of 10.8.16 in June 2008 and a more general release of 10.8.17 in July 2008. The latter two contain, mostly, additional analysis facilities but see also point (18) under D.17.5 regarding possible differences in numerical outputs. Thus 10.8.17 can be expected to give different results (probably only slightly different) from 10.8.15.

The “final official” release was, firstly, 10.8.20 in December 2008. With the exception of one extremely minor change to the simulation routines (point (19) under D.17.5), which was added to avoid a potential crash and should never occur in a well-formulated network, there were **no** changes to the basic simulation or assignment routines in 10.8.20 over and above 10.8.17 so that the results should be identical. However a number of extensions were made to the various subsidiary programs; see, for example, points 10) to 12) under **SATME2** which may be extremely useful.

A second “even more final” release of 10.8.21 was made in February 2009 with the specific objective of including a small number of quite useful analysis options which had been developed as part of release 10.9 but which could easily be shoe-horned into 10.8. See points 46) to 48) under **P1X**, 22) under **SATNET**, 7) under **SATLOOK** and 3) and 4) under General (D.17.10). In addition a number of minor bugs were corrected. However there were **no** changes to either the simulation or assignment routines between 10.8.20 and 10.8.21 so that 10.8.21 should give identical results to 10.8.20 and, in turn, almost certainly, identical results to 10.8.17.

A third and definitely “final” release of 10.8.22 was made in June 2009 with the specific objective of enabling the release of SATURN Multi-Core as part of v10.8. As with v10.8.21, there were **no** changes to either the simulation or assignment routines between 10.8.21 and 10.8.22 (other than facilitating multi-core) so that 10.8.22 should give identical results to 10.8.21.

Or maybe not all that “definitely final” as there is yet another unofficial release, 10.8.23 in November 2009, which corrects various obscure bugs detected in 10.8.22 (e.g., see 40) in Appendix E.5) but is only being circulated to users who experience those bugs.

The recommended version of 10.8 is therefore the final release 10.8.22.

The following sections describe the changes made to **SATURN** 10.8 over and above release 10.7.9 (some of which may equally have been included in 10.7.10, etc.).

D.17.1 P1X

- 1) Dumping isochrones as data files. Isochrone data, i.e., the minimum “cost” from a selected zone to all other nodes/zones/ may now be dumped either to

an external text file or stored internally in a node data base column. The basic intention is to be able to export the data into a GIS system to produce a “proper” isochrone plot. 11.8.3.3.

- 2) An option to include the “map sequential number” has been added under annotated Node Data. This is potentially of interest since it is the map sequential numbers which are used under SATCOBA if sequential node numbers are used for output.
- 3) The difference between a link/turn count and its capacity, when the count **exceeds** the capacity, may now be plotted under either Count Validation or ME2 Analysis.
- 4) Plotted data under either Count Validation or ME2 Analysis may now be restricted to the “Top Ten”, e.g., the 10 links with the maximum error, and the top ten data displayed in a window.
- 5) Converting a buffer node with more than 6 arms to a simulation node under PMAKE is not permitted; previously it caused a crash. 22/03/07
- 6) Critical GAP values when reported/displayed by turn now differentiate between merges and non-merges; in the former case GAPM is reported, in the latter, GAP. 02/04/07
- 7) The editing of GAP values by turn within network editing has improved in several respects; e.g., a change to a single turn can optionally be transferred into the “nodal value”. 02/04/07
- 8) Network edits now accept input files to list all those buffer nodes to be converted to simulation with their new junction type indicated. See 11.9.12.4. Equally files containing lists of links (A,B) and turns (A,B,C) plus data may be input to automatically edit various link and/or turn properties. See also #24 below. 30/03/07
- 9) Node selection now allows nodes to be selected on the basis of whether or not they had any Warnings, Serious Warnings, etc. etc. during network building. 09/04/07
- 10) The editing of simulation nodes under Network Editing of the .dat file now allows a “loop” to be set up whereby all selected nodes are processed in order, rather than having to select each individual node with the mouse. In particular, this may be combined with the new option (#9 above) to select nodes with particular levels of coding errors so that you may now simply select all nodes with, say, a particular NAFF error and loop over all occurrences of that error. 09/04/07
- 11) Editing bus routes which have errors already has been made simpler. 10/04/07
- 12) Dummy nodes may now be optionally represented by a “star” rather than left as a “hole” as previously. Controlled on/off by a parameter 4STAR = T/F in P1X0.dat. See 11.6.5.1. 18/04/07.
- 13) A new “search option” MOVE has been added under Window to allow the current window to be moved incrementally in any direction from the current

window – a sort of generalization of the Left, Right Up and Down commands. In addition, the extent of the overlap between incremental windows, previously fixed at 0.5, and the degree of expansion/contraction under Pan/Zoom are now user-set parameters. See 11.5.1. 06/05/07.

