Modelling for the future

Martin Wylie asks if traffic models can assist in the real-time management of traffic networks?

For sometime now planners have used modelling techniques to predict the likely impact of additional traffic demand on our highway networks, but there is a growing trend towards using these modelling techniques to assist with the real-time operation of highway networks through the assessment of control options and strategies.

Ever since the reduction in new road building the capacity of the highway network has been under pressure from the increase in traffic demand, pedestrian accessibility and public transport priority. The burden on the highway network due to this ever-increasing traffic demand has required innovative approaches to maximise the capacity of the network.

Much of this extra capacity or traffic flow redistribution has been achieved by the deployment of intelligent transport systems such as urban and adaptive traffic control techniques, car park guidance systems, route advisory systems, bus priority etc, and when a highway network operator has installed all of these systems they then have to optimise the use of these systems to manage the increasing demand on the highway network by taking strategic control of the network and prioritising some routes over others.

As capacities on our networks increase, even the 'car is king' optimisation techniques have become more strategic with the addition of bus and pedestrian priority, congestion weighting etc. Often these techniques are controlled artificially by the alteration of their validated parameters to suit the prevailing traffic conditions rather than giving the optimisation algorithms free rein.

WHAT IS MORE IMPORTANT: JOURNEY TIMES OR RELIABLE JOURNEY TIMES?

As we move to more over-stretched networks it may well be the case that we need to be providing more reliable journey times rather than fluctuating journey times which although may be shorter at times cannot be maintained in periods when the network capacities are exceeded. In Southampton the use of traffic gating and route discipline is currently being deployed to maintain some main route journey times. This is where the ability to use modelling to assess the viability of such strategic control options is a potentially valuable resource to the network manager. Not only can these strategies be tested with the model before being implemented on the live network but the ability will also exist to understand the effect that traffic growth will have on these strategies.

Strategies can come in many guises with varied trigger points including pollution, congestion, journey time reliability, public transport priority, major event management etc. We may well, for instance, have to restrict the density of traffic in certain areas of the network based upon unacceptable levels of pollution whilst at the same time improving the flow of vehicular traffic or pedestrian movement in areas where congested traffic may lead to pollution reaching unacceptable levels.

With the event of the Traffic Management Act 2004 in the UK a duty has been placed upon local authorities to demonstrate their management of the highway network. At the ROMANSE Traffic and Travel Information Centre in Southampton work has started to look at the opportunities for the future in urban traffic control and congestion management.

It is our perception that traffic models can provide the network operator with a clearer understanding of the networks capacity constraints and the strategies that can be deployed to assist in the movement of traffic within the network.

Modelling can assist us with the effectiveness of strategy deployments and probably, more importantly, demonstrate the maximum achievable outcome based on the physical constraints of the network and ultimately leading to more efficient use of available funds used to deliver highway improvement schemes.

This paper sets out the steps that we have already taken and intend to take in order to explore the potential for traffic modelling to assist in the real-time management of traffic networks.

SOUTHAMPTON'S NETWORK

Southampton has an over arching motorway network in the M27 and M3 which is controlled by the Highways Agency. This Motorway network provides and receives traffic from all of the main routes in and out of the city.

ROMANSE recently commissioned a congestion 'Hot Spot' study of the Southampton Network from transportation consultants Halcrow A specialist team led by Bruce Slattery (Technical Director) delivered a detailed analysis of the build up of congestion along the main routes in Southampton during the peak and inter-peak periods.

