SCATS

The New Generation

SCATS 6

Functional Description

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An Introduction Scats 6

What is SCATS?

SCATS 6 is an area traffic management system consisting of hardware, software, and a unique control philosophy that operates in real-time, adjusting signal timings in response to variations in traffic demand and system capacity *as they occur*. Rather than changing individual intersections in isolation, SCATS manages groups of intersections that are called 'subsystems', the basic unit of the system. Each subsystem will consist of between one and ten sets of signals, and contain just one 'critical' intersection.

SCATS 6 adapts and coordinates the signals within each subsystem, and is able to coordinate a subsystem with adjacent subsystems. This coordination aims to divide the traffic on major roads into 'platoons' (groups of vehicles), and to allow just enough time for each platoon of vehicles to enjoy a smooth journey while allowing the needed green time for competing flows. This maximises the network capacity for the benefit of all.

Improvements of the New Generation SCATS

The SCATS 6 development team has always applied the latest improvements in technology for the benefit of SCATS users over the world. We now proudly introduce SCATS 6, which provides far more flexibility—for the decision maker, the Traffic Engineer, and the accountant!

This new generation features:

- The use of a PC platform;
- an increased number of intersections that can be connected to a PC;
- improved data collection resources, reporting facilities, and even better management and monitoring methods.

A SCATS System to Suit Your Needs

SCATS 6 can be supplied and configured with a pricing to suit the needs and budget of any user.

Full Real Time Traffic Adaptive. The latest version of the intelligent system that responds to changes in conditions *as they occur*.

Fixed Time Plans.

Dial In Dial Out. This format offers unique remote access to sites in outlying cities that need to be monitored on a daily basis, reducing the need for constant visits to check operation.

In this document, the emphasis is on SCATS 6 in its most functional role, that of a real-time responsive, adaptive traffic management system. Contact the RTA authorised distributors, listed at the end of this document for full details of the other two formats — the improved fixed time plan and the Dial In Dial Out system or for more details about adaptive control.

Adaptive SCATS — Superior to 'Fixed Time' Systems

Many traffic control systems manage the signals on a 'fixed-time' basis, where a series of signal timing plans are scheduled by day of week and time of day. The time relationship between signals is pre-calculated; based on previously surveyed traffic conditions. Such fixed-time systems cannot be expected to cope with traffic conditions that differ from those prevailing when the intersection was surveyed.

Furthermore, as traffic patterns change with the passage of time, fixed time plans become outdated. This requires the area to be resurveyed, and new signal timing plans calculated every few years. Experience has shown this procedure to be expensive, and to require resources which are not always readily available. As a result, the development of new plans is either deferred beyond the useful life of the old plans, or improvised changes are made to the plans and timetables; either case results in sub-optimum performance.

The problems of most fixed-time systems make it clear that a more responsive approach to changing traffic conditions is needed. One cost-effective answer is the SCATS 6 Fixed Time Plan system. This is a great improvement on other 'fixed time' systems because it has the benefit of improved decision making capabilities built-in.

The full answer, of course, is the Adaptive SCATS 6. Unlike most fixed-time or semi-responsive systems, it requires no costly pre-calculation of signal timing plans. Additionally, SCATS is self calibrating, automatically adjusting to changing traffic patterns over time. The SCATS 6 controllers and traffic control computer analyse real-time traffic data from vehicle detectors, and produce signal timings which are suitable for the traffic conditions *as they really are*. It offers a variable sequence of signal phases, and the option to omit phases or movements from the sequence on a cycle-by-cycle basis when there is no demand.

The implementation of a fully responsive system does not, however, mean that the careful design of each intersection can be avoided. The present state of technology only allows for the real-time variation of signal timings at intersections which have known or anticipated traffic requirements.

Capacity to Suit Different Size Traffic Networks

- The SCATS regional traffic control software has a maximum capacity of 250 intersections per region. With a maximum of 64 regions, the total capacity is 16,000 intersections. All SCATS software comes with the Central Management Computer (CMS) software that allows a number of other software packages that are part of the SCATS family to be used as part of the traffic management package.

SCATS

Operation of Scats 6

In this section various aspects of the operation of SCATS 6 will be described. It is not comprehensive, but if further details are required you can contact one of the RTA authorised distributors listed at the end of this document.

The Principal Signal Timing Parameters

SCATS manages three main parameters to achieve traffic signal coordination:

Cycle time: The total time of all signal sequences in a cycle

Phase split: The proportion of the cycle time allocated to each phase

Offset: The time relationship between the starting or finishing of the green phases of successive sets of signals within a coordinated system.

Strategic and Tactical Control

Traffic control is affected at two levels, *strategic* and *tactical*.

Strategic control is managed by the regional computers. Using flow and occupancy data collected from loop detectors in the road by the local controllers, the computers determine, on an area basis, the optimum cycle length, phase splits, and offsets to suit the prevailing traffic conditions.

Tactical control is undertaken by the local controllers, and meets the cyclic variation in demand at each intersection. Tactical control primarily allows for green phases to be terminated early when the demand is low, and for phases to be omitted entirely from the sequence if there is no demand. The local controller bases its tactical decisions on information from vehicle detector loops at the intersection, some of which may also be strategic detectors.

It should be emphasised, however, that the degree to which tactical control is able to modify the signal operation always remains entirely under the control of the regional computer.

The tactical level of control operates in a similar way to Isolated operation (described further on in this document). A basic difference from Isolated operation is that one phase, usually the main road phase, cannot skip nor terminate early as a result of lack of demand. This is because all controllers in a linked group must share a common cycle time to achieve coordination. Any time saved during the cycle as a result of other phases terminating early or being skipped may be used by subsequent phases, or is added on to the main phase to maintain each local controller at the system cycle length.

Subsystems

The subsystem is the basic unit of the SCATS 6 system. Each contains a single *critical* intersection, one which demands accurate and variable phase splits. The intersections in a subsystem form a discrete group which are always coordinated together, and they share a common cycle length, with an inter-related phase split and offset. Phase splits for all the other intersections in the subsystem are non-critical, and are therefore either non-variable, or are allocated phase splits which are compatible with the splits in operation at the critical intersection. To give coordination over larger groups of signals, subsystems can link with other subsystems to form larger systems, all operating on a common cycle length. These links may be permanent, or may link and unlink adaptively to suit the prevailing traffic patterns. A SCATS 6 region has 250 subsystems.

Degree of Saturation

Adaptive SCATS 6 bases its adjustments on a traffic demand measurement known as ‘Degree of Saturation’ (DS). However, in this context, DS represents how effectively the road is being used.

