Public Transport Priority in Melbourne, Australia

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INTRODUCTION

This paper is an overview of the type of traffic signal priority techniques used in Melbourne for trams and buses and some of the current and most recent trials being conducted. The signal priority has included passive and active priority which is enabled by using the SCATS (Sydney Coordinated Adaptive Traffic System) and designs at each traffic signal controller. 'Top-Down' system using SCATS, GPS location data and schedule adherence information is currently being implemented.

SCATS can be configured for active priority for public transport. The traffic signal controllers used in SCATS allow for complex phasing arrangements to be programmed. The adaptive nature of SCATS control allows public transport delays to be minimised whilst ensuring some compensation to other transport modes and approaches.

The nature of the priority scheme depends on several factors. For instance, treatments along routes with exclusive right of way tram lanes are quite different from treatments where traffic shares the roadway with trams and can interfere with a trams progress.

Further to this, levels of priority are influenced by additional considerations such as the road hierarchy (Movement and Place Framework), the complexity of intersection layouts and traffic congestion.

TRAM OPERATIONS

The private operator, Yarra Trams manages Melbourne's entire tram network. Melbourne has the largest operating tram network in the world with 250 kilometres of double track. There are more than 1700 tram stops across the network, with more than 400 level access stops (25 per cent).

Seventy-five per cent of Melbourne's tram network operates on shared roads with other vehicles. The average speed of a tram is 16 km/h and within the CBD this drops to 11 km/h. This is a result of the shared roadway and spacing between stops.

Yarra Trams has approximately 450 trams, ranging from the iconic W-Class to the modern E-Class. There are about 410 trams on the road during peak periods, approximately 30 per cent of the tram fleet are low-floor trams (C, D and E-Class).

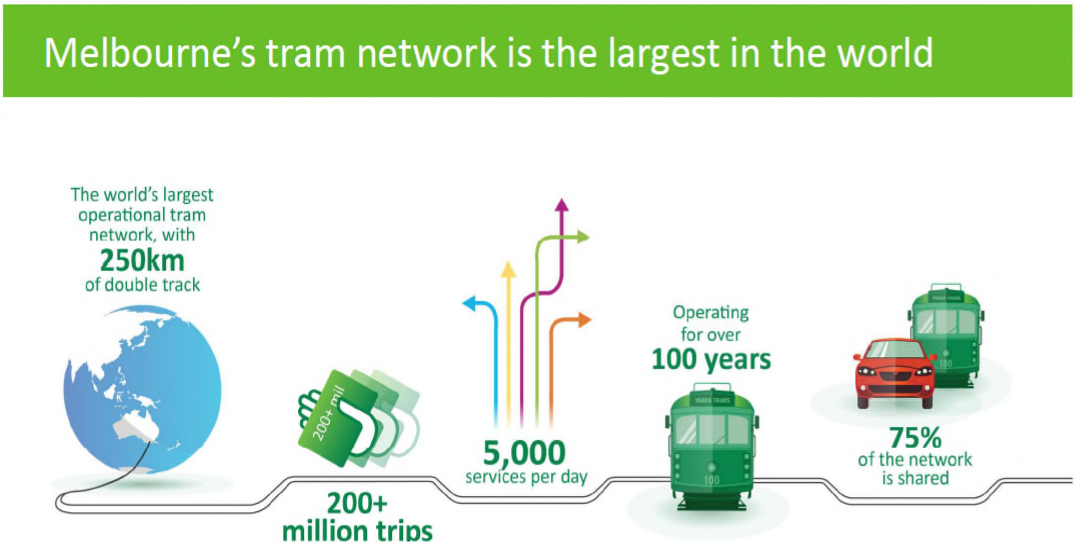


Fig 1: Statistics on Melbourne's Tram Network *Source: Yarra Trams*

BUS OPERATIONS

Bus Operations are managed by several private companies. There are 12 bus operators with approximately 350 regular bus routes, 122 million passengers per annum and 22,000 scheduled trips per weekday.

There are approximately 1800 contracted buses. Ventura (Bus Operator) operates 950 buses and the first trial using TRANSnet was undertaken on a Ventura bus route 201 (Box Hill Interchange to Deakin University). TRANSnet is a system using GPS data, schedule adherence and other performance triggers to enable signal priority via the SCATS ITS port.

Trials are being planned with Transdev (Bus Operator) in regards to using TRANSnet on Smart Bus routes. Transdev has 508 buses and covers both urban and school services including the highly patronised Smart Bus routes that provides orbital services connecting Melbourne's middle ring suburbs.

Fig 2: Smart Bus Routes *Source: PTV*

PASSIVE SIGNAL PRIORITY

Passive Priority is more the strategy in configuring traffic signal operations and VicRoads uses the Movement and Place framework to determine modal priorities. Therefore, Passive Priority tends to operate every cycle and uses some of the following techniques:

(a) Operating lower or reduced cycle times which reduces delays for public transport crossing main roads,

(b) Green time weighted towards the priority movement,

(c) Phasing design, a right turn phase maybe set to operate every cycle in SCATS dependent on time of day to clear right turn queues or implementation of part time right turn bans.

Priority provisions are said to be passive when signal control reflects, and attempts to satisfy, the anticipated requirements of public transport. That is, prior knowledge of public transport operations, by location, congestion and the time period, is used to predict the priority requirements. Passive techniques provide priority every cycle, whilst *active* techniques provide priority only when a public transport vehicle is detected and requires priority. Consequently, passive signal priority techniques are simpler and cost less than active techniques.

ACTIVE SIGNAL PRIORITY

TRAMS

Active signal priority techniques require the selective detection of trams as they approach a signalised intersection. When a tram is detected, the phasing and signal timings can be changed to provide better service for trams. The advantage of active priority techniques is that the disruptive effect of the priority only lasts while the tram is in the vicinity. Therefore, a higher level of priority can be given.

The active techniques described below are preferred because conditions on the tram street are improved only when a tram is present, whereas some of the passive priority methods encourage extra traffic because of the general improvement in operating conditions on the priority approach.

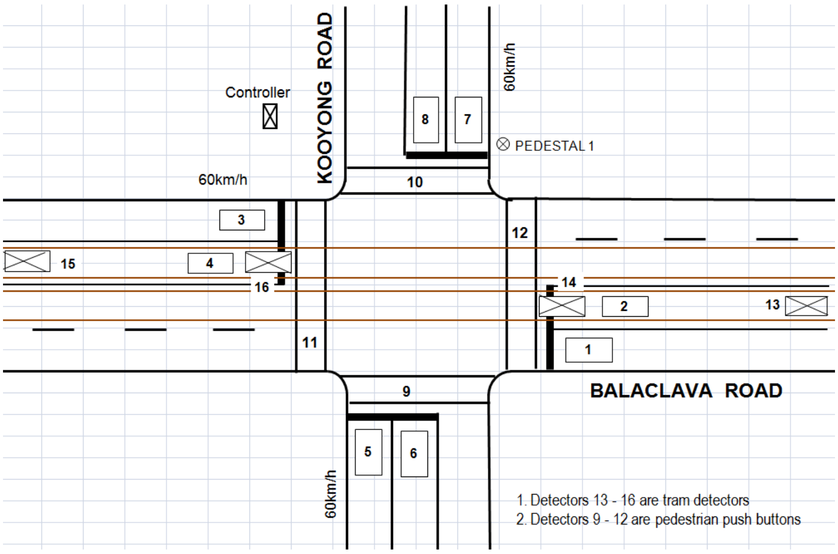


Fig 3: Typical detector layout for a tram intersection with tram priority where advance tram detectors are usually located 200m in advance of the intersection. Tram detectors (crossed) indicate that trams with transponders will only be detected on a shared roadway.

A transfer of demand via SCATS can be used at the tram stop line detector at an upstream intersection if the distance is within 300m. When the tram departs, the upstream tram stop line detector, a software message is transmitted via SCATS to the downstream intersection that a tram is approaching and then activates priority.

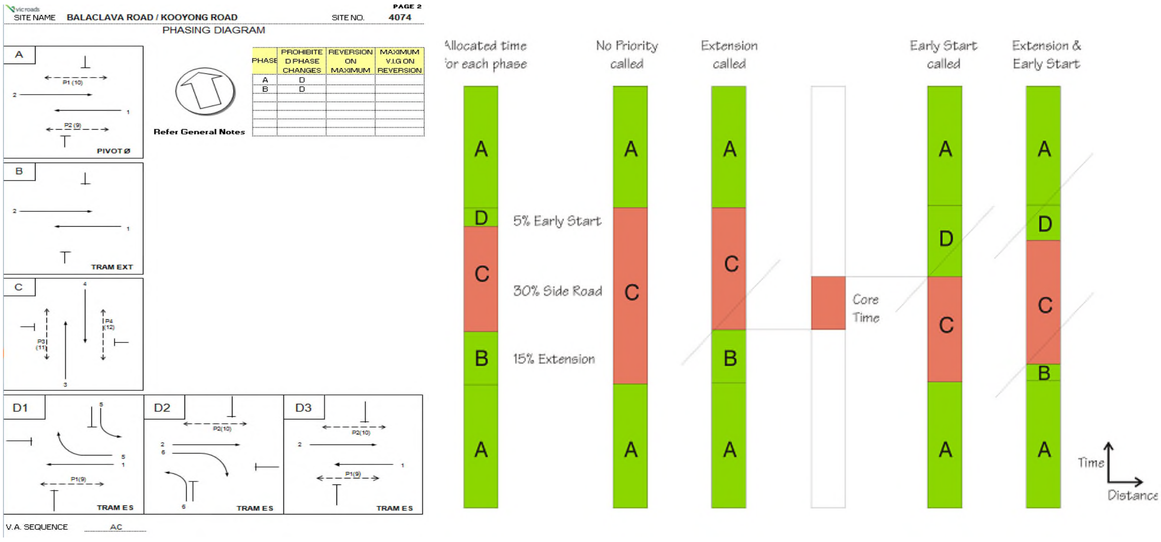


Fig 4: The typical tram priority phasing with extension and early start phases with flexible phasing timing

Some of the active tram techniques, include flexible window stretching, are described below:

(a) Early starts: Using right time movements to clear an approach for a tram in a shared roadway. When it is anticipated that a tram will be ready to clear the signals prior to the next green, the green can be forced on earlier than if there were no tram approaching. This is achieved by shortening the preceding phase. When a tram arrives at the stop line, the through early start sub-phase is demanded.

(b) Extensions: This technique causes the green to terminate later than if there were no tram approaching so that the tram has a good chance of clearing the signals (pedestrian or intersection) before losing right-of-way. However, an extension is not effective if a right turning vehicle blocks the tram during the extension time or the tram is stopped during the loading or unloading of passengers.

(c) Special Tram Phases: This technique introduces a special tram phase not included in the normal phase sequence. It is normally called when a tram is at the stop-line. Such a phase is often an exclusive tram phase and usually runs for a short time - sufficient to clear a tram through the site. Typically, it is sandwiched between phases when the tram cannot proceed. A further example is a phase that allows trams to turn a corner.

BUSES

For buses, detectors placed 7.5m apart detect the dimensions of a bus to enable bus priority. The first detector is activated prior to the second detector and must stay on until the second detector is also activated.

Buses are provided with an early start by delaying the adjacent through vehicle signal group. Exclusive bus phases can also be included in the phase sequence.

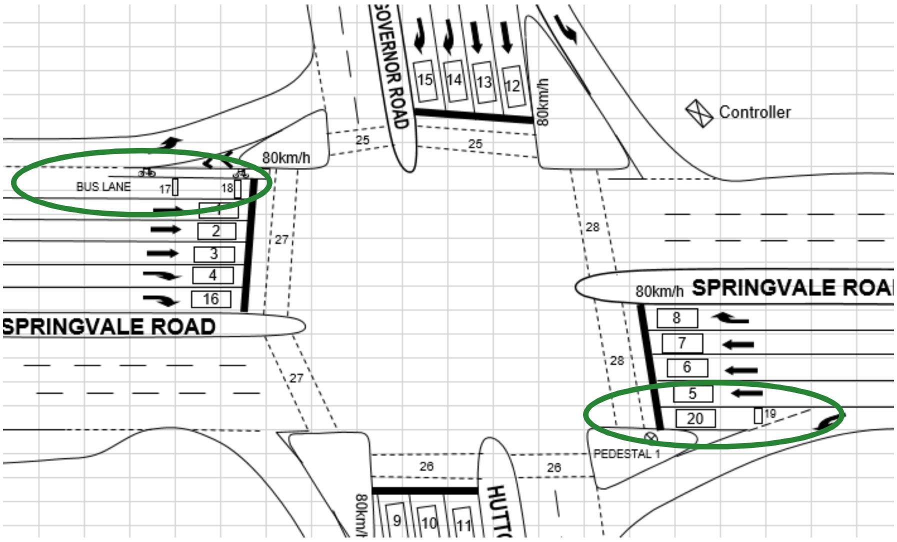


Fig 5: Bus detectors which demand bus early starts and exclusive bus phases

ENHANCED TRAM PRIORITY TRIAL

In 2016, more aggressive techniques were adopted on two routes in Melbourne to improve tram travel time and reliability.

The techniques included:

- Terminating side road phases when a tram is detected at the stop line.
- Measuring congestion on the main road and restricting or gating side road phases.
- Improved tram detection using video and tram transponders.
- Program additional exclusive tram phases to operate.
- Operate counter peak right turns every second cycle.
- For more aggressive priority, terminating the side road phase after minimum green and holding the priority phase for an extra 40 seconds was tested on Balaclava Road. The priority is terminated after a timer has expired or the tram has cleared the stop line.

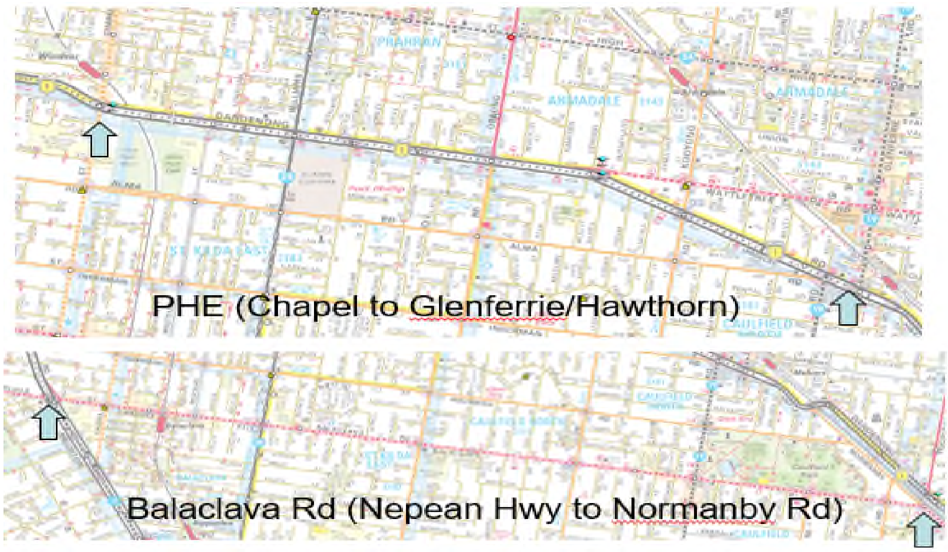


Fig 6: Routes of the Enhanced Priority Trials

Two Routes were selected, Princes Highway East (PHE) and Balaclava Road. PHE is a major arterial route with approximately 80,000 vehicles/day where the trams are in their own right of way and

Balaclava Road has approximately 15,000 vehicles/day and the trams are in a shared roadway. The priority on Balaclava Road was set to be more aggressive due to the less congested surrounding network.

Some of results of the trial were as follows:

For PHE:

- The general vehicle travel time on PHE (Glenferrie Rd to Chapel St) for the AM peak had reduced from 9.50 mins to 5.70 mins, a reduction of 40%.
- The general vehicle travel time on PHE (Chapel St to Glenferrie Rd) for the PM peak had reduced from 7.47 mins to 5.86 mins, a reduction of 22%.
- However, the corresponding average tram travel times remained relatively the same, except for Route 64 (Chapel Street to Hawthorn Road, outbound) in the AM peak, where the tram travel time reduced from 9.02 mins to 8.39 mins, a reduction of 7%.

For Balaclava Road:

- The dwell from the east and west approaches at Balaclava Road/Kooyong Road via SCATS had resulted in a reduced number of stops for trams. This is close to providing absolute priority.
- However, there was an increase in the queue length (52 m, a 48% increase in the AM peak) on Kooyong Road.

It is expected that tram travel time on PHE did not improve due to trams adhering to the timetable. The conclusion is that public transport priority should only be provided when a tram or bus is behind schedule, unless the operation is free running. Hence trials using technology that tracks the tram or bus and activates priority on schedule adherence are being tested.

TRAM and BUS TRIALS BASED ON SCHEDULE ADHERENCE

TRANSnet is a public transport priority system developed by Advantech Design, based in Melbourne, which utilises the SCATS traffic signal control system and GPS bus tracking information. TRANSnet applies a top-down approach to public transport priority where the local traffic signal controller does not require reprogramming. The bus detection uses ‘virtual detectors’ for queue detection and journey time information. The virtual detectors can be configured by Signal Operations in any geo-spatial dimension.

Therefore, the physical installation of detectors is not required. The priority can be activated on several performance conditions such as schedule adherence, delay, headway and the frequency of the demands for priority. The trial location was on bus route 201 from Box Hill Interchange to Deakin University.

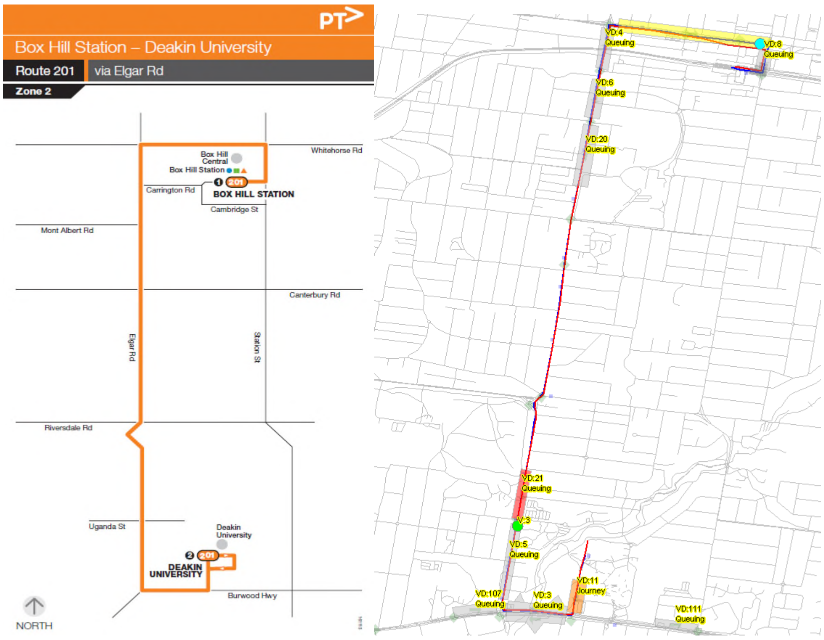


Fig 7: TRANSnet trial conducted on Bus Route 201

Bus Route 201 and TRANSnet GUI (showing location of buses and virtual detectors) is shown in Fig 7.

The type of priority that can be enabled via TRANSnet, includes Green Window Request which terminates side road phases after minimum green or when the pedestrian movement has cleared and with the option of skipping phases. Priority can be enabled via the SCATS Action List (via a ITS port) which allows any operational signal parameter to be changed. This includes demanding and extending phases, adjusting cycle times and coordination for one or as many intersections connected to a SCATS Region.

The virtual detector can be any length or shape, allowing flexibility in setting advance priority location. Some examples of the type of priority include the following operations:

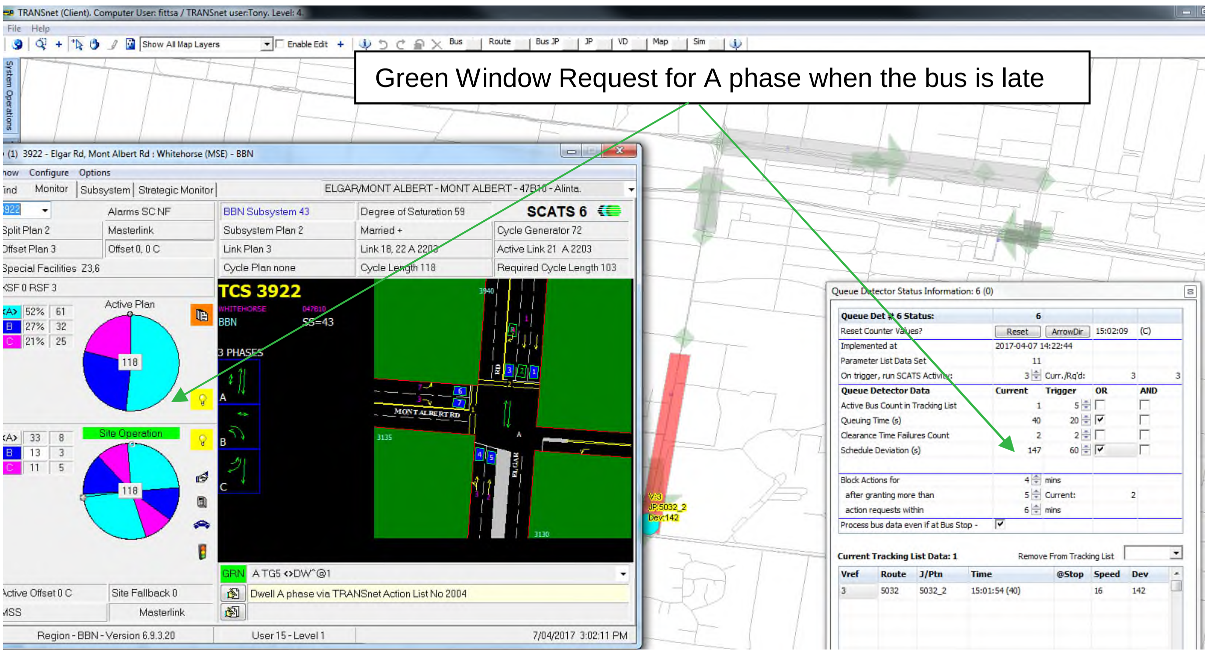


Fig 8: A phase (Elgar Road) is dwelled (Green Window Request) when the bus is running late

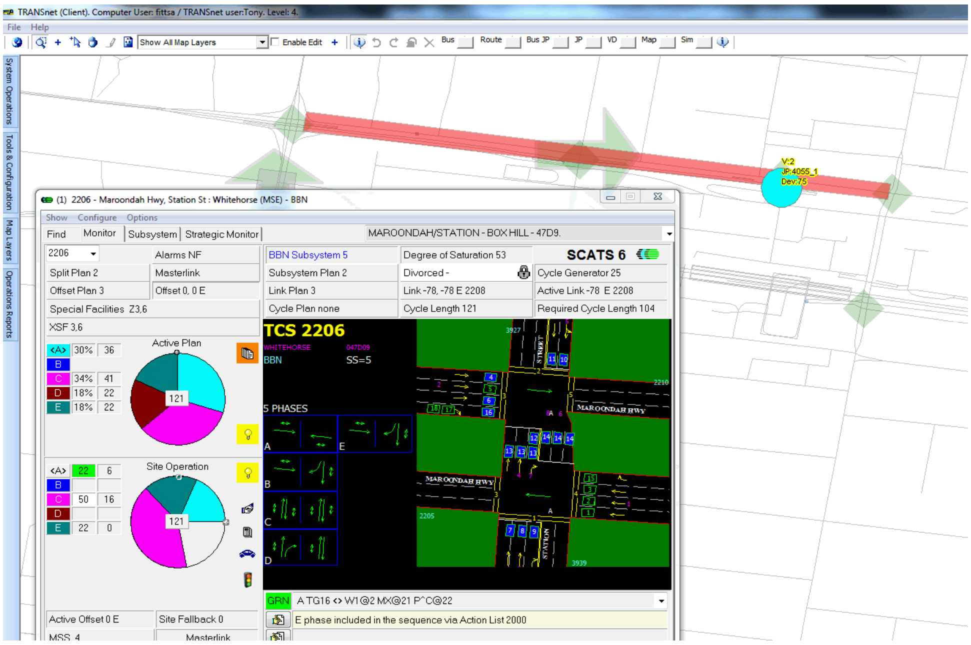


Fig 9: Virtual queue detector on Whitehorse Rd activating E phase (right turn phase) at Whitehorse Road/Station Street

(Note: Blue circle is showing the bus location and schedule deviation, maroon rectangle is the virtual detector activating priority, via a SCATS Activity (Action List). SCATS Access window shows the Action

A Pinch-Point Project to install a right turn phase at Whitehorse Road/Station Street was undertaken. The right turn phase is demanded by TRANSnet when a bus is late running by 2 minutes. The schedule adherence timing can be configured per site.

OPERATION REPORTS

There are several reports that can be generated from TRANSnet.

Queuing Time

The queuing time in the virtual detector on Whitehorse Road between Elgar Road and Station Street (VD1) is shown in the Fig 10 below. Delays have been reduced for buses in the PM peak. The photo below shows buses queuing out of Whitehorse Road right turn lane turning into Station Street prior to the TRANSnet trial.

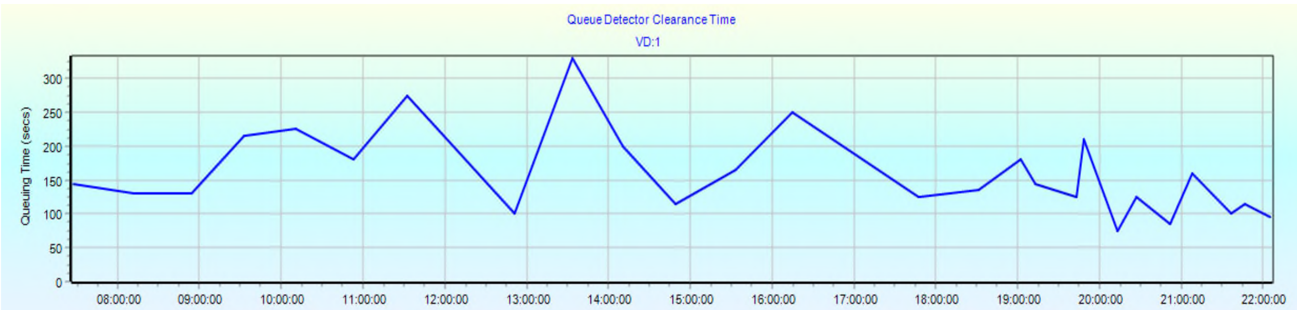
