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Traffic Light Phasing To Achieve Traffic Flow Efficiencies in Auckland Transport and their Economic Benefits

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Abstract

This paper provides a brief overview of how the traffic signals are managed and how their efficiency is monitored, adjusted, improved and what further measures are being implemented to gain efficiencies from the traffic lights. The economic efficiencies of achieving optimisation are measured through the regional optimisation programme. The regional route optimisation programme is a key link between planning, infrastructure development and operational management to achieve network efficiency.

This paper provides information on how traffic signals are being operated and what is being done to make them more efficient. Traffic signal operation and the regional route optimisation programme are relevant to the strategic goal of increasing efficiency on the transport network.

Keywords: *Traffic Signals, Route Optimisation Programme, Transport Network*

INTRODUCTION

Traffic signals are a traffic control device used on the road network to assign priority where there are multiple conflicting traffic movements. Traffic includes pedestrian's cyclists and all types of vehicle movements. Planning is based on both measured and anticipated traffic flows. In urban conditions there are four distinctly different periods of traffic flow and these are:

- AM peak period
- Day inter-peak
- PM peak period
- Night-time

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PLANNING

Plans are developed for each time period based on movements required and amount of green time that will give the best use of the available time in terms of getting the most through put and optimum safety at the intersection. Traffic varies all the time so a minimum green time and a maximum green time are set for each movement. For example a pedestrian movement needs a defined time to cross a road. These minimum and maximum times are loaded into the computer controlling the intersection. Computer software is used for remote monitoring, linking, co-ordinating and where applicable manually adjusting the controls for unusual incidents. The computer software used for this is SCATS (Sydney Co-ordinated Adaptive Traffic Systems) which is a programme that has been in use since the early 80's and is widely used throughout the world and is extensively used in New Zealand and Australia for the control of traffic lights.

DESIGN

SCATS uses detectors (inductive loops in the road which can detect the presence of a vehicle) on each approach and in each lane approaching an intersection to measure the volume of vehicles approaching an intersection and shares the time between the movements in a manner that will allow for the most efficient operation of the intersection within the overall parameters set for the intersection. SCATS will assign the minimum green time and extend the green time as required up to the available maximum green time depending on traffic demand. When traffic conditions are at capacity there is no flexibility for SCATS to make adjustment and the system runs at maximum and at the fixed maximum times. This is quite a usual occurrence for most of the urban road network at peak conditions.

Intersections that are close to each other have a plan that links them to the adjacent signals. These plans are set up to enable traffic to travel through with a minimum amount of stops. Priority is given to the peak flow direction and to routes that have a high use of public transport. Where two or more routes cross each other, priority is allocated subject to timing requirements.

Each intersection is connected to a regional server and this allows the SCATS programme to collect and display data on the operation of all traffic signals connected to SCATS for use by the operators. The information is used in a number of ways.

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Congestion Monitor

Measured traffic is compared with older traffic patterns to determine whether there is an unusual amount of activity or congestion. These intersections are displayed on the congestion alert monitor so that the operators at JTOC (Joint Transport Operations Centre) can see how the network is operating. The congestion is confirmed with Traffic CCTV cameras and the operator can decide whether a manual intervention is required. This is an area that has in the past been under resourced and is an area where there is an opportunity for improved service delivery.

Manual interventions can include:

- Increasing the cycle time to reduce the amount of lost time during cycle phase changes
- Increasing the green time for a particular movement experiencing the worst congestion. This is used to good effect to manage unusual traffic due to lane blockage or special events.

Fault Monitoring

SCATS can report a number of faults and the most common ones are:

- Detector failure
- Lamp failure
- Power failure
- Damage due to collision/crash
- Controller fault

The team at JTOC who monitor the system can then log a fault for rectification by the traffic signal contractors.

Proactive Traffic Management

This is where a planned event requires special or unusual operation and was used to good advantage during the Rugby World Cup to ensure that teams travelling to the sporting venue receive priority (green) along the route. This requires the SCATS operator to manually override the system. A further example was allowing more pedestrian green time for the crossing at intersections on the fan trail.

Public Transport Priority

Public Transport buses are equipped with devices that can be detected by SCATS and which will then assign either extra green time to get the buses through or will give a priority call so the buses will get the green light sooner than normal. This product enables an enhanced (shorter) journey time for buses when compared with normal traffic.

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OPERATIONS

Active Monitoring

The SCATS system is monitored by staff that are especially trained in both traffic operations and the operations of the SCATS software. Several years of experience are required to become an independent and competent SCATS operator and there is a limited pool of qualified operators. SCATS operators are on duty at JTOC from 06:00 to 20:00 Monday to Friday, from 10:00 to 16:00 on Saturday. Outside of these times, JTOC has a team of motorway operators that also monitor the SCATS system and can call in standard maintenance requests. In the event of an incident requiring SCATS intervention a SCATS operator is on 24/7 standby remotely for assistance to the operators. In addition where there are planned events outside of normal operating hours SCATS operators are rostered for managing traffic flows as required.

Prior to the establishment of AT there was limited monitoring of SCATS. The only Council with some resource for monitoring and effecting changes to SCATS was Auckland Council. The other Councils relied on service level agreements with the previous Traffic Management Unit (TMU). The TMU had limited resources and would in general have only had one or two SCATS operators on duty.

With the formation of JTOC on 1 July 2011 there was an opportunity to review the resources available for SCATS and the number of operators is being increased so that there are at least two operators rostered on for each Peak period to improve the level of active monitoring.

Response to Issues and Customer Requests

The SCATS team are backed by a technical team that receive requests for service from a number of sources. The response depends upon the nature of the request. Requests include:

i. **Responding to Enquiries Regarding**
   - Co-ordination
   - Safety issues
   - Pedestrian walk times
   - Cycle detection
   - Audio volume at intersection
   - Congestion
   - Lights out
   - Damage
   - Short phasing

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- Detectors not calling lanes or movements

ii. Temporary Traffic Management

- Road works
- Utilities
- Land-use development
- Utilities
- AT major projects
- Temporary traffic management
- Special events
  - Santa parades
  - Sporting fixtures
  - Graduation parades
  - Military parades
  - Political marches

iii. Incident and Extreme Congestion Management

- Crashes
- Bridge strikes
- PT breakdown
- Storm damage causing road closures

iv. Land-Use Development

- Assessment of effects
- Planned improvements
- Consents for access
- Engineering plan approvals

v. Liaison with Other Stakeholders

- Auckland Transport
- Auckland Council
- NZTA : major projects and operations
- Others

Intersection Annual Review

The technical team have in the past reviewed the operation of intersections on a regular but individual basis, the introduction of the route optimisation programme has provided an avenue for the systematic, co-ordinated and programmed review of the intersections in the context of network efficiency. Critical intersections may still be reviewed if there are changes or circumstances that require a special review. The review includes a full traffic count review against planned operation to assess whether the timing and phasing plan is still appropriate for each movement and each period of operation. The review will also check the link plans with adjacent intersections and with the overall route optimisation plan. Any changes to the intersection route optimisation plan will be documented and incorporated into the optimisation plan.

Maintenance and Renewal

The infrastructure and technical hardware of each intersection is reviewed on an

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annual basis to ensure that the quality of the equipment meets the required standards. There is an active plan of monitoring the equipment and its planned renewal. The contract team actively reviews the fault log to identify equipment that has logged an unusual amount of faults and this is often an early indication of impending failure.

Upgrades

Technology is and there is a programme for upgrading older equipment to bring it up to the newer standards. An easily recognised example of this is the move from quartz halogen lamps to LED lamps. The LED lamps are brighter, last 5-10 years as opposed to 2 years and use less power. Changing to LED lamps is reducing the maintenance cost and is bring power consumption down by as much as 50%.

Recording, Measuring, Monitoring and Reporting

Advances in technology, the better retention and reporting of information and advancing the ability to compare before and after data are enabling better understanding and reporting of network performance. There is an interface software programme that has the ability to interrogate the historical SCATS data for up to 2 years and make comparison in before and after traffic volumes and travel times. The programme requires a rigorous setup of data feeds and consistency of conditions for fair comparisons. A work stream is currently working on enabling this network performance reporting on arterial routes. It will enable better understanding of how the network is performing.

The work stream is a budgeted network performance project related to Real Time Travel Information (RTTI) that is using this software to develop live data on key arterials within Auckland. The project is using a combination of in-house and external resources. The live data will be presented to the public using “virtual information signs” on a map showing the road network similar to the way signs information available on the NZTA web-site. 30 routes are being incorporated into the programme during the current financial year and it is expected that the information will be available on the AT web site by the end of June 2012.

Currently, travel time information, monitoring and reporting is being undertaken using GPS related travel time information, which is expected to continue to inform, audit and support validation of

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the ARTIS / SCATS-related information. The automation of RTTI on key arterial roads will enable better communication of conditions on the network and will also enable identification of areas for improvement.

Route Optimisation

All of the above work is complemented and enhanced by the route optimisation programme. This enables a more holistic and strategic look at a complete route or long segment of road to ensure that it is working as a continuous route aligned with the strategic direction and setup to be as efficient as possible. Over and above the normal intersection reviews it enables the full link plan to be reviewed in the context of the strategic direction for the whole route. This often results in changes that improve the overall performance and safety of a route. It can also enable major changes in traffic patterns to be reprogrammed into the operation of the route. The changes can be complemented with infrastructure improvements such as localised widening at “pinch points” and by regulatory changes such as clear ways at peak times in the peak flow direction.

Route optimisation has focussed on the most inefficient areas of the network with the greatest potential for improvement through better signal co-ordination. The results so far have been excellent. It is expected as further work progresses there will be a range of benefits from the route optimisation programme and that some routes will have a lower benefits. It is expected that the BCR could range from 1-100 but it is important to note that some of the benefits may not be quantified with the conventional recording techniques. Examples of additional benefits not quantified are: increased safety, reduced public transport times at the expense of increased general traffic times and increased pedestrian amenity. A good example of the latter is the increased pedestrian time on Queen Street resulting in a higher level of service to pedestrians and a lower level of service to general traffic.

To illustrate the method and some of the overall benefits of route optimisation Symonds Street will be used as an example of a route that has been optimised in year.

Travel time surveys were done before any changes were made to the SCATS system or controllers and then again after the changes were implemented. A route traffic model was setup based on the actual signal settings and measured “before” traffic

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flows. The model was calibrated by car travel time surveys and on-site observations. The model uses a specialist traffic signal optimisation programme called TRANSYT to simulate a number of different settings that determine the optimum traffic signal settings for the morning, inter-peak and evening peak. The traffic signals settings were then changed and the traffic allowed a brief period to settle down prior to the "after" travel time runs. The comparison of the before and after surveys indicate that the optimisation measures successfully reduced congestion and improved progression for both northbound and southbound traffic in the morning, inter-peak and evening peak periods.

Average travel time reductions of 19.8% were achieved for northbound traffic in the morning peak direction and 60.3% for southbound traffic in the evening peak direction. Northbound and southbound inter-peak travel times were also reduced by 21.7% and 31.6% respectively. These savings were achieved through SCATS data setting and controller time setting changes. The overall annual travel time savings, CO2 reduction and fuel savings were reported to the Board in April.

A number of other route improvements were identified in the final report and these include:

- Improvements to pedestrian signage.
- Addition of tactile paving markers at several locations.
- Improvements to road markings.
- Improvements to footpath and pram crossings where the footpath surfacing was in a poor condition and where the pram crossing was steep.
- Service chambers and manhole crossings that are not flush with the adjacent surface and present a trip hazard.
- Improvements to traffic signal perception through the addition of supplementary lights
- Overhead traffic signal lights partially obscured by vegetation.
- Changes to the traffic signal controller software at a number of locations was identified for consideration to improve pedestrian walking times and thereby pedestrian safety at high volume pedestrian locations.

Most of these items are addressed through the maintenance contract or with a minor

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works project. The software changes to traffic signal controller settings are each individually evaluated and either accepted for action or noted as items requiring attention with the next optimisation review. The model can be used for any future reviews or changes to the route.

This is a brief example of how route optimisation is applied and some of the further actions that get identified which result in additional benefits to the network such as pedestrian amenity and safety improvements.

FUTURE INITIATIVES

A number of additional measures are being progressed to understand and improve performance on the road network.

Improved Communications

Many of the traffic signals (60%) are connected with telephone lines and AT has an active programme to convert these lines to high speed digital lines at the rate of around 50 intersections per month. This will increase reliability, enable us to provide additional CCTV coverage and will also result in lower communication costs for traffic signal control. This programme will take between 12 and 24 months to complete depending on the complexity of the conversion. It is expected that substantial progress will be made within the 12 months.

All Traffic Signal Sets on SCATS Control

Some mid-block pedestrian crossings and isolated intersections are not on SCATS. The advantages of having them on SCATS are primarily fault monitoring but in certain cases linking them to adjacent traffic signals will improve overall route reliability. 49 Intersections need changing. This will be completed within 12 months. Estimated costs are $5000.00 per site and will be funded within existing budgets.

Improved Incident Response Capability

The establishment of AT and JTOC has enabled the standardisation of operational protocols across the network. The further work done with NZTA on the “one network” approach has enabled AT and JTOC to consider a unified approach to incident management. The ability for better incident response will reduce the impact of incidents on the road network enabling better and more consistent network performance. Work is underway to improve the incident response protocols and capability.

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Increased Traffic CCTV Coverage of the Network

The majority of our arterial road network is not visible to the operators on CCTV. There is a plan and an active programme for increasing the CCTV coverage of the arterial network. This is facilitated by the move to digital lines where CCTV pictures can be transmitted through the same communication lines that SCATS uses. The cost of CCTV cameras has reduced substantially through technology change enabling AT to get more cameras within the programmed budget allocation. The programme will allow AT to increase the coverage of Traffic CCTV cameras by about 30-50 new cameras per year over the next 3 years. A programme has identified 122 new sites and this programme will be reviewed on a regular basis and revised annually.

Increased Vehicle Detection Capability on the Network

There are sections of the road network which do not have traffic signals but where data on vehicle movement will be beneficial to managing traffic flows on the network Sites where additional loop detectors will add value to the active traffic management have been identified and work has commenced on developing a programme for additional loop detection.

As an example the RTTI requirements for the 30 key arterial routes identified a number of lengths of road without sufficient data for accurately determining traffic volumes and travel times. An additional 132 loops will be installed to provide the minimum density of data collection points for data collection.

New Technology is being investigated which uses CCTV camera detection for automatic data counting of vehicles, cyclists and pedestrians. The additional data sources will assist with peak flow management and will also be a data source for network improvement projects.

CONCLUSION

The work done to date by NZTA and AT in the establishment of JTOC has provided the opportunity for developing a comprehensive, robust work programme to consistently manage the transport network and develop improvements that will:

- Enhance the understanding, planning and overall development of the transport network
- Enhance the way the transport network is managed

There are a number of „business as usual" activities through AT and JTOC that

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contribute to traffic signal and network efficiency. The regional route optimisation programme provides a key link between the operation of the traffic signals, traffic flows on the network and improvement opportunities.

The four year regional route optimisation programme will be an essential component to improve the operation of traffic signals, traffic flows, safety and economic efficiency.

REFERENCES

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