

Managing Traffic Congestion Through the Use of Real-time Micro Simulation of Area Wide Traffic Signal Systems

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ABSTRACT

Over the last decade there have been significant advances in micro simulation traffic modelling technology mostly aided by the increasing power of desk top computing. More recently, advances have been in the interfacing of micro simulation software with area wide traffic signal control systems to achieve more realistic modelling of road networks under this form of control. The purpose at this present point in time is principally for operational planning and management. An example of this is the Roads and Traffic Authority (RTA) in NSW, Australia, developing a SCATS (Sydney Co-ordinated Adaptive Traffic System) interface with micro simulation software packages such as Paramics and VISSUM. This paper describes the current development of a traffic micro simulator that would tightly integrate with SCATS. The simulator would be tailored to have only those features required for analysing urban networks under SCATS control and in doing so, have superior runtime speed, reflect more precisely SCATS and other RTA management systems such as PTIPS (Public Transport Information and Priority System) and SRMS (SCATS Ramp Metering System) operation. Through the use of the online SCATS data such as network descriptions, detector counts, and historic signal timing data, area wide models can be developed that would allow real time scenario testing ('run head' modelling). This real-time forecasting would allow traffic management centres to pre-empt areas of traffic congestion and take appropriate management action. The combination of micro simulation interfacing with real world data opens up other endless possibilities in terms of developing road based public transport strategies, incident management, emergency priority control, and training of SCATS operators.

1. INTRODUCTION

Significant advances in traffic micro simulation modelling technology over the last decade have made it more accessible to the traffic and transport planning profession as a planning tool.

These new generation models simulate the movement of individual vehicles and as such are substantially different from traditional models. They model driver behaviour, vehicle physical characteristic, and road geometric form. Not only can these models deal with some of the inherent problems of the previous models, they also provide graphical output immediately interpretable by persons not expert in signal control systems.

This advancement has largely been made possible due to enormous advances in desktop computing power.

More recently, there is recognition that micro simulation can make a valuable contribution to operational planning, particularly in the realm of area wide traffic management systems and congestion management. Micro simulation models can aid the development of signal co-ordination strategies, and the development of new algorithms to aid these strategies.

This paper describes development work in the merging of the two technologies, micro simulation and the area wide traffic signal management system of SCATS (Sydney Co-ordinated Adaptive Traffic System) (Lowrie 1992).

The Roads and Traffic Authority (RTA) of NSW, Australia, is the owner and developer of SCATS. This system of area wide management of traffic signals has been licensed to 15 countries and implemented in over 110 cities with over 23,000 signalised junctions. Countries include China, Indonesia, Malaysia, Philippines, Singapore, Mexico, New Zealand, and the United States.

2. EARLY DEVELOPMENT OF SCATS INTERFACE

The RTA was the first Australian road authority to widely adopt micro simulation modelling as a traffic planning tool. Through the use of this tool, the RTA soon recognised the potential of interfacing this software with SCATS to dynamically set signal times in the models. This would provide a more realistic representation of real world conditions. In doing so, the models could then be used as a test beds for a variety of situations including:

- development of new and improved SCATS strategies;
- system optimisation;
- testing new bus operating plans and routes; and
- testing incidents management systems.

While leading commercially available micro simulation software such as Paramics, AIMSUM, and VISSIM can produce a similar result for a given set of traffic conditions, each has its own special features and strengths. The RTA, for the present, has selected Paramics (Quadstone 2003a) software for its micro simulation modelling. The principal appeal of the Paramics software is its ability to model user-defined traffic behaviour through custom developed software modules known as Application Programming Interface (API) (Quadstone 2003b). This API facility makes Paramics more adaptable for interfacing with SCATS.

However it is noted that testing and development is currently underway to link other simulation models, such as AIMSUM and VISSIM.

3. HOW THE INTERFACE WORKS

Conceptually, the interfacing of micro simulation software to SCATS is simple. The simulation software acts as the “real world” condition and passes loop detector information through an interface to the SCATS system. In return, SCATS passes signal group data back to the simulation. All the controller logic and signal co-ordination is contained in SCATS and the interface program. Detector id, signal group movements and turns are mapped from the simulation to match the actual road layout and associated SCATS coding.

