Simulation and testing of strategic control rationales

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Forward

This paper sets out a process for devising and evaluating urban road network active management strategies using micro-simulation and offline traffic control emulation, using an Aimsun micro-simulation suite which includes micro, macro and meso-scopic modelling capability connected to a Siemens offline Urban Traffic Control (UTC) emulator which includes the SCOOT (Split Cycle Offset Optimisation Technique) optimisation algorithm with the Siemens SCOOTLINK software interface.

Introduction

The use of micro and macro modelling is now common place in the assessment of road networks both for the evaluation of new developments and more recently in assisting with the testing of network efficiency and the potential for improvements. At ROMANSE in Southampton an Aimsun micro-simulation model has be connected via a software interface SCOOTLINK from Siemens to their UTC offline software which includes the SCOOT optimisation algorithm. The SCOOTLINK interface provides the SCOOT detector information, signalised intersection demand dependant stage demands and stage green confirmations from the micro-simulation model to the UTC offline software and in turn the UTC offline software replies with the optimised intersection stage timings. The traffic signals in the model can be controlled in both fixed time and SCOOT optimisation modes. What was missing in the interface was the ability to pass strategic triggers generated from the model to the offline UTC software such that strategic control can be deployed. Strategic triggers such as queue detectors and traffic flow counters are common place in the road network and assist in the central management of traffic control; therefore having the ability to test these strategies is incredibly beneficial in the quest for more efficient traffic control and the development of event, environmental and incident management techniques.

Development of the strategic control interface

Quite fortunately both Aimsun and the UTC offline software have the capability to exchange data outside of the Siemens SCOOTLINK by means of a TCPIP interface and Python scripting. Ably assisted by Dr Ken Fox of Fox Traffic Simulation the first task was to explore the potential outputs which could be generated from an Aimsun model for the use in strategic control rational assessment. It became apparent that there were a number of outputs which could be produced including detector queue triggers, vehicle flow counts, detector density, road section emissions, vehicle speeds and vehicle headway to name but a few. It was decided to initially concentrate on queue loop triggers and vehicle flow thresholds.

The next step was to develop a script which could be used to generate a trigger when a queue was present in the model and to allow variable queue trigger times to be determined. To this script was then added the functionality to generate the averaged vehicle flow over time.

Finally a script was written by Imperial College London which provided the TCPIP interface to the UTC offline software and allowed for the transfer of strategic triggers. Once these scripts were built and tested we had the ability to generate triggers and pass instructions to the UTC offline software which would in turn modify the way in which the traffic is controlled within the micro-simulation model.

Developing and testing the strategies for active traffic control management

Queue models

It was decided to model an existing queue strategy such that the functionality of the new interface could be tested with a known and measureable event. The strategy in question is used to assist in the egress from one of the City's cruise ship terminals Dock Gate 10 as shown in figure 1.

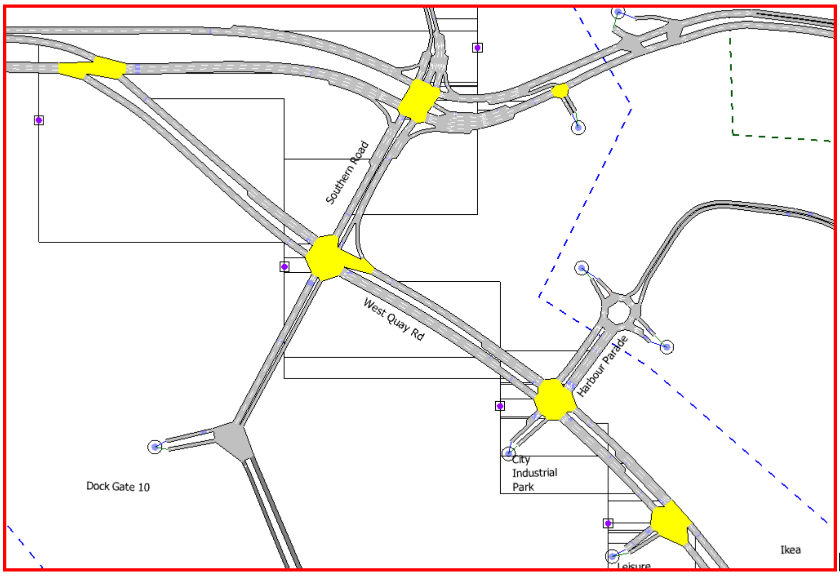

Figure 1 Dock Gate 10

The main intersection with the Dock Gate and West Quay Rd is controlled by the traffic optimisation technique SCOOT and will attempt to manage any increase in traffic demand through its optimisation of the intersection and its logical neighbours within the SCOOT region. There are times however when as is the case here that we have a large peak in traffic demand as passengers disembark from their cruise ship and head home, in order to manage this egress pressure special parameters must be introduced so as to massage SCOOT into making the correct strategic decision for the prevailing traffic demands. When the strategy is activated SCOOT parameters are adjusted which assists in weighting the egress and the neighbouring intersections offset optimisation which further assists the downstream vehicular movement. As can be seen from figures 2-3 The Dock Gate 10 approach delays and overall intersection delay in 5 minute intervals has been measured and compared with the unassisted and assisted cruise ship egress and shows that the strategy improves the egress of traffic from the cruise terminal without adversely impacting on the main intersection.

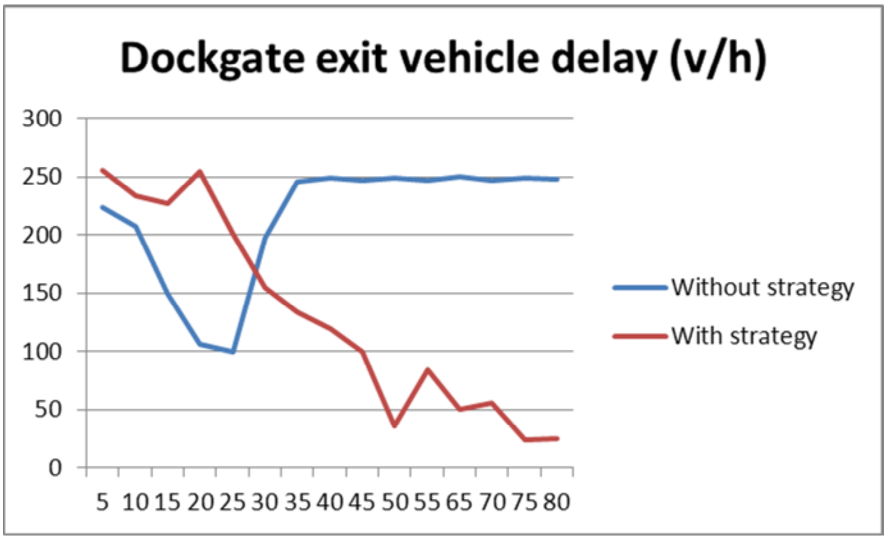

Figure 2 Dock Gate 10 exit vehicle delay / hour

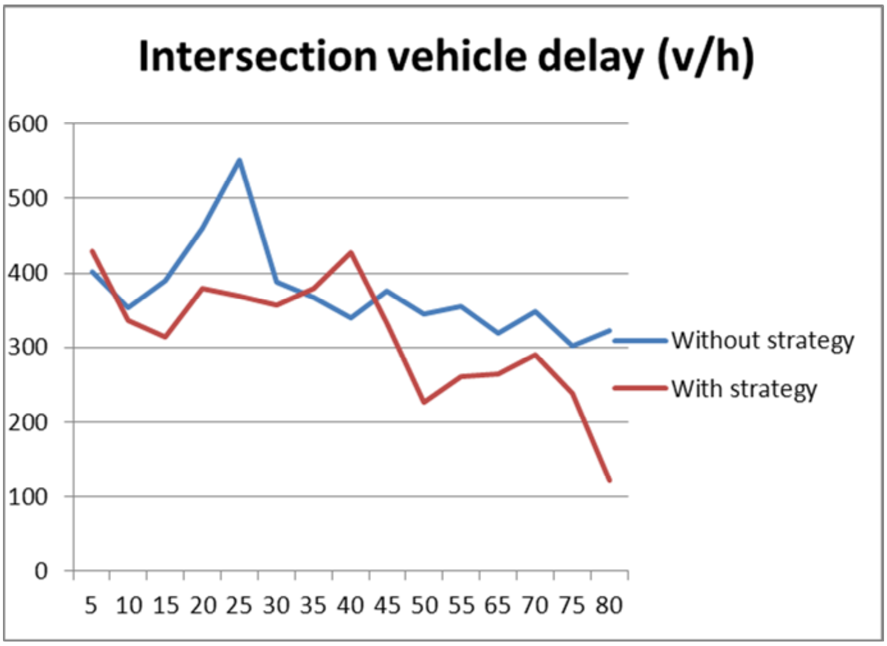

Figure 3 Overall intersection delay vehicle delay / hour

Flow threshold models

Flow threshold strategies have a number of uses in informing the current traffic control methodology that changes are required to accommodate rising traffic demands usually outside of the normal baseline traffic flows.

The strategy tested here was one of demand and capacity exceedance pre-emption, figure 4 shows the Cumberland Pl which is Southampton's inner ring road and culminates in a signalised roundabout at Charlotte Pl. If the traffic demands on the ring road approaches exceed the normal baseline flows additional queuing will ultimately occur. Two conventional approaches can be taken to delivering active traffic management here, information can be provided to drivers such that some will divert onto other routes or start their journey at a later time and traffic gating and flushing control strategies can be introduced to reduce the formation of adverse congestion and its subsequent effect to the movement of traffic. The basis of the strategy is to use flow count information to provide flow threshold triggers which alter the method of traffic control and trigger the release of driver information. Model runs using the existing method of traffic control were undertaken and then by increasing the traffic demands and rate of traffic arrival until congestion was witnessed, journey time and delay information were collected so as to evaluate the potential benefit of introducing strategic control rationales. Model runs were then undertaken with the strategies in place using the congestion generating flow demand profile as the trigger.

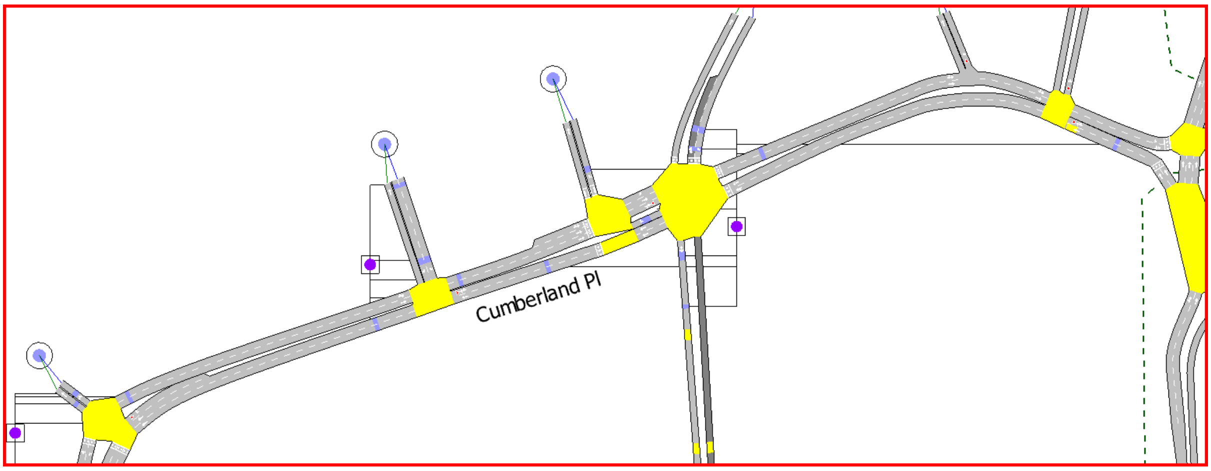

Figure 4 Inner City ring road Cumberland Pl

Figures 5-6 show the delay comparison before and after the deployment of strategic traffic control measures. As can be seen the delay and traffic speeds are improved by the strategy being deployed

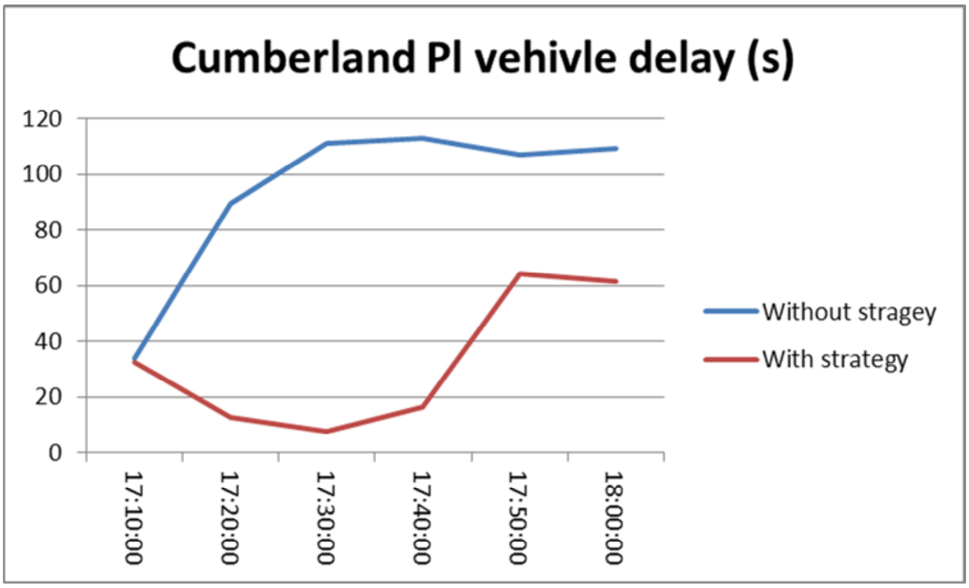

Figure 5 Cumberland Pl vehicle delay with and without strategic intervention

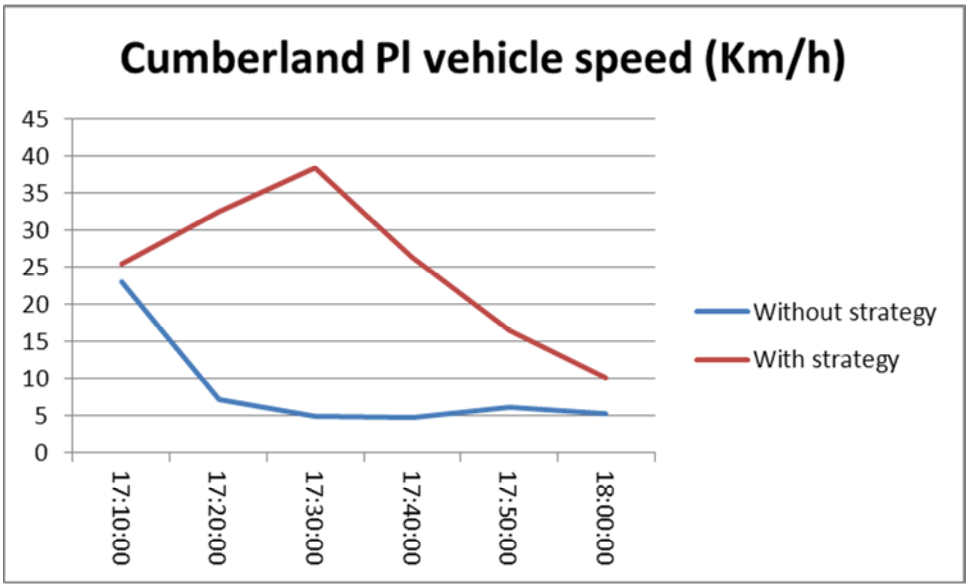

Figure 6 Cumberland Pl vehicle speed with and without strategic intervention

Emissions estimation and management strategies

Next we added the ability to generate triggers based upon the calculated emissions from the micro-simulation model.

Figure 7 shows the network in question The Bevois Valley in Southampton which like may urban areas suffers from high peak traffic demands and pollution from vehicle emissions.

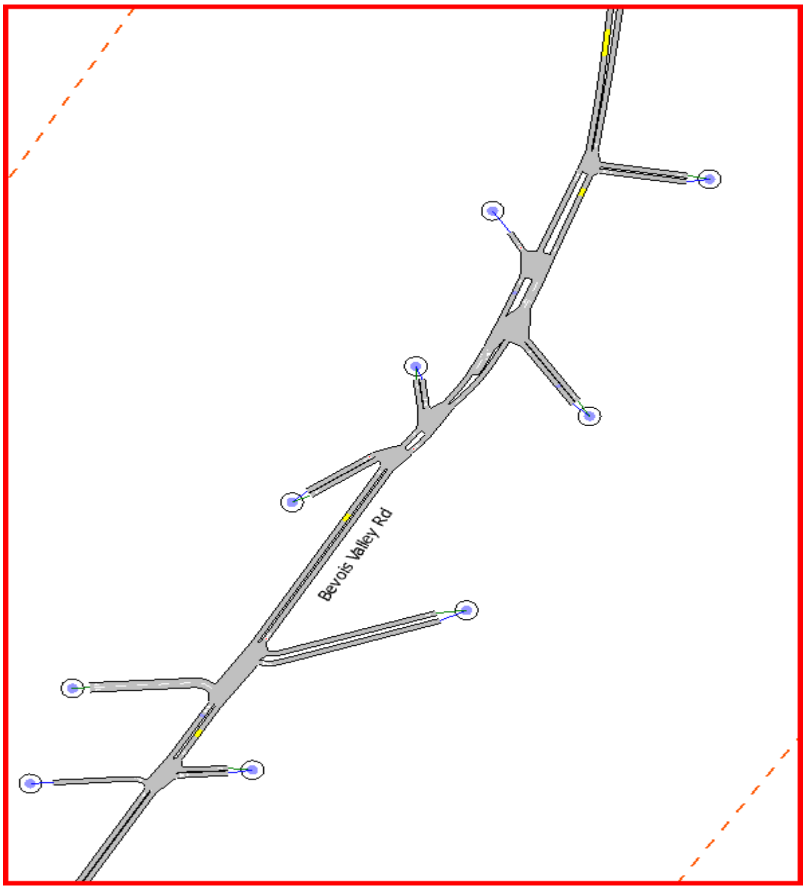

Figure 7 Bevois Valley Rd Aimsun Model

The strategy works in a similar way to that of the flow threshold strategy explained previously with the difference being that the strategy uses triggers from roadside emissions sensors to introduce the flushing and restraining traffic control strategies. We have to use two pre-emption triggers, flow thresholds and pollutant levels; queue detection is used to introduce vehicle flushing techniques.

A traffic flow threshold strategy monitors traffic flows and upon the occurrence over a rolling fifteen minute average of increased traffic demand over and above the baseline demand for that time of day a flushing strategy is introduced which encourages the downstream traffic control to provide more vehicle green time to the prevailing increased traffic demand, should the measured traffic demand be of sufficient level that experience shows that the flushing strategy will not dissipate the increased traffic demand a restraining strategy is introduced in order to limit the number and duration of vehicles queuing in the area where increased pollution is likely to be detrimental to health. A queue detector is installed to assist in triggering the flushing strategy and to remove it once the desired effect has been achieved. However should the levels of pollution rise without the increase in traffic demand which may be due to atmospheric conditions the pollution threshold trigger will introduce the flushing and restraining strategies regardless of traffic flow volumes.

Figure 8 shows the effect on emissions levels which the increase in traffic demand and congestion has on Bevois Valley. Figure 9 shows the comparison of traffic density and when compared to Figure 8 the correlation between density and NOx levels. Figure 10 shows the effect on overall journey times and shows that journey times are reduced by the deployment of the strategy even though the strategy restrains vehicles for part of their journey.

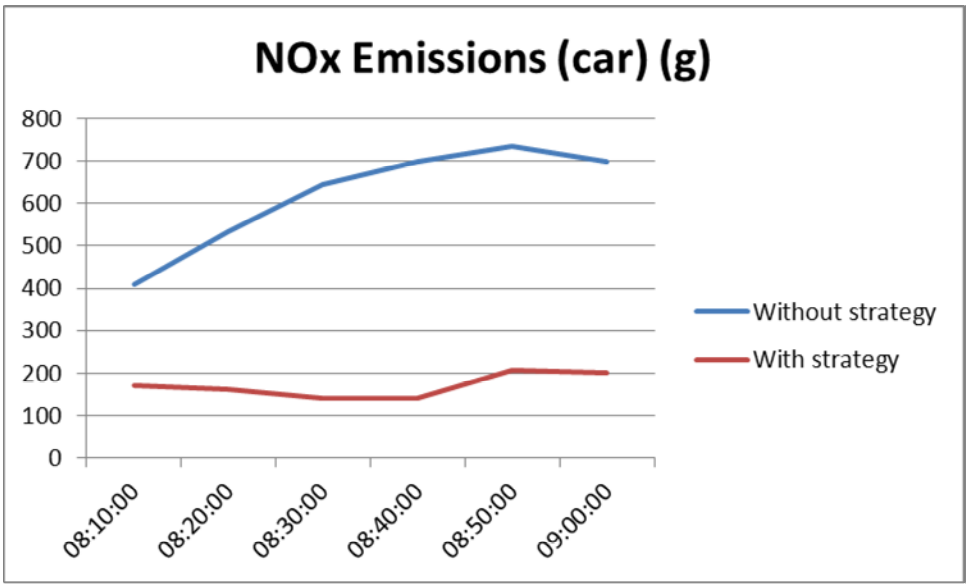

Figure 8 Comparison of NOx values

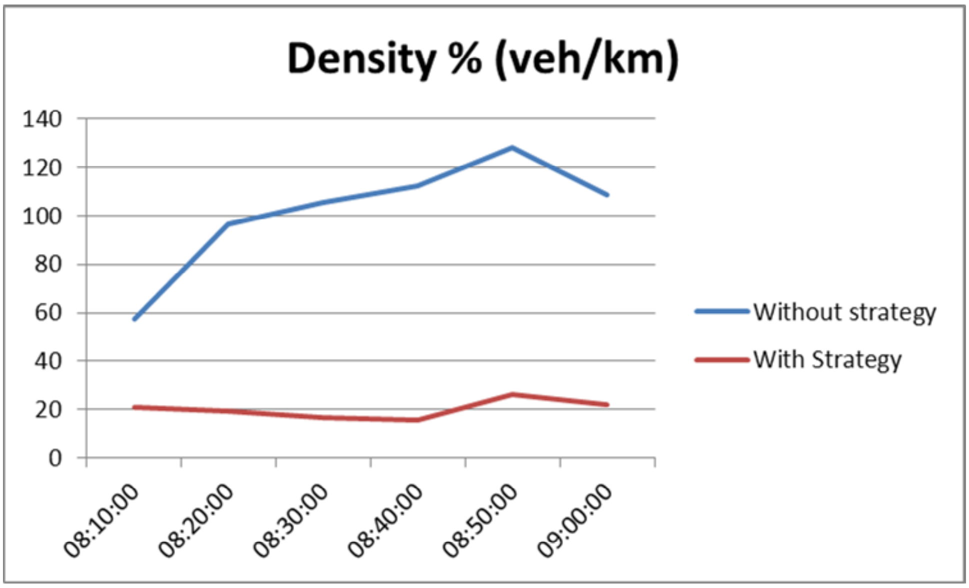

Figure 9 Comparison of Density values for Bevois Valley

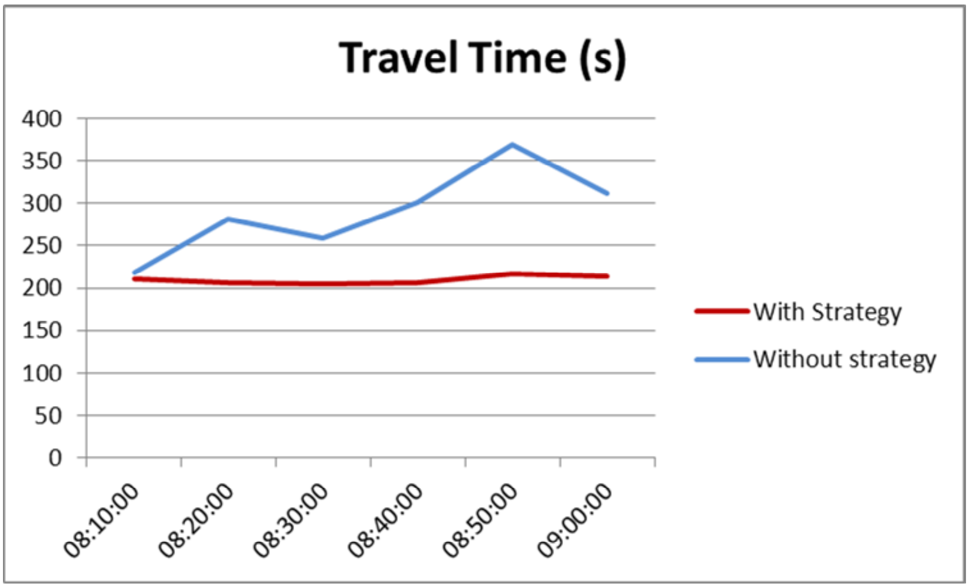

Figure 10 Comparison of overall route journey times

Acknowledgements

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