The output of this 'Hot Spot' study has proved very useful in identifying where resources can be most effectively deployed in tackling congestion. A simple but effective scoring system was employed so as to rank the potential

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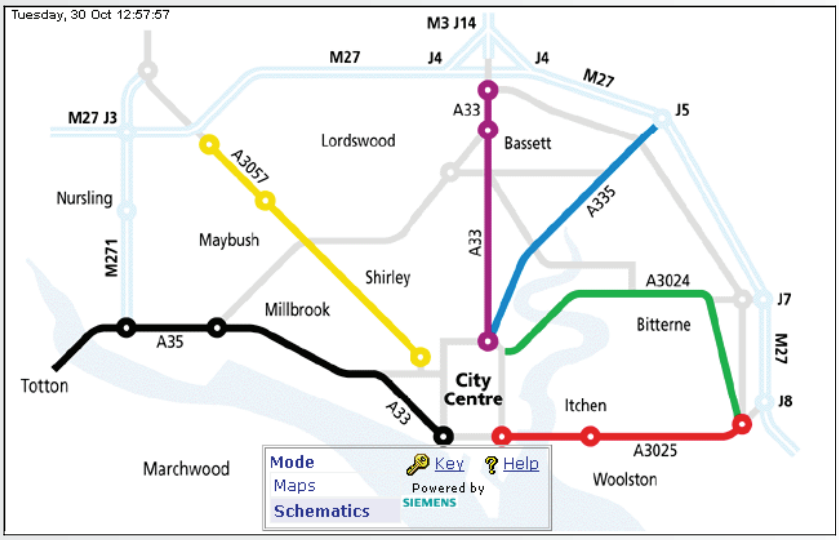
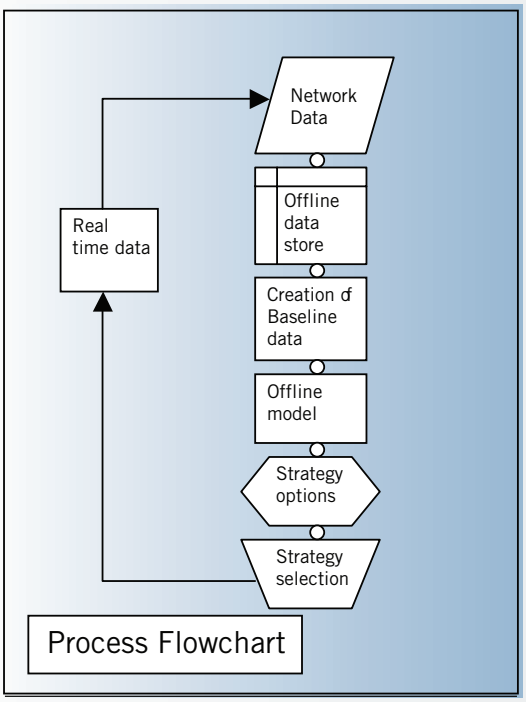




The process flowchart shows the envisaged data flow.

schemes in order of deliverable efficiency. By identifying a number of schemes for congestion reduction from longer-term aspirations to quick wins, we are now better able to understand the potential for strategic control requirements and which areas we have to take into account when affecting the network's operation.

ROMANSE is now in the process of producing and commissioning a number of simulation baseline models that will be used to assist in the delivery of our congestion reduction plans.

THE PROJECT OUTLINE

Working with TSS - Transport Simulation Systems and Siemens Traffic Controls, Southampton ROMANSE have begun a development programme to link the Aimsun traffic simulation software to an offline urban traffic control system for the purposes of evaluating the effectiveness of the existing methods of control and the benefits which may be offered by deploying alternative methods of control at certain times.

This interface will provide an offline UTC SCOOT, MOVA and strategic control system, the strategic control being provided via an offline COMET database.

By linking these systems together with Aimsun modelling software it is hoped that a library of strategic plans can be assimilated over time and once confidence has been achieved in the systems, validated plans can be deployed on street to manage the network when required.