Using the in-ground loop detectors at the critical intersections, the local controller collects flow and occupancy data during the green phase. The data is sent to the regional computer which calculates the degree of saturation. Values of DS greater than unity (insufficient green time to satisfy demand) will occur in congested conditions, and SCATS will quickly respond to such an over-saturated situation.

Phase Sequencing

The signal cycle is divided into phases. These phases are labelled A, B, C, etc, and they can be introduced in any defined sequence. Any phase, except for that on the most important road, can be skipped if no vehicle is waiting for a green on that phase (e.g. if no vehicle is waiting for B phase the sequence would be A–C–A). In Isolated and Flexilink modes, the sequence is as defined in the local controller settings. In Masterlink mode, the regional computer determines the sequence.

Cycle Length is Used to Maintain an Ideal Degree of Saturation

Cycle length is increased or decreased to maintain the DS at around 0.9 on the lane with the greatest saturation. Cycle time can range between 20 seconds and 240 seconds, but a lower limit for cycle time (usually 30 to 40 seconds), and an upper limit (usually 100 to 150 seconds), are specified by the user. Cycle time can vary by up to 21 seconds, but this upper limit is resisted unless a strong trend is recognised.

Phase Split Adjustment

Phase splits are specified as a percentage of the cycle time and are varied by a small amount each cycle in such a way as to maintain equal degrees of saturation on competing approaches. The minimum split which can be allocated to a phase is either a user definable minimum or, more usually, a value determined from the local controller's minimum phase length. The current cycle length and the minimum requirements of the other phases limit the maximum split that can be allocated to a particular phase. Fixed time phases can have their phase time specified in seconds.

Offsets

Offsets are selected for the signals within each subsystem, and also between the subsystems which can link. Subsystems carrying lower flows may not receive good coordination if the cycle time is inappropriate. However, when traffic conditions permit the use of a cycle time that can provide good offsets over a number of subsystems, the system tends to maintain this cycle time even though a smaller cycle time would provide sufficient capacity. SCATS does this because optimal offsets on the heavy flow links minimise the *total number of stops* in the system, reducing fuel consumption and increasing the capacity of the network.

Available Operating Modes

SCATS local controllers can operate in any of several modes. These modes can be invoked manually or automatically by the regional computer or at the local controller:

Masterlink

This is the real-time adaptive mode. In Masterlink mode the regional computer determines the phase sequence, the maximum phase duration, and the duration of the walk displays. The local controller may terminate any phase under the control of the local vehicle actuation timers or skip an undemanded phase, unless prohibited by instructions from the regional computer.

The regional computer controls the phase transition points in the local controller, but subject to the local controller safety interval times being satisfied (e.g. minimum green, pedestrian clearance). On completion of the transition to a new phase, the local controller times the minimum green and minimum walk intervals, and then waits for a phase termination command from the regional computer. On receipt of the command to move to the next phase, the local controller then independently times the necessary clearance intervals (e.g. yellow, all red) for the phase termination.

These safety settings prevent communications errors or regional computer faults from causing the local controller to produce dangerous signal displays, such as short greens or all-red periods.

The termination of pedestrian walk signals is also under the control of the regional computer so as to allow the walk timing to be varied to match prevailing traffic conditions. As for the other settings, however, the duration of the walk signal cannot be less than the minimum time programmed into the local controller.

Flexilink

In the event of failure of a regional computer or loss of communications, the local controllers can revert to a form of time-based coordination known as Flexilink. In this mode, adjacent signals are synchronised by the power mains frequency or an accurate crystal controlled clock. The phase sequence and duration of each, and the duration of walk displays are determined by the current plan according to the time of day. Local vehicle actuation facilities are still operational in this mode.

The local controller may terminate any phase under the control of the local vehicle actuation timers or skip an undemanded phase, unless prohibited by instruction within the plan. Flexilink is the usual fallback mode of operation.

Isolated

Signals may also operate in Isolated mode, with local vehicle actuation (by detector loops) being the sole operating strategy. In Isolated mode the sequence and the maximum duration of each phase is as specified in the local controller time settings. The local controller may terminate any phase under the control of the local vehicle actuation timers or skip an undemanded phase, unless prohibited by the local controller settings. Isolated mode may be specified as the fallback mode of operation.

Hurry Call

The local controller invokes a pre-programmed mode usually associated with an emergency phase or local pre-emption such as a train or tram phase.

Police Off

The lamp state at the local controller has been turned off using a facility key to actuate a special switch provided on the controller housing.

Police Red

All lamps at the intersection have been turned to red using a facility key to actuate a special switch provided on the controller housing.

Police Manual

The phases at the local controller are being manually introduced using a facility key to actuate a special switch provided on the controller housing.

Maintenance Mode

A technician is on-site service the controller.

Flashing Yellow

The normal signal display is replaced by flashing yellow displays on all approaches, or flashing yellow and flashing red to competing approaches. Provided communications are functional, signal operation can still be centrally monitored in Flexilink, Isolated and Flashing modes. Any of the Masterlink, Flexilink, Isolated and Flashing Yellow modes may be applied by an operator using a SCATS workstation, or be programmed by time of day. Flashing Yellow is also the fall back mode if the controller has a fault.

Control

Operator Control

SCATS provides the operator with a range of manual functions to override the normal automatic operation. These functions allow manual control of:

- Signal lamps to *on*, *flash*, or *off*;
- selection between Masterlink, Flexilink or Isolated mode;
- alteration of phase split, cycle time or offset, either at an individual intersection or for a whole subsystem;
- a dwell facility which allows any signal to be held on a nominated green phase for as long as required.

Variation by Timetable and Special Routines

SCATS also allows for system operation to be scheduled. Almost any function which can be executed manually can also be set up to occur at specified times on specified days. For example, in a central business district, pedestrian walks may be automatically introduced on business days, late shopping nights and other periods of high pedestrian activity.

A range of special routines is also available in SCATS which allows the user to vary operations to suit special conditions. These routines can be used to detect events and address requirements not covered by the general operation of SCATS. It is features of this type that enable every detail of signal operation to be tailored to meet the operational needs of each individual intersection. SCATS is the *only* system to offer such a feature.

Fallback Operation

Default Fallback

In the event of regional computer failure, loss of communications between the computer and any local controller, failure of all strategic detectors, or certain other local malfunctions, the affected intersection(s) will revert to a user-specified mode of operation. This may be either Flexilink (coordinated) or Isolated (uncoordinated) operation.

Coordination Maintained During Fallback

If specified by the user, fallback at one intersection will also cause other intersections in the subsystem to fall back and, optionally, intersections in adjacent linked subsystems. In this way, if Flexilink is specified as the fallback mode, a degree of coordination can be maintained between intersections affected by the failure.

Alternate local signal timings, as well as plans and schedules for Flexilink operation are stored in RAM at the local controller. The master copy of this data is held in the regional computer, so that it may be downloaded from the regional computer to the local controller in the event of it being lost. The clocks in the local controllers are regularly checked by the regional computer and adjusted as necessary.

Computer System Requirements

Distributed, Hierarchical System

SCATS has been designed in a modular configuration to suit the varying needs of small, medium, and large cities. In its simplest form, a single regional computer can control signals at up to 250 intersections. Expansion of the system is achieved by installing additional regional computers. All systems have a Central Management Computer to manage global data, access control, graphics data as well as data backup. A typical SCATS system is shown in the Figure 1 below.

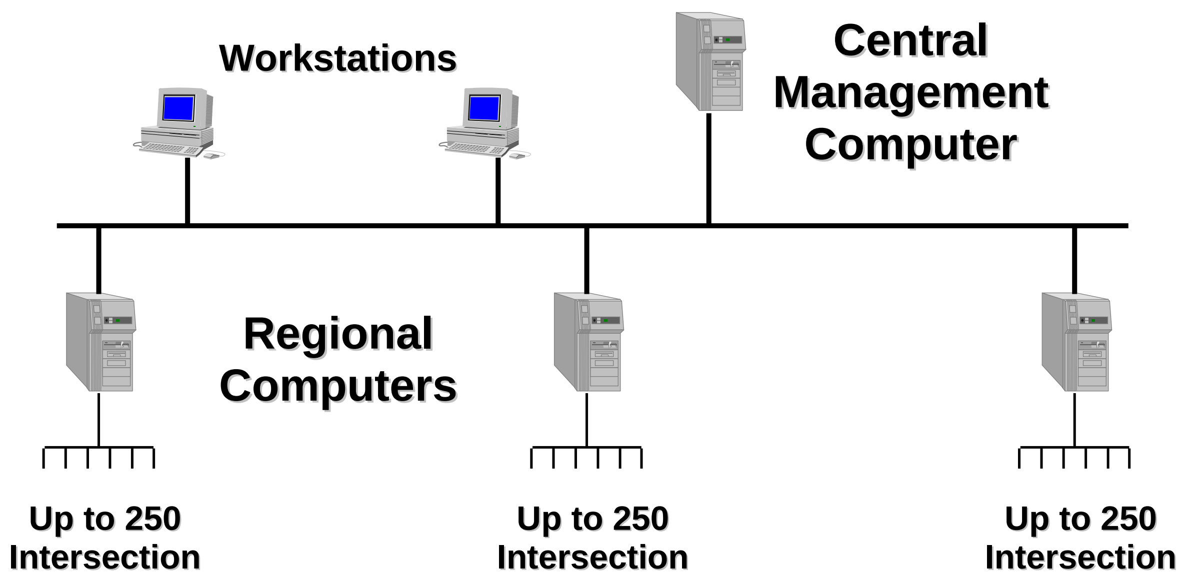

Figure 1: Typical SCATS system

Regional Computers

The regional traffic control function utilises standard personal computers operating under the Windows operating system. A range of intersection communication methods are provided and include network (TCP/IP), serial, dial-out and dial-in.

Central Management Computer

The Central Management computer is also a personal computer operating under the Windows operating system. Communications with regional computers and workstations is via TCP/IP.

Monitoring and Control Facilities

User Interfaces

A graphical user interface provides the full range of operator commands and monitoring functions. Up to 200 users are catered for with full access control. The data displayed includes:

<u>For Intersections</u>

Lamps ON/OFF/Flashing
Current phase demands
Detectors occupied
Cycle length
Operational mode
Alarms
Phase running
Time in phase

<u>For Subsystems</u>

Current splits
Current offset plan
System cycle length
System detector data

The intersection-monitoring window with its intersection graphic display is illustrated in Figure 2. Data entry is by forms, an example of which is shown in Figure 3. All alarms are logged, and can be viewed with the alarm management window as seen in Figure 4.