Figure 1 details the Simulator-SCATS topology. The whole software package is referred to as SCATSIM owing to the fact it is an off-line version of SCATS which enables it to run faster than real time. The standard version of SCATS needs to deal with much slower communication protocols which exist in the real world, e.g. the physical distance between central control and the traffic signals.

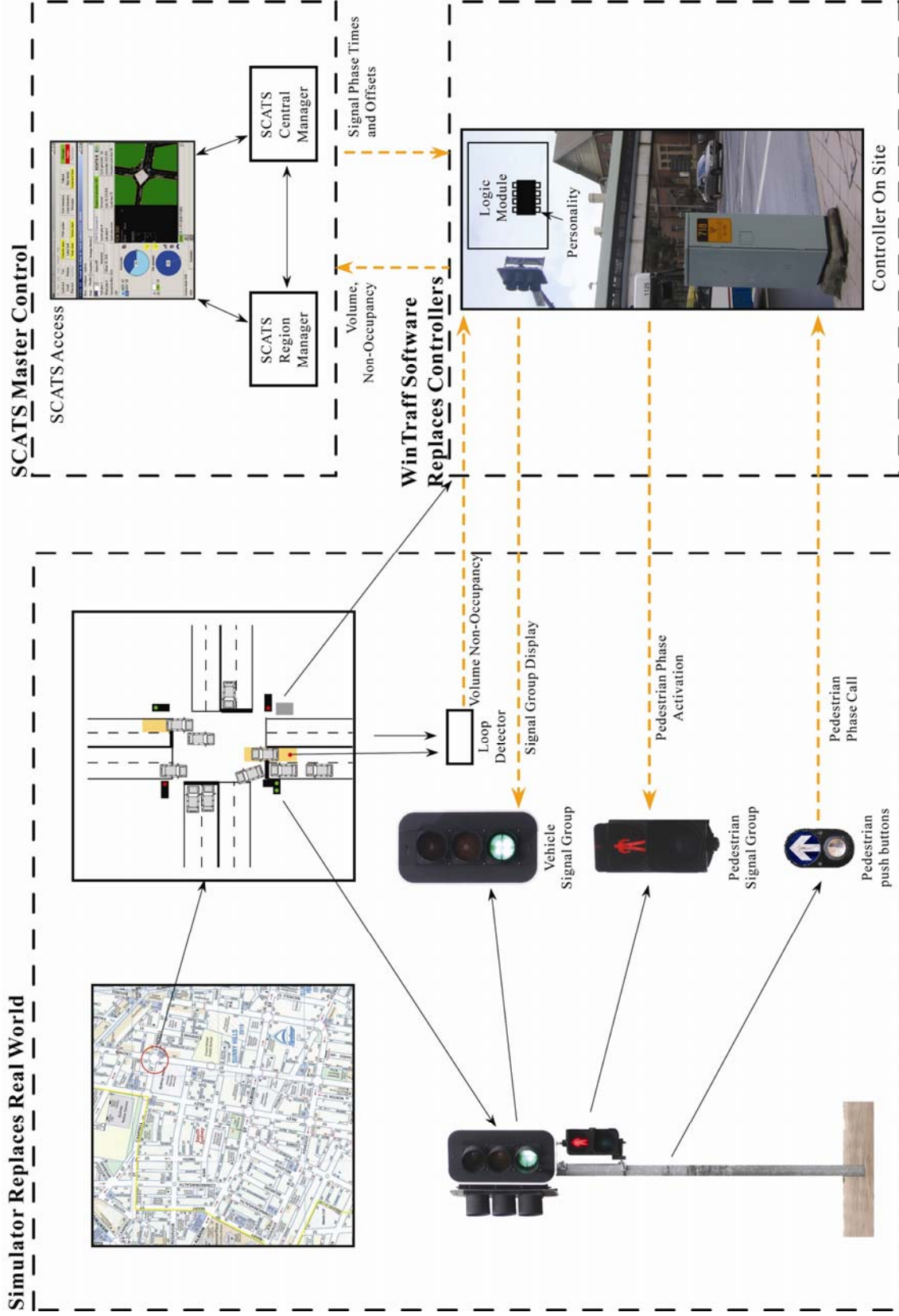


Figure 1 – SCATSIM Topology

Further detail of how simulator and SCATS interact can be found in Millar et al (2004).