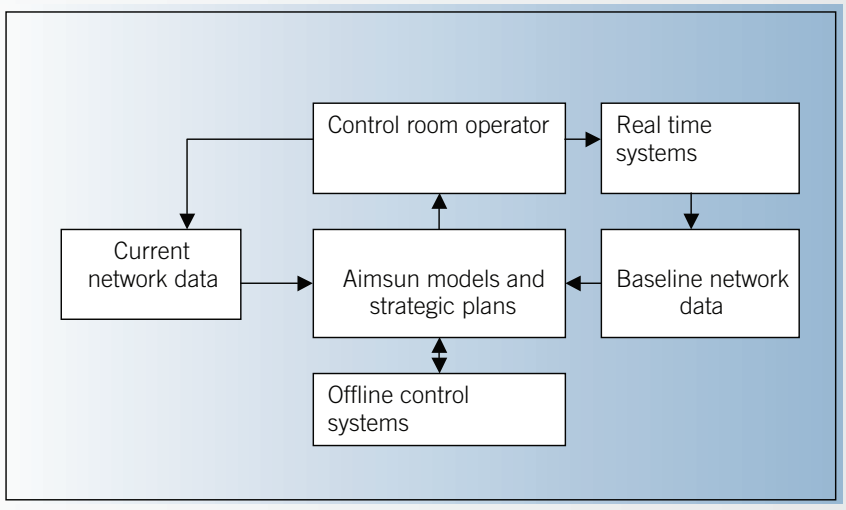
PROPOSED METHODOLOGY

Data collected from the live Southampton network via existing SCOOT loops, count loops, number plate recognition, COMET and the Urban Traffic Control system will be archived into an offline database. This will provide flow data, intersection timings, journey times, origin and destination data and incident records to be used as the modelling input and for the purposes of evaluation baselines.

It is initially intended only to model the main routes within the City in isolation but the longer-term aspiration is to link these models together so that some assistance in evaluating the impact on other areas of the City network can be provided.

The following process chart shows the intended data flow management that will be used to collect the data from the live network and process it with the model before producing the traffic control strategies that may be deployed on the network.

The live model scenario flowchart shows how the systems architecture of an automated strategy tool might look.



STRATEGY DEPLOYMENT

It is intended that strategies are initially implemented manually but the long-term thinking is that a network modelling system receiving specific triggers could provide the network operator with a choice of predefined strategies and a confidence factor for these strategies as to their likely ability to deal with the prevailing network conditions.

Further feedback to the modelling system could then provide the network operator with the effectiveness of the strategy being deployed and any subsequent strategies, which may need deploying.

Maybe once these types of systems are in place the evaluation of strategy effectiveness can then be modelled in real-time and improvements automatically made to baseline strategies if appropriate, therefore developing the effectiveness of the system to deploy strategic control by improving its prediction reliability as it begins to learn itself what is an appropriate method of control for the prevailing network conditions. As we see in nature that evolution manifests change in its organisms so neural computing technologies can evolve to manage traffic networks by constantly improving the prediction and assessment of network operation and efficiency.

SYSTEM ARCHITECTURE

The following flow chart shows how it is envisage that an automated system may evolve with live data being collected from the network and transferred to the Aimsun model where strategic plans are evaluated faster than real-time using the offline control systems to predict the likely scenarios thereby outputting options for strategic control to the operator who can then implement them as they see fit.

The Real-time systems controlling the network would then feedback to the baseline data improving the prediction process through the addition of further scenario deployment and congestion management evidence to the database possibly adding to the number of existing strategies or by improving the confidence in existing strategies to manage the network.

Some parallels can be drawn to the telecommunications industry that use similar software techniques to manage their data demands switching capacities and rerouting connections to facilitate the demand.

We have also seen that digital video capture and object recognition software techniques are becoming more powerful and therefore the ability to deploy these in the highway environment more practical. Imagine of you will an imaging device taking per second snapshots of the networks traffic and digital imagery software being able to count the number of vehicles on a route, identify their type, identify which lanes are moving and by how much and where queues are forming etc and pass this geocoded to the model for instantaneous evaluation.

ROMANSE would be very interested to receive any feedback to this paper and from anyone who feels that they or their organisation could be able to assist us with this project.