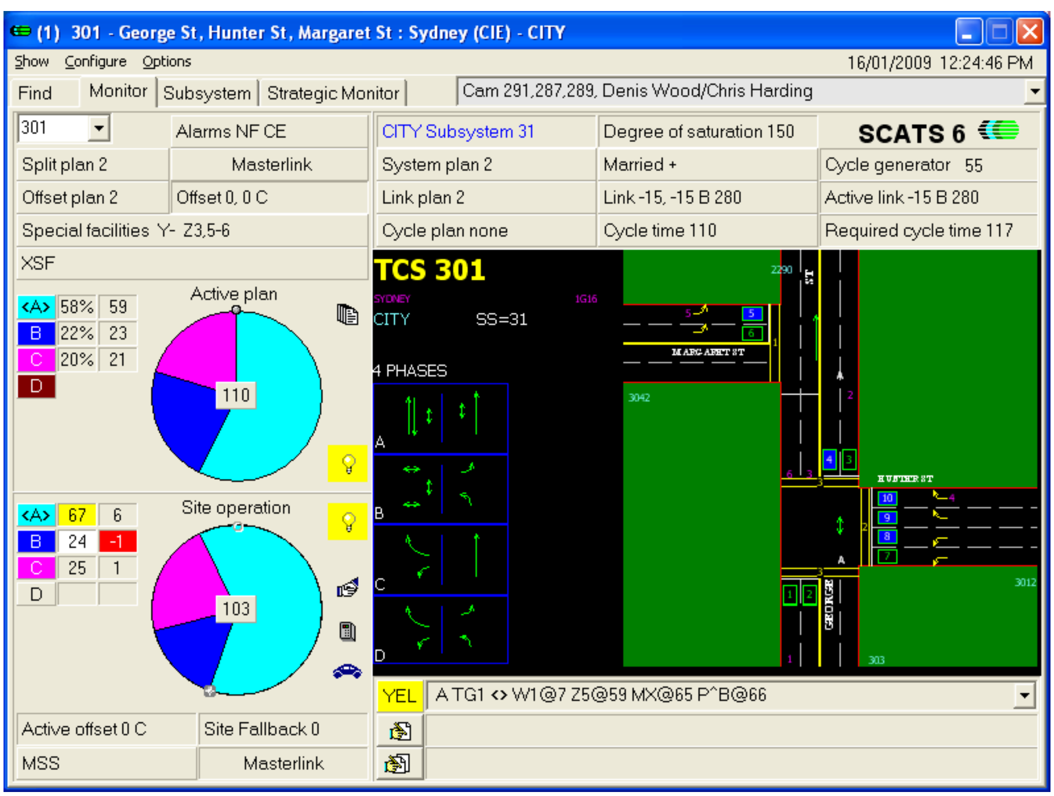

Figure 2: Monitoring window

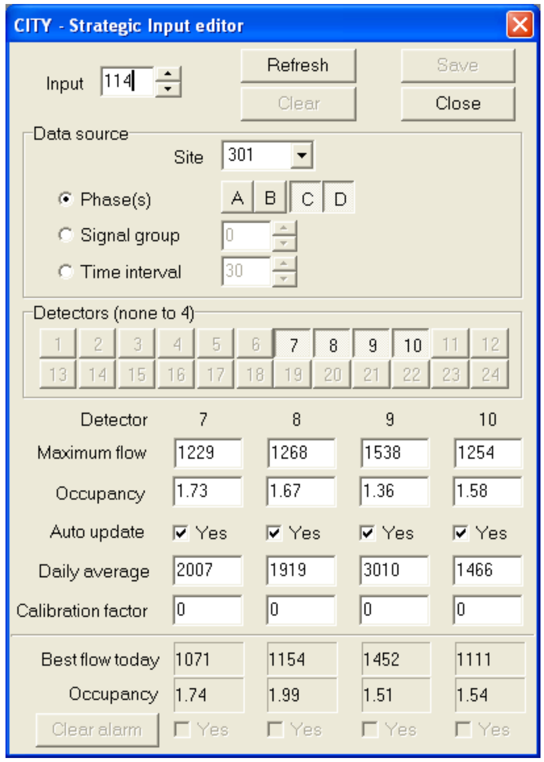

Figure 3: Data entry form

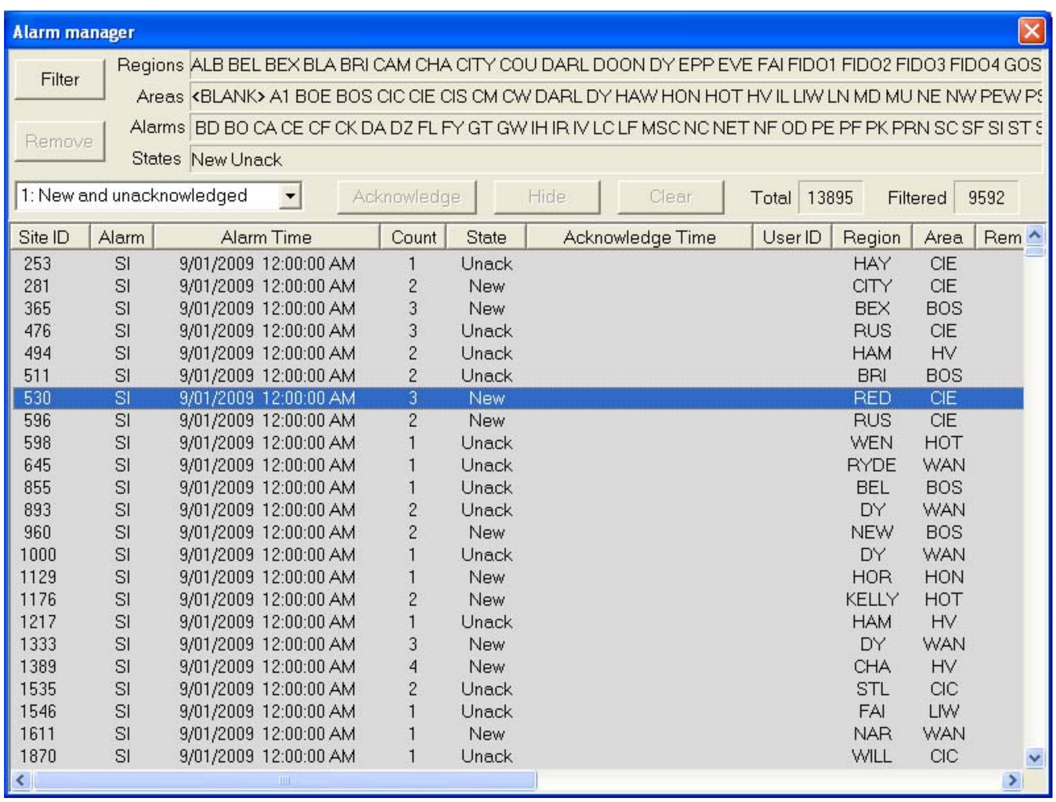

Figure 4: Alarm Manager

Graphics

The workstations support full colour graphics. The user may choose to view the system as a whole, a region, a subsystem or just a single intersection. These four levels of display are described and illustrated below:

The server window: Figure 5 shows a map of the whole system, showing by colour the boundaries of each region and, with the coloured bar graphs on the left side.

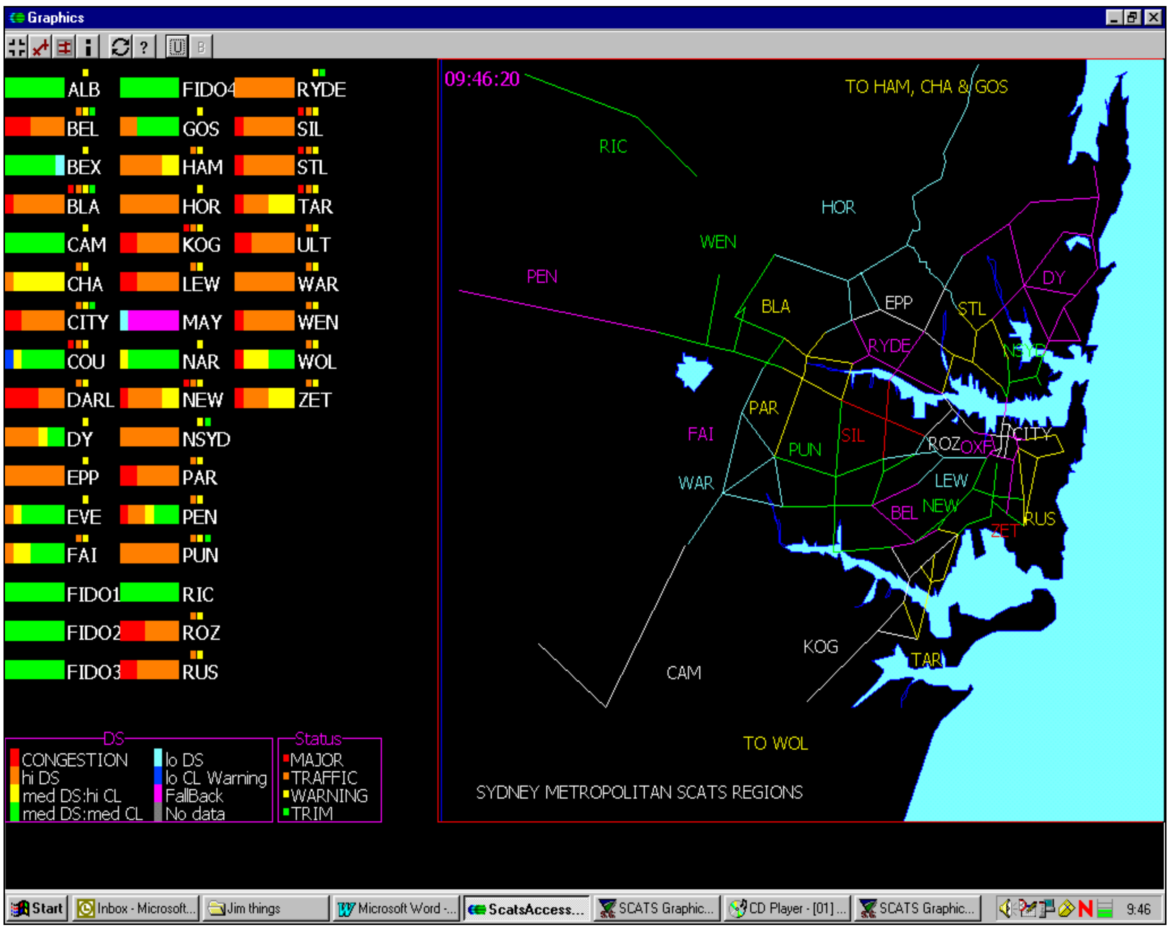

Figure 5: Server Window

The graphics window *regional* display: Figure 6 shows a map of the selected regional area. There is an on-line representation of traffic flow conditions using five different colours. These represent traffic conditions from very light traffic to heavily congested. The colour legend is on the left.

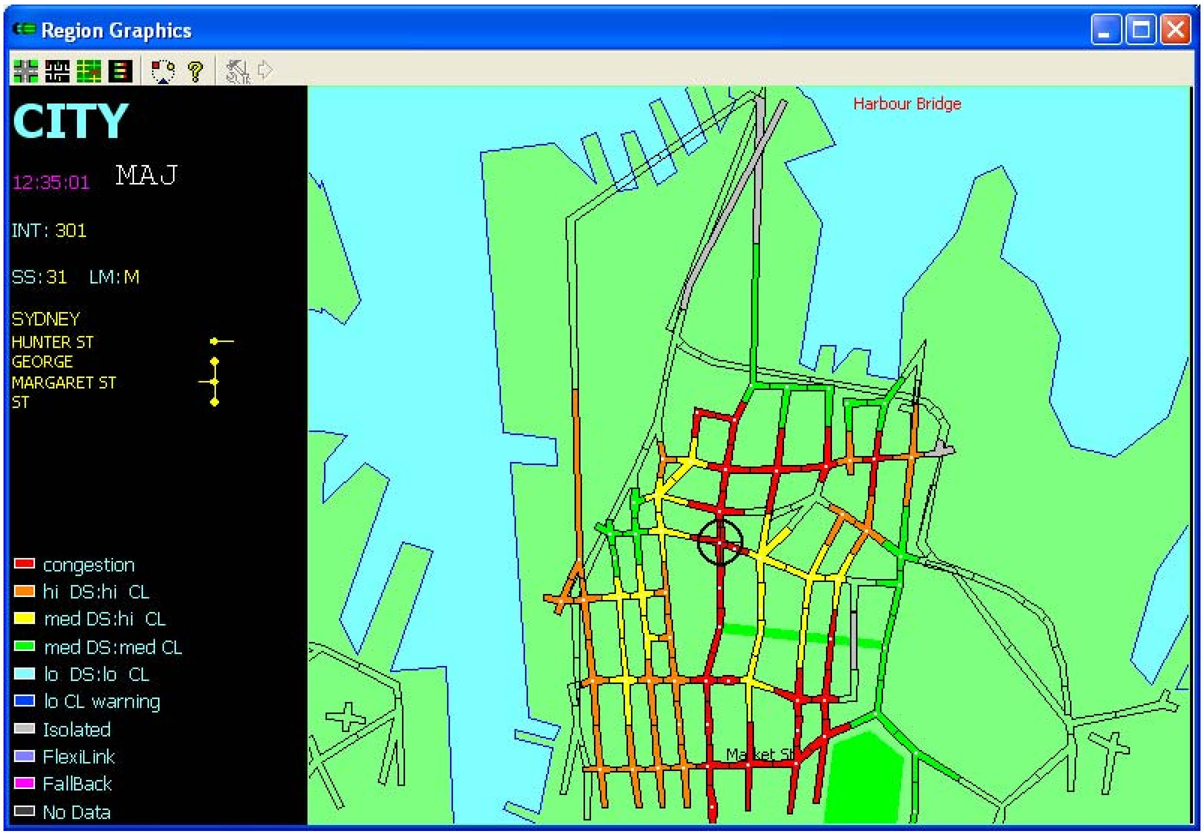

Figure 6: Region Display

SCATS

The graphics windows *subsystem* display: Figure 7 shows the selected subsystem layout together with an on-line graphical bar chart representation of traffic flow and density, as measured by the strategic detectors in the subsystem. The subsystem number is displayed below the region name.

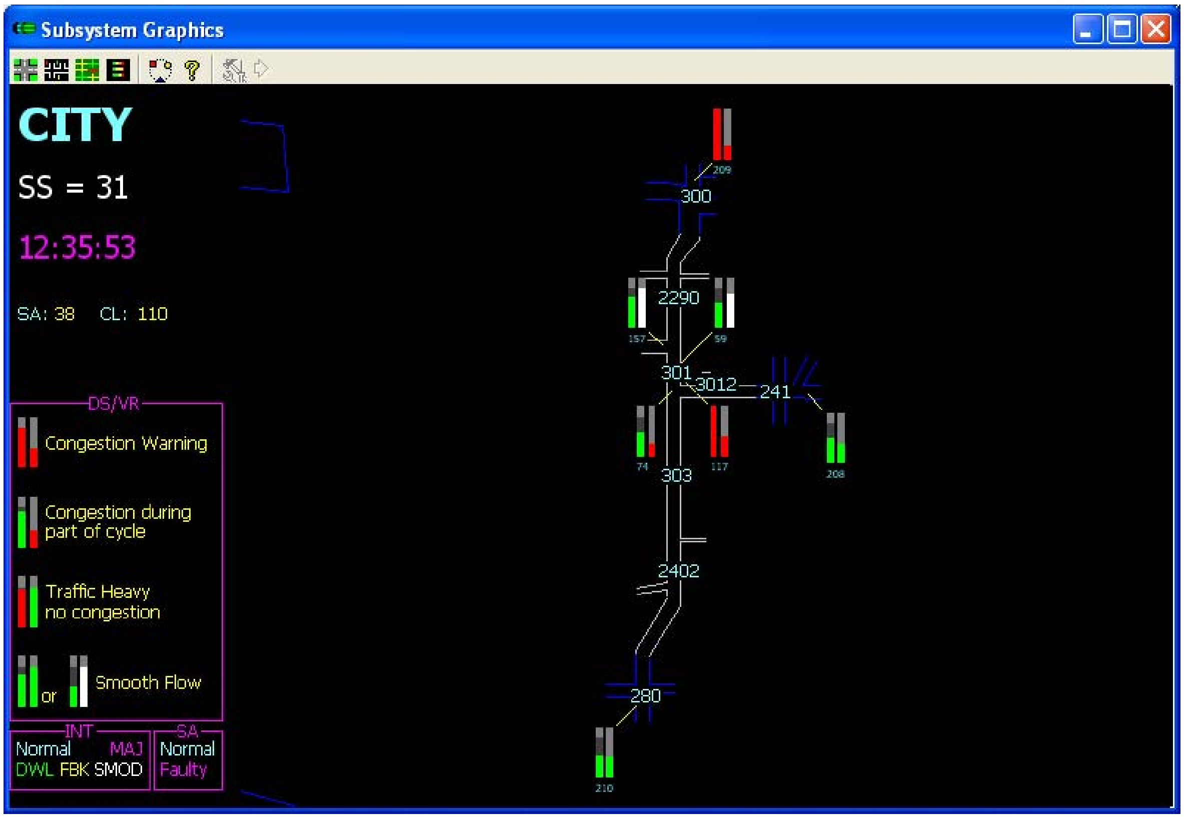

Figure 7: Subsystem display

The graphics window *intersection* display: Figure 8 shows the selected intersection layout and phasing design, with real time display of detector operation and phase greens.

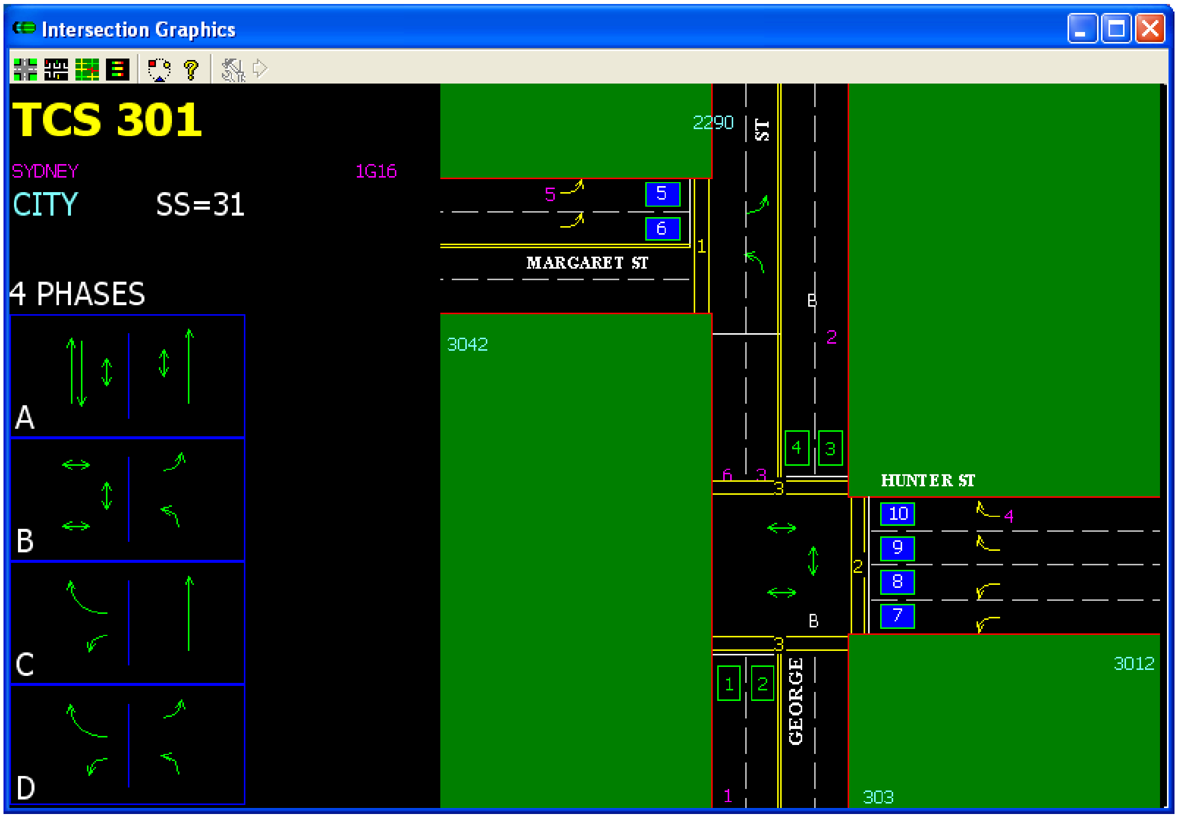

Figure 8: Intersection display

Time / Distance Diagram

The time distance diagram shows the relationship of the phase splits and the offsets in real time.

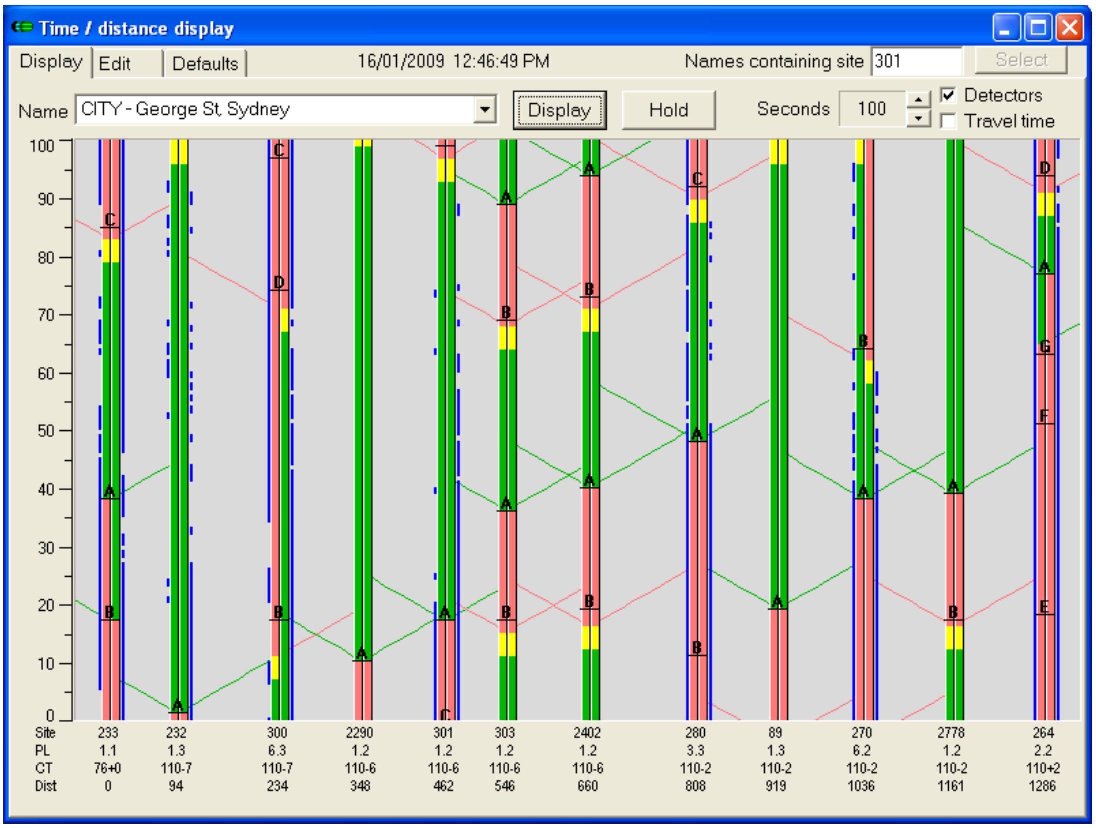

Figure 9: Time / Distance Diagram

Route Pre-emption

Route pre-emption allows a user to manage the sequential introduction of a green window through a set of intersections and is typically used for emergency vehicles.

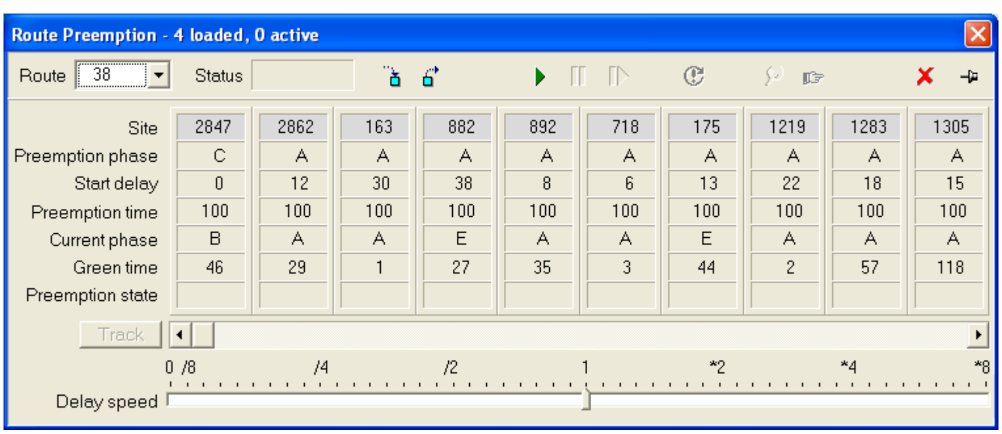

Figure 10: Route Pre-emption Control

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On-Line Control

It is possible to display and/or change all adaptive control parameters from any workstation while the regional computer is on-line. This can be achieved either by operator command or automatically by time of day. There is no need to take the regional computer off-line when altering data. Manual control of any intersection is also possible from any workstation.

Alarm Conditions

The system provides a comprehensive set of alarm conditions to warn the operator of all unusual or fault conditions. These alarms are logged automatically on occurrence and clearance, and can be queried at any time. Alarms are also provided for congested traffic conditions in each subsystem.

Detection

Stop Line Detection

There are loop detectors for both strategic and tactical level control. All detectors (both strategic and tactical) are normally located at or near the stop line (one in each lane). The detector length is crucial for accurate calculation of DS. If they are too short they may register large values of space under conditions of slow moving, closely spaced traffic (which would appear to a detector to be the same as light traffic widely spaced). On the other hand, if they were too long they would not measure any spaces when traffic moves freely. Research has shown the optimum length of the detection zone to be 4.5 metres.

Strategic Detectors

Strategic detectors are located at the stop line in order to measure how effectively the green time is used by *signal-controlled* traffic. If the strategic detectors were placed remotely from the stop line, assumptions would have to be made about the flow rate actually achieved during the green period.

Tactical Detectors

Tactical detectors located at the stop line enable differentiation between the left turn, straight ahead and right turn movements at the intersection, both by knowledge of the lane usage in lanes of exclusive use, and by speed differential in a lane shared by two or more movements. If the detectors were remote from the stop line, it would not be possible to identify the intended movement (direction) of detected vehicles due to subsequent lane changing. Additional detectors may be installed in advance of the stop line but this has been found unnecessary.

Detector Requirements

Tactical detectors should be provided on all lanes of an approach (or movement) that would benefit from tactical control, the minor movements being the most suitable.

It can be seen that approaches most requiring strategic detection are those least requiring tactical detection, and vice-versa. There will therefore be a need for detection of one kind or the other on most approaches. In general, the approach lanes which can be left undetected are lightly used kerb lanes on approaches which otherwise require strategic detection, and at minor intersections on the main road approaches which are not immediately upstream of a major intersection.

Communications

SCATS 6 supports the following communication methods between a region and an intersection:

- Serial – e.g. leased line
- Network – e.g. dial IP or ADSL using TCP/IP
- Dial out
- Dial in – using the dedicated DIDO unit

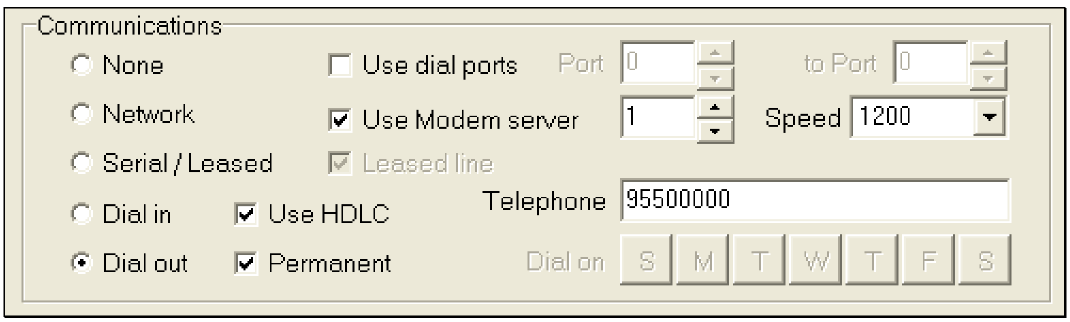

Figure 11: Communication options

There are messages to and from each intersection controller every second. The minimum requirement is 300 bits per second. The low speed rate required for SCATS communications allows for a high degree of tolerance in the reliability of the communications network.

Software

Scats Core Software

SCATS core client software includes the following:

- SCATS Access, incl. Graphics
- Picture
- SCATS Log

SCATS core server software includes the following:

- Central Manager, incl. Configuration
- Region, incl. Configuration

SCATS is an area wide traffic management system that operates under the Windows environment. It controls the cycle time, green splits and offsets for traffic control intersections and mid-block pedestrian crossings. With the inclusion of vehicle detectors, it can adaptively modify these values to optimise the operation to suit the prevailing traffic. Alternatively, it can manage intersections in fixed-time mode where it can change plans by time of day, day of week. It is designed to coordinate traffic signals for networks or for arterial roads.

Intersection connections to a regional traffic control computer can be permanent or may be on-demand using dial-in or dial-out facilities. Each regional computer can manage up to 250 intersections. A SCATS system can have up to 64 regional computers.

Monitoring is provided by a graphical user interface. Up to 100 users can connect to a SCATS system at the same time. Up to 30 users can connect to a single regional computer simultaneously. Performance monitoring, alarm condition notification and data configuration facilities are included. SCATS automatically collects alarm and event information, operational and performance data and historical data. SCATS operates automatically but operation intervention is provided for use in emergencies.

The software includes utilities supporting configuration of SCATS computers, creation of SCATS graphics, production of traffic performance reports and alarm/event/incident reports.

Optional Scats Software

SCATS client software option suite

- Traffic Reporter

This utility provides reports for detector volumes and traffic performance in graphical or tabular form.

- SCATS Alert

This program allows a user to be alerted when a nominated event is detected for a user definable period.

- SCATS Alarm Analyser

Alarm analyser can report on a specific fault over an extended period. It produces a detailed tabulated summary that includes alarms by duration, occurrences per site and occurrences by generation time.

- SCATS Communication monitor

Communications monitor is used to evaluate the communications between intersections and their SCATS regions with particular emphasis on loss of communications and loss of adaptive control due to fallback. Similar to Alarm Analyser, a detailed summary is produced that includes communications uptime and adaptive uptime.

- SCATS History reader

History reader allows a user to view the phase sequence and phase time at any intersection after the event.

SCATS Server Software option suite

- Event Generator

Allows alarms to be raised from non-SCATS devices

- SMS Server

Component to send SMS alerts

SCATS Congestion Server c/w Unusual Congestion Monitor

Server component to report Unusual Congestion

SCATSMap

A PC Windows based program used to display SCATS data in control rooms

ITS port activation

SCATS has an ITS port that allows operational data to be exchanged with other Intelligent Transport Systems. Enabling of the port to third party applications is subject to an additional licence fee.

SCATS

Scats Value Added Software

WinTRAFF software suite:

WinTRAFFsingle

WinTraff Single is a Windows application that allows the simulation of a single RTA standard controller. An RTA standard controller is one that operates using the RTA traffic software (TRAFF) and standard configuration data.

WinTraff can operate in isolation or communicate with a SCATS region

WinTRAFFsimulation

WinTraffSimulation is a Windows application that allows the simulation of multiple RTA standard controllers. An RTA standard controller is one that operates using the RTA traffic software (TRAFF) and standard configuration data.

The application was developed for the purposes of enabling traffic modelling and the visualisation of RTA standard controllers operating in a SCATS environment.

WinTRAFFtest

WinTraff Test is a Windows application that allows the simulation of multiple RTA standard controllers. An RTA standard controller is one that operates using the RTA traffic software (TRAFF) and standard configuration data.

The application was developed to allow load testing of the SCATS environment. WinTraff Test establishes socket connections with a SCATS Region and a test application using TCP/IP. The test application is used to setup/alter the detector simulation operation in the WinTraff Test controllers.

WinTraff Test can be configured to operate connected to SCATS alone.

SCATSIM

A suite of software that allows SCATS to be linked to a traffic micro simulation. This provides a faithful simulation of a network of SCATS controlled intersections or motorways with entry ramps controlled by SCATS Ramp Metering System (SRMS)

Other PC Based SCATS Software

TMIS

Traffic Management Interface System (TMIS) is a framework that can combine inputs and control from traffic management systems into a uniform and where applicable spatially oriented view. Currently TMIS provides access to live SCATS information only.

The TMIS installation is comprised of an ITS service (TMIS SCATS Service) that communicates with SCATS. A naming service (TMIS Naming Service) used to locate TMIS services on a network. A messaging service (TMIS Messaging Service) used to deliver information between services and clients and a client user interface. TMIS also provides a separate administration GUI for monitoring of the application.

The TMIS client user interface presents SCATS phase, alarm, dwell, lamp, congestion and subsystem information. The information is displayed in a range of formats including spatially via a map. The TMIS client user interface also provides, (subject to user access) a number of commonly used SCATS control operations. In addition to the basic map background the TMIS user interface can be configured to display 3rd party maps images and data (dependent on availability and format of content) for enhanced map visualisation and usability.

SCATS

Contacts

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Rhodes NSW 2138	Fax:	+ 61 2 9736 9990
Australia	Website	www.aldridgetrafficcontrollers.com.au

Quick Turn Circuits	Attention	Sales and Marketing
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