- 14) External simulation nodes which are **also** part of the buffer network are now assigned a **light** blue colour in order to distinguish them from external nodes which on the “true” edge of the network. And which continue to be blue 11/05/07
- 15) The ME2 Analysis display options include an option to annotate **only** those X_a Balancing Factors which are equal to the max/min values. 14/05/07.
- 16) The “main” text window which is used, for example, by the **SATLOOK** and/or **SATDB** options now permits Edit/Copy/Paste functionality. 26/05/07
- 17) Links from external simulation nodes which have been artificially coded with, e.g., 6 lanes are now plotted with a reduced number of lanes. 08/06/07.
- 18) Annotated turn data may now be “selected” using the same link selection criteria as used in the **SATDB** link data base. 08/06/07.
- 19) LOG and KEY files now contain a reference to the user network coordinates as well as the pixel coordinates when the mouse is being used to select a point on the display screen (e.g., creating a Box as opposed to selecting an item from the banner). This means that if the KEY file is used on a computer with a different pixel resolution the desired coordinates should be identified. 21/09/07.
- 20) Bus routes may be selected under Information by first selecting a specific “bus company” 10/10/07
- 21) The network filename is now displayed on the right hand side of the top “caption band” in addition to the **P1X** program name. 15/10/07
- 22) A form of “Select Link Bus analysis” marks all links served by bus services through a selected link. See 11.8.4.2. 02/11/07
- 23) The Preferences File has been extended to include a complete list of all parameters used to define different colours by range value for annotated data. 22/11/07
- 24) Options have been introduced within Network Editing to edit complete “data fields” (e.g., link distances, turn saturation flows, etc.) covering **all** simulation nodes/links/turns. By contrast the normal simulation node editing allows one to edit any of the individual data values associated with a single simulation node but not the same data field (e.g. distance) over all nodes. The data may be obtained either from an ascii text file (e.g., generated from a GIS data base) or by an internally created DB column (e.g., to calculate saturation flows from an equation involving more fundamental variables such as lane widths). See 11.9.17. 09/01/08.
- 25) The 44444 records dumped under the “re-create a .dat file” option under Files have been corrected: (a) to exclude bus-only links or turns which will

already have been indicated by negative signs under 111111 and (b) to add \$ to tolls. 09/01/08.

- 26) The automatic node graphics loop over selected simulation nodes as mentioned under 10) above has now been extended to cover non-editing mode. For example, you can automatically loop over all nodes which have been selected on the basis of having a particular error. See 11.12.1. 17/02/08
- 27) .Dat files dumped from **P1X**, e.g., from network editing or re-created from an existing .ufs file, now contain a **full** list of all &PARAM parameters, not just those that differ from their defaults. 10.8.16 only. 11/03/08
- 28) An explicit option has been added when a new .ufs file is output under Files to set the parameter SECRET = T on output (the default is F) so that the .ufs file cannot then be used to re-create the basic .dat file information. 10.8.16 only. 11/03/08
- 29) An "UNDO" option added within the interactive definition of nodes in both a joy ride and the definition of bus routes within network editing. 10.8.16. 30/03/08
- 30) Joy ride definitions set interactively may now be "dumped" into a text KEY file that may be input into **SATLOOK** to, effectively, repeat the same operation with, e.g., a different network. 10.8.16. 30/03/08
- 31) The input .UFC file may now be re-set interactively under the Files Menu. This could be useful if filenames have been changed and the "correct" .UFC file cannot be located automatically; on the other hand it opens up the possibility of selecting the "wrong" .UFC file. Be careful! 10.8.16. 17/04/08.
- 32) An option has been added in the Master Menu to enter Node Graphics in an automatic loop over all "**highlighted**" nodes. E.g., you can choose under Display to highlight all nodes with a particular Serious Warning and then examine all nodes with that particular error. See 11.6.5.4. 10.8.16. 18/04/08.
- 33) Equally a node-graphics loop over all "highlighted" nodes may be requested within the simulation node sub-section of Network Editing. (At the moment you can do the loop but only have first selecting the highlighted nodes.) 10.8.16. 19/04/08.
- 34) The Network Editing of 33333 Buffer Links now contains an option to automatically delete all "second records" containing KNOBS data. This is part of several new facilities to assist users to transfer KNOBS data into an external ascii file. See 15.14.7. 10.8.16. 18/04/08
- 35) Node Graphics and **SATLOOK** simulation node analyses now allow the user to list a table of the **original** input delays at a node, i.e., **not** the delays which may have been re-calculated due to a selected node having been through a re-simulation process. Normally the two are identical (or extremely close). However, if you are looking at a .UFS file from an older version (i.e., 10.7 or earlier) then the 10.8 simulation may be slightly different

from the previous simulation due to the new rules in 10.8 and therefore give different delays. Which can be confusing! 10.8.16. 08/05/08.

- 36) The set of “10 worst” statistics now contains a list of the 10 worst “gaps” where the gap is defined to be the difference in delays as calculated by the simulation and the previous assignment multiplied by the flow. See 9.9.1. 10.8.16. 24/05/08.
- 37) A Gap or Delta contribution by individual link may now be calculated under Analysis / Trees and should prove useful in helping to identify problem areas in terms of convergence. See 11.8.3.5. 10.8.16. 27/05/08.
- 38) The validation of count data may now be carried out using count data (of the format used for 77777 data in network .dat files) may now be directly input to **P1X** as opposed to using only the counts pre-set in the original network .dat file. 10.8.18. 18/07/08.
- 39) Node graphics data display now allows (basic) data extracted from a second input .ufs file to be displayed as well as that from the main network. This applies to both turn-based and link-based data displays. 10.8.19. 22/07/08.
- 40) “Navigation options” have been added to the Menu Bar which replicate standard window options such as move Up, Down, etc. etc. but which enable those steps to be carried out repeatedly from a fixed position of the mouse with multiple clicks. Try it! See 11.5.5. 10.8.19. 31/07/08.
- 41) The Convergence Options now include two new options: (1) to highlight the nodes printed under any of the “10 worst” categories, e.g., delay differences; (2) to enter a node graphics loop over the (up to) 10 worst nodes in order to examine the source of the problem more closely. See also 7) under **SATLOOK** in D.17.6 and section 11.15 of the Manual. 10.8.19. 04/08/08.
- 42) In addition the edit simulation node options under Network Edit also allow a loop over, say, the 10 worst converged nodes in terms of turn delays as in 41) but with the extra possibility to edit the .dat file directly. See section 11.9.3. 10.8.19. 18/08/08.
- 43) Extra navigation options (see 40) above) added to allow: (a) a single mouse click to set the centre of the plot and (b) the last window. 07/10/08. Release 10.8.20
- 44) Background bitmap images from .jpg format files is now permitted. See 11.3.6. 07/10/08. Release 10.8.20. See point 48) below for outputs to .jpg.
- 45) Link data annotated from two or more networks may now be calculated as the GEH difference statistics between the flows on networks 1 and 2. See 11.6.2.3. 22/11/08. Release 10.8.20
- 46) A red bar has been added on individual node plots to indicate when an exit and/or entry link is blocking back. 10.8.21. 24/01/0
- 47) An explicit option to print standard Node Table 2 (Flow and delay data) from within Node Graphics has been added. 10.8.21. 27.01/09

- 48) The option to output screen images to .JPG files (in addition to importing .JPG files; see 44) above) has now been added. 10.8.21. 01/02/09.

D.17.2 MX

- 1) XCL command line extensions removes the upper limit of 9 on the number of arguments used on a command line. See 14.8
- 2) New procedures to stack and unstack .ufm matrices, UFMSTACK and UFMUNSTACK, have been introduced to allow an unlimited number of matrices to be stacked by listing their filenames as individual records with a text "control file". They provide an alternative to the use of XCL, See 10.20.17 and 10.20.18 09/03/07 and 14/02/08 for UFMUNSTACK.
- 3) Origin and destination totals for matrix Furnessing can be copied from one to the other and/or swapped between them. 29/03/07.
- 4) Fortran Equations can now use TOT(n) as a function to denote the total number of elements in matrix n. See 10.8.1. 10/07/07.
- 5) The compression of matrices via M5 (/MXM5) is now based on double precision calculations to avoid possible loss of values due to rounding errors. 22/10/07
- 6) An output .ufm matrix can be created containing 1/0 values to indicate whether that cell has been selected or not. See 10.6.3. 13/11/07
- 7) With stacked matrices the "selection by location" rules have been extended to include "multiple locations" so that, for example, rows 3 to 5 may be selected in **all** levels of the matrix or, alternatively, only in a single level. See 10.6.1. 15/11/07.
- 8) The screen editing of "row-based vectors" such as origin trip ends, origin factors, etc. etc. now takes proper account of levels within stacked matrices. See 10.7.3. 15/11/07.
- 9) Various print formats have been changed so that matrices which have very large individual cell values, e.g., which would require more than 7 digits to write as an integer, or (more commonly) equally large row or column totals will appear with a reduced number of decimal points to avoid values appearing as *****. 04/01/08. 10.8.13 only.
- 10) The default number of decimals used in CSV output dumps has been increased from 2 to 5 (parameter NDPS in the preferences file). This is in response to the current trend to require trip matrices to be "in-filled" such that all cells contain positive (if very small) numbers. See 10.15.2. Release 10.8.14 only. 25/01/08
- 11) At the same time the sum of the "rounding errors" caused by writing a "real" variable to a CSV file with a finite number of decimal places is calculated and printed. Increasing NDPS is designed to minimize this error. 10.8.14. 25/01/08.