More recently development of the interface has included the following add-on facilities to SCATS:

- Public Transport Information and Priority System – PTIPS.
- SCATS Ramp Metering System – SRMS

PTIPS is a time and spatial awareness package that tracks public transport vehicles in the network and compares position against timetables. Should the vehicle be off schedule, PTIPS considers the feasibility of providing signal priority at a junction which may result in a direct call for a phase in SCATS.

SRMS is a management system which monitors entry ramp flows to freeways and motorways to management traffic flows to optimum capacity.

SCATSIM models are able to test various traffic management strategies employing PTIPS and SRMS features.

Presentation of this paper will include audio visual material that will provided greater understanding of the complexity of the SCATSIM, the issues arising, and advancement in design and management that were not previously achievable with traditional modelling tools.

4. THE DEVELOPMENT OF AN INTEGRATED SCATS SIMULATOR

The SCATSIM/simulator in its current form is essentially an off-line planning tool. As a first step it requires calibration to fundamentally emulate/model a chosen historic traffic condition. Once this is achieved, the model can be employed for a variety of situations as previously mentioned, such as;

- assess the benefits of implementing adaptive traffic signal systems;
- optimise the configuration of existing SCATS systems;
- test SCATS algorithms before real world application; and
- train SCATS operators without affecting real traffic.

While the package as it now stands has provided a significant advance in the ability to more efficiently managed urban road networks, its full potential has not been realised in terms of real time management of traffic congestion.

The lack of integration with the online version of SCATS does not enable real time response to traffic congestion issues.

In addition there is duplication in the signal group, turn movements and detector coding in SCATS, the simulator, and controller specification. All three data banks are coded manually and this introduces the increased chance of human error, as well as an inefficient use of resources. Clearly a single graphical user interface (GUI) which accesses a common data source (or combined data sources) would have enormous benefits.

Further, the authors' experience with plugin development work has made it clear that there are gaps in the functionality of the simulator software Paramics (and all other commercially available simulation software) in four key areas. These are:

1. Speed of simulation when simulating large areas
2. Data integration with source RTA data
3. Software integration with existing (and possibly new) RTA software
4. Ability to calculate optimum phasing designs, phase splits and cycle lengths

It is the authors' intention to rigorously pursue the development of a new tightly integrated SCATS/simulation package in partnership with the RTA to overcome the above issues.

The software will consist of a core simulation engine, a data structure which is consistent with available data source (mainly RTA data) and a GUI to interface between the simulator and data.

The aim is to have a GUI and data source structure which is consistent with SCATS and only RTA software such as PTIPS. The simulation engine could then be an add-on to the RTA suite of software as well as a stand alone simulation software package.

Within this development framework, the capacity of SCATS to management the system can be greatly enhanced. Particularly in relation to appropriate signal plan selection to optimise cycle time and off set plans based on traffic network demand.

5. FURTHER ADVANTAGES OF INTEGRATION

Ultimately the success of the simulation will be dependent on the quality of data relating to vehicles travel patterns. This problem is common to all network traffic modelling, traditional and micro simulation.

Techniques such as "matrix estimation" allow development of vehicle origins and destinations based on traffic count data. The process does require an initial estimate of the traffic patterns drawn from sample surveys.

The interface with an area traffic control system such as SCATS enables access to real time data that would allow good estimation of traffic demand patterns. Further integration with other databases such as electronic tags that are commonly used for toll collection and road pricing can enhance the trip pattern estimation.

As SCATS continually collects data, ongoing refinement and adjustment of travel demand patterns as a 'learning' process is possible. The outcome is the development of robust models able to predict and pre-empt management strategies with high degree of confidence.

6. CONCLUSION

The ongoing development of a fully integrated simulator module for SCATS will provide a tool to more effectively manage congested road networks by being able to implement pre-emptive action.

It will provide an improved basis for efficient public transport planning, anticipating network impacts from major land use redevelopment, and incident management. In relation to the latter, the online simulator could track the effects of an incident (traffic accident or breakdown) in the network by allowing the simulator to 'run head' of real time. This real-time forecasting would allow traffic management centres to pre-empt areas of traffic congestion and take appropriate action.

The combination of micro simulation interfacing with real world data opens up other endless possibilities in terms of examining congestion pricing policy, emergency priority control, and training of traffic management control operators.

7. REFERENCES

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