- 12) The “matrix number”, e.g., mf45, used when creating an output matrix in EMME format may now take values from 1 up to 999, not 1 to 999. 10.8.19. 29/08/08.
- 13) Option added to suppress the final 99999 record for matrices dumped to a ascii/text file with the one line per cell format (effectively TUBA-1). 03/10/08. Release 10.8.20.
- 14) The automatic factoring procedure MXFACTOR may now be applied to only **one** level of a stacked matrix, See 10.20.3. 11/10/08. Release 10.8.20.
- 15) A new batch file MXAGG has been introduced in order to aggregate a stacked matrix into a square matrix equal to the sum of all levels – with extra options to select a subset of levels. See 10.20.20. 12/10/08. Release 10.8.20.

D.17.3 SATNET

- 1) Several new Warnings, Serious Warnings and Non-Fatal Errors have been added and users are strongly recommended to check for “new” errors in existing networks. More specifically, Warnings 90 – 96, Serious Warnings 49 – 63 and Non-Fatal Errors 72 – 76 have been added.
- 2) Bus route “names” input under 66666 previously were read from columns 2 to 5; they may now be read anywhere within columns 1 to 5 with a maximum length of 4 characters. If all 5 columns are used column 1 is ignored (as before). See 6.9.1.
- 3) The number of records per route has been increased from 20 to 78 (including elements such as timing points etc. in addition to per nodes). See note (9), 6.9.2.
- 4) The list of Serious Warnings etc. that are upgraded to NAFF errors under WRIGHT = T has been extended. Zero Tolerance! See 6.12.2 for a full list. 26/05/07
- 5) Single lane arms at signals which include a X-marked right turn are now classified as a Serious Warning 152 (previously they were Warning 12) on account of the severe problems they frequently cause for simulation convergence. 26/05/07
- 6) Warning and/or Serious Warning introduced for node-specific values of NUC which are judged to be too small. 15.15.2.
- 7) NUC may now, in effect, be disaggregated by node type such that NUCJT(j) sets a default value of NUC for all simulation nodes of type j and therefore over-rides the “global global” default set by NUC. 15.15.2
- 8) The upper limit on NUC (number of time units per cycle) has been increased to 125. 15.15.2
- 9) A new logical parameter AUTNUC has been introduced to allow the program to decide automatically on an “optimal” node-specific value of NUC depending on, for example, stage times at signals. 15.15.2.

- 10) A potentially very useful extra error check (Non Fatal Error 273) has been added to detect links A,B which have exit turns from B but no entry turns into A,B at A. It would appear from looking at a number of existing networks that this occurs not infrequently and almost certainly unintentionally. It may also have been the cause of program crashes prior to 10.8; see note 20) in Appendix E.5. 27/06/07.
- 11) DIADEM. Setting DIADEM = T in &PARAM allows the external control procedures in the Diadem demand models to differentiate between when UPDATE = T and/or WSTART = T are being used on the **first** supply-demand loop and subsequent supply-demand loops. It avoids problems of errors occurring on the first loop when essential files have not yet been created. 15.51
- 12) The data extracted from the update .ufs network file under UPDATE = T has been extended to include extra necessary information in order for the first new simulation in **SATALL** to carry on as closely as possible from the final simulation of the update network. Previously it essentially started from scratch. With luck this should speed up convergence. 15.3. 12/08/07
- 13) Link counts under 77777 may now be read as Free Format by setting a parameter FREE77 = T (although the A-node, B-node and C-node are still read in fixed columns). Note (12), section 6.10. 22/08/07
- 14) If a GIS file is defined in the .dat file (via FILGIS) and that file contains curved link data under 77777 then the crow-fly distances as used to compare against input link distances (SHANDY = T) are calculated point-by-point along the curved links rather than end-to-end directly. See 15.10.1. 23/11/07
- 15) KNOBS data read from an external KNOBS file (FILKNB) may now define links using a “wildcard” principle whereby, if an A-node/zone is defined but the B-node columns are left blank, then the program assumes that the KNOBS data applies to all links **out of** the A-node/zone. Similarly, if the A-node entry is blank but the B-node is defined it applies the data to all **entry** links. In particular this facility is designed to enable users to set entry/exit tolls on zones without having to precisely specify each individual centroid connector to or from a zone. See 15.14.5. 26/11/07.
- 16) The “Parameter Examination” previously available within **P1X** Information is now used in both **SATNET** and **SATALL** to critically evaluate the choice of parameters and to “suggest” improved choices. The outputs appear in the relevant .LP files. 04/12/07
- 17) Networks with Semi-Fatal or NAFF errors cause the program to terminate with a stop code of 5. In normal **SATURN** applications this has no direct effect but users who wish to create their own control .bat files may be able to make use of this feature. 10.8.14. 23/01/08.
- 18) The parameter RB106 now defaults to .TRUE. See 8.7.3. 26/02/08.
- 19) A new option TOPUP introduced to allow new network coding to be added without removing the existing coding in £INCLUDE files. See 6.15.2. 10.8.16 only. 28/03/08.

- 20) Warning 18 (zero sat flow turns included in green stages) has been upgraded to a Serious Warning 128 while Non-Fatal-Error 251 (funny bus route turns out of bus lanes) has been downgraded to Warning 18. 10.8.19. 26/08/08.
- 21) If you have a single user class (NOMADS = 1) and you set, say, MCGILL(1) = 2 it is now treated the same way as defining MCGILL = 2; previously it would be ignored.
- 22) A new logical parameter BANKER has been added which, if T (default is F), outputs an ascii file with extension .BNT with a complete list of banned turns including both U-turns and turns into non-exit 1-way roads in addition to explicitly banned turns under either 11111 or 44444 data inputs. 10.8.21. 29/01/09.

D.17.4 SATALL

- 1) A "QUIET" option has been introduced into the Command Line such that, e.g., "SATALL net QUIET" will run SATALL totally "in the background"; i.e., it will not open any special reporting windows or "grab" the mouse. See section 14.9.
- 2) The averaging of two OBA solutions under AUTOK has been improved in order to improve assignment-simulation convergence.
- 3) The initial assignment under a Warm Start takes the input set of link flows without any further re-assignment.
- 4) AUTONA introduced to automatically set NITA on each assignment iteration and thereby reduce CPU time / improve convergence. (Although it defaults to .FALSE. and is only used if re-set to T.) To date AUTONA has been mostly tested with OBA where it shows considerable benefits; experience with Frank-Wolfe is more limited. 9.5.4.
- 5) Default values of NITA_M and NITS_M (minimum number of iterations for assignment and simulation respectively) now default to 3 and 5. Equally NITA_S has been increased to 99. 10.8.14. 25/01/08
- 6) The use of the network namelist parameter CLIMAX to model **flat** speed-flow curves for, e.g., HGVs under CLICKS has been introduced. 15.41.3. 31/01/08
- 7) An option to represent the "stochastic" valuation of tolls (i.e., variable values of time) denoted STOLL which has actually been around since 10.6 is now documented. See 20.6. 04/02/08.
- 8) The stopping rules have been modified when SIGOPT and/or SATOFF are being used in conjunction with NIPS such that, every time the signals are updated, the "counter" of successful loops is put back to zero such that NISTOP successful loops are required **after** the last update. Previously it was possible for the loops to terminate prematurely. 10.8.15. 05/03/08.
- 9) The output screen window that gives on-going convergence statistics now prints the gap values rather than GEHBAR (except under stochastic assignment, etc. when gap values are not defined). 10.8.16. 10/04/08.

- 10) The reported out-turn elasticities under elastic assignment are now split by generalised cost bands (with the objective of detecting different elasticity values between short and long trips). See 7.7.6. 22/11/08. Release 10.8.20. P1X
- 11) Introduction of the Multi-Core algorithm add-on module enabled by the MULTIC parameter (default = FALSE). Release 10.8.22 16/06/09.

D.17.5 SIMULATION

- 1) A highly unlikely bug affecting X-turns at signals which share a single lane with traffic whose flow is almost but not quite zero (e.g., 0.001 pcu/hr) has been corrected. See error 2) under Appendix E.5. 30/01/07.
- 2) Merges may now merge into “major” turns which do not use the inside lane. See #12 under Appendix E.5 for a more complete explanation of the problem and its correction. See 6.4.2.3. 05/07.
- 3) The procedures whereby the “choke factors” (section 8.4.4) applied to turn capacities to bring link capacities into line with link speed flow curve capacities have been modified to remove a discontinuity between over and under capacity turns. This improves convergence, particularly in situations where successive assignments were taking flows just above and just below capacity. The new procedures are optional and may be de-selected by setting a parameter LCR108 to F (in &PARAM); the default is T. 01/08/07
- 4) In addition the calculated “choke factors” are preserved on the .ufs files and between internal loops rather than being calculated “on the fly” each time a node is simulated. 01/08/07.
- 5) Finally, possible oscillations in the choking factors have been damped down. The net effect of changes 2) to 4) has been to improve both the internal convergence of the simulation as well as the convergence of the assignment-simulation loops. 01/08/07
- 6) The lane choice rules have been slightly modified to make it easier for an over-capacity turn with a choice of two or more lanes to use one lane exclusively if that lane has a lower V/C ratio than the alternative lanes. 01/08/07.
- 7) Relatively minor changes have been made to the treatment of multiple X-turns in a single lane so that a discontinuity in the algorithms applied above and below capacity has been corrected. Delays and capacities are now continuous functions of flows, etc. which improves convergence. The impact should otherwise be small. 17/08/07
- 8) A new option MONACO has been introduced to allow more, e.g., straight-ahead traffic to pass in an outside lane which may be partially blocked by X-turners. Thus, if MONACO = T (default = F) it requires TAX + 1 queued X-turns to block the lane; currently it only requires one. This increases the number of straight-ahead pcus which are allowed to pass “at the head of the queue” by a factor of TAX+1. See 8.2.5.

- 9) If RTP108 = T random delays per simulation turn are set by “estuary” as opposed to “river”; this reduces a possible source of discontinuity and may therefore improve simulation-assignment convergence. See 8.6.3.
- 10) The rules for blocking back have been slightly modified to allow for mid-link priority nodes which have been inserted near the upstream end of a simulation link (and which should probably not be there in the first place) such that any blocking back from these nodes uses the FULL stacking capacity not only of the link upstream of the priority junction but also any 2-arm links downstream. See 8.5.4. 17/07/07
- 11) The rules for how many vehicles can get through “at the head of a queue” (8.2.5) which is partially blocked by, say, right turners have been modified and may produce different results. 15/11/07
- 12) The rules to treat two opposing X-turns, in particular when they are in single lanes, have been “improved”. 16/11/07
- 13) The standard array dimensions for storing CFP’s (Cyclical Flow Profiles) have been increased by 50%, partly to account for the extra demands required by setting AUTNUC = T. Alternatively it allows an increase in the global value of NUC by up to 50% (not necessarily recommended). 24/11/07
- 14) The rules for merges (turns coded with a Priority Marker M) have been modified in a number of respects. Arguably the most important applies to “single” merges (as opposed to a Y-merge), e.g., a ramp entering a motorway where the ramp has a priority marker M but the motorway does not. Prior to 10.8 the capacity of the motorway arm was reduced in proportion to the merging traffic within the shared lane but not vice-versa. In 10.8 the capacity of the merge is also potentially reduced **if** the total (ie ramp plus motorway) V/C ratio in the shared exit lane appears to be greater than 1. However this is only likely to occur if the value of GAPM is relatively small, e.g., less than 2 seconds and the normal gap acceptance rules have not sufficiently restricted entries from the ramp. The old pre-10.8 rules may be re-instated by setting an &PARAM parameter M108 = F (default T). Full details are given in Section 6.4.2.3 and 8.8.4. 03/12/07.
- 15) Further to 14 and the use of M108 = T the new rules also affect the calculation of capacities at Y-merges, possibly significantly. The new rules appear to be “better” and, all other things being equal, are recommended. 20/02/08.
- 16) The lane-choice rules for signalised links with an under-capacity X-turn lane have been modified to achieve a more equal V/C ratio in adjacent lanes for non-X turns. Generally speaking this marginally increases capacity and decreases delay. 10.8.12 11/12/07.
- 17) If a filter (Priority Marker F) has been coded at signals in, presumably, lane 1 and another turn has also been allocated to lane 1 then the simulation gives very strange results. This situation is detected as Serious Warning 105 in **SATNET** but, arguably, it should be converted to a Semi-Fatal error under WRIGHT = T. The simulation is corrected in 10.8.12. 17/12/07

- 18) Various relatively minor corrections have been made to the simulation within releases 10.8.16 and 10.8.17 such that, e.g., running 10.8.16 and/or 10.8.17 may give slightly different outputs from 10.8.15. (Although, inevitably, there may be certain “pathological” cases where the differences are more significant.)
- 19) A further minor simulation correction has been added in 10.8.19 to correct an inconsistency which occurs when the initial queue at a roundabout arm due to PASSQ flows takes much, much longer than LTP to clear and the flow in the current time period is also much, much greater than the capacity. The simulated delays are no longer restricted by MAXQCT as they should be. Note that the problem only occurs if the demand is very much greater than capacity and almost certainly means that there is a problem with the trip matrix. 28/08/08.

D.17.6 SATLOOK

- 1) SATMECC is a new option to calculate the **Marginal External Cost of Congestion** via simulation, i.e., the impact of adding 1 extra pcu per turn or link. The outputs may then be used to calculate/.estimate optimum tolls. Full documentation in Section 15.50.
- 2) The output TUBA format 2 for skimmed matrices now provides a “width” of 15 columns instead of 10 so that there is no longer a need to reduce the number of decimal places NDPS to 2 to avoid overflow problems (as originally recommended by DIADEM). Actually included in 10.6. 15.51.
- 3) Simulation Summary Statistics calculated internally (as opposed to simply being read from a .ufs file) may now be disaggregated by properties **other** than just Capacity Indices. For example, you may create a list of Traffic Boroughs per link and disaggregate by boroughs. 11.11.4. 04/09/07.
- 4) Simulation Summary Statistics may now be output in full to a .CSV file such all data for a single flow/index category is in a single record. 11.11.4. 04/09/07.
- 5) Simulation Summary Statistics which are created “on the fly” – option 2 - may now be output to a .CSV file which contains the 14 basic statistics disaggregated either by link or by node. 10.8.16 only. 04/04/08.
- 6) The standard data-printing options for a simulation node now include a listing of all the standard “convergence” errors, e.g., the differences in delays as calculated by the assignment and by the simulation. See also 41) under **P1X** in D.1.7.1. 10.8.19. 04/08/08.
- 7) A facility to skim O-D time, distance and tolls **simultaneously** from a forest (as opposed to carrying out 2 or 3 separate skims in order to reduce CPU time by a factor of roughly 2 or 3) has been added. This may be called either interactively under main option 9, via a standard batch file SKIM_ALL (cf SKIMTIME, etc.) or in SATTUBA. It should be applicable to external applications such as Diadem where multiple skims are repeatedly required. See 15.27.7. 10.8.21. 24/01/09

D.17.7 SATUFC & SATUFO

- 1) An additional option 'UFO' on the SATUFC command line now allows a .UFO file to be created in addition to the .UFC file. See 15.23.6. 17/07/07
- 2) SATUFC now produces a new .ufs file which contains correct information for SAVEIT and/or SAVUFO. This avoids a number of problems of analysis programs not realising that SATUFC has been run and therefore not finding the UFC/UFO files. See also #13 in Appendix E-5. 15.23.5. 17/07/07
- 3) If the original network had been through an elastic assignment the SAVEIT assignment which creates the .UFC file uses a **fixed** trip matrix assignment algorithm using the output trip matrix from the original elastic run. 15.23.4. 17/07/07
- 4) **SATUFO** has been created in order to create a .UFO file from UFS/UFC files assuming that SAVUFO was not originally set to .TRUE. (or, if the UFC file was also created "after the fact" by **SATUFC**, that the UFO option (see #1 above) was not invoked. 15.23.6. 21/07/07

D.17.8 SATME2/SATPIJA

- 1) Before and After Trip Length Distributions may be printed in the .LPM file in order to compare the before (prior) and after (output) trip matrices. 13.3.10
- 2) Extra checks have been included in **SATPIJA** to detect: (a) counts which are totally or largely downstream of queued links which effectively "fix" the flow through the count; (b) counts which are over capacity, (c) possible inconsistencies between adjacent counts.
- 3) **SATME2** will now accept (a) stacked matrices as input and (b) stacked matrices as output. See 13.4.3. 24/08/07.
- 4) The standard array dimensions per release level have been increased so that, e.g., the maximum number of ij matches per link is 50% greater. (Also in 10.7.11) 10/08/07
- 5) **SATPIJA** can calculate weighted PIJA factors over all user classes within a common vehicle class in order to update the **total** trip matrix for that vehicle class. This means, for example, that you can update a total matrix of car trips which, for assignment purposes, is sub-divided by purpose. See sections 13.4.2 and 13.4.6. Version 10.8.13. 03/01/08.
- 6) **SATPIJA** now contains a series of checks to detect violations to Kirchoff's Rule, i.e., the sum of the counted flows into a node does not equal the sum of the counted flows out of that node. It also detects "near" violations whereby if, say, all input arms to a node and all but one output arms are constrained then the "missing" arm is equally constrained and its implied flow may be compared against the current assigned flows to detect large discrepancies. See Section 13.3.3. Version 10.8.17. 18/06/08.
- 7) The most important error messages are now grouped together and re-printed near the **end** of the .LP output files from both **SATPIJA** and **SATME2** in order to make them more obvious to users. 10.8.19 08/08.
- 8) Equally the summary of errors from **SATPIJA** is included in the .UFP files and re-printed by **SATME2**. 10.8.19 08/08.

- 9) A new parameter SUBPQ has been introduced into **SATME2** in order to subtract **only** the PASSQ flows from the counts as opposed to SUBFIX which removes **all** the fixed flows, including the PASSQ component. Included in 10.8.15 but not fully documented until 24/07/08 and with certain errors within MUC applications corrected at the same time. See 13.1.4, 13.3.1 and 13.4.9.
- 10) Further to 6) an option AVERK has been added such that if counts at a node violate Kirchoff's rule (flow in equals flow out) they may be automatically corrected by averaging the input and output flows at the common node. The updated flows may also be output to an ASCII file if a filename FILKP is set. See 13.3.2. 10.8.20. 01/10/08.
- 11) A new method has been introduced to allow **SATME2** to update multiple levels in a stacked trip matrix as identified by their vehicle class IVC by (a) updating the aggregated trip matrix for that vehicle class and then (b) updating the individual matrix levels proportionately. Set parameter TURBO = T in the **SATPIJA** Namelist parameters (Think TURBOprop!), See 13.4.6. 10.8.20. 14/10/08.
- 12) A new source of potential error has been identified in situations where the "SAVEIT assignment and the "actual assignment" give significantly different flows on counted links. This means that **SATME2** will be trying to factor the trip matrix based on incorrect PIJA factors. Appropriate Warning and Serious Warning messages have been introduced into **SATPIJA**. See 13.3.12. 10.8.20. 21/11/08.

D.17.9 SATWIN

- 1) Command line length increased to 2048 characters. 15/10/07
- 2) The date of each .exe file which is run is now recorded within the header records at the start of every .LP file. 17/12/07.
- 3) "Module Run" menu has been extended with more categorised menu items so as to include "most" of the various **SATURN** programs and processes available. Version 10.8.15 21/03/08;
- 4) The dialog box from the "Batch Run" menu has been extended with categorised **SATURN** batch files available from a selection menu with integrated 'help' function. Version 10.8.15 21/03/08;
- 5) The QUIET option, enabling **SATURN**, **SATALL**, **SATNET**, **SATPIJA** and **SATME2** to run in the background when using SATWIN, may be switched ON/OFF via the main SATWIN toolbar. Version 10.8.15 21/03/08.

D.17.10 General Procedures

- 1) Namelist character variables, e.g. used to define file names,, may now contain up to 256 characters by using a "continuation" option whereby the full name is defined on two or more input records. See Note 17) in Appendix A. The previous upper limit was around 68. 14/10/07.

- 2) Files which are “read only” are now opened in such a way that, in principle at least, the same file can be accessed by two or more **SATURN** programs running concurrently. 10.8.14. 25/01/08
- 3) No .LOG files are created when interactive programs such as **MX** or **P1X** are run in KEY + VDU mode. 10.8.21 12/01/09.
- 4) If the file sat10key.dat cannot be opened because it is temporarily in use by another program running in parallel the program pauses briefly and tries again, up to 6 times in total, before the program is finally terminated. 10.8.21. 15/01/09.

D.17.11 SATDB

- 1) The calculation of link travel times from flows may now use a column of **either** demand or actual flows; previously the assumption was that the flows were always demand flows and that they were therefore always factored down to actual flows before doing the time v. flow calculations. 31/03/07
- 2) Actual flows by user class may be directly accessed via a DA code by using, say, 3808 in place of 3803; i.e., replace the final 3 by an 8. See 15.21.4. 9/04/07
- 3) Miscellaneous ASCII data input files may now have the node numbers in either fixed column blocks of 5 or 6. Previously only blocks of 5 were permitted (or completely CSV free format input) whereas a number of **SATURN** programs produce output with fixed blocks of 6 for easier identification. 13/05/07
- 4) When dumping link data to an ascii (.txt) file an option has been added to automatically suppress all links which contain nothing but missing values. 28/07/07.
- 5) Single trees can now be built from either nodes or links in addition to zones and they can be built either out-bound or in-bound. In addition a vector of trips may then be assigned to the calculated routes. See 11.10.7.1. 22/08/07.
- 6) The input of data from an ascii (e.g., txt) file now automatically distinguishes Reals from Integers. 04/09/07
- 7) Copy/Cut/Paste functionality added to the link and/or node Display Windows. 20/09/07.
- 8) When reading in a DA code which does not contain data on **all** possible links (e.g., simulation link or simulation turn data as opposed to assignment link data) and the other links are assigned missing values then an option has been added to automatically select only those links. This makes it simpler to suppress the output of “m’s” to terminal or ascii file outputs. See 11.10.2 (4). 19/01/07
- 9) Both the SATRAP and ONE SONG ... options now explicitly store re-assigned flows for individual user classes in internal data base columns in addition to the total flow. 10.8.16 12/03/08.

- 10) The .ufa file output under One Song ... now contains the name of the latest trip matrix files, the total trips loaded and the individual updated user class flows (see #9). 10.8.16. 12/03/08.
- 11) An option has been added under Select to easily de-select all links which contain nothing but missing values. 10.8.16. 18/04/08.
- 12) An option has been included under Miscellaneous Inputs to automatically input all items of KNOBS data into data base columns. 10.8.16. 18/04/08.
- 13) An external batch file KNOBDUMP has been created to automatically dump all KNOBS data into an ascii file. This facility is intended to assist users who currently have KNOBS data stored as extra lines within the 33333 data set to transfer that data into an ascii file which can then be input to **SATNET** via KNBFIL. See 15.14.7.10.8.16. 18/04/08
- 14) Stage definitions per signalled turn may now be created under Miscellaneous Input / Packed Turn Data giving a series of data columns 1/0 to indicate green/red in the corresponding stage. 10.8.19. 29/07/08

D.17.12 Signal Optimisation Programs

- 1) A new "batch procedure" SIGOPT.BAT has been introduced in Release 10.8.16 to automatically optimise stage times and/or offsets and to store the new settings in either: (a) a new .UFS file, (b) a new .DAT file or (c) a .RGS file. It makes use of routines already included in **P1X** but runs in an off-line or batch mode. It effectively supersedes **SATOFF** in terms of offsets. It may also be run for a selected sub-set of nodes. See 15.31.6. 24/05/08.

D.17.13 Documentation

- 1) A full update has been carried out for the June 2009 release with subsequent ongoing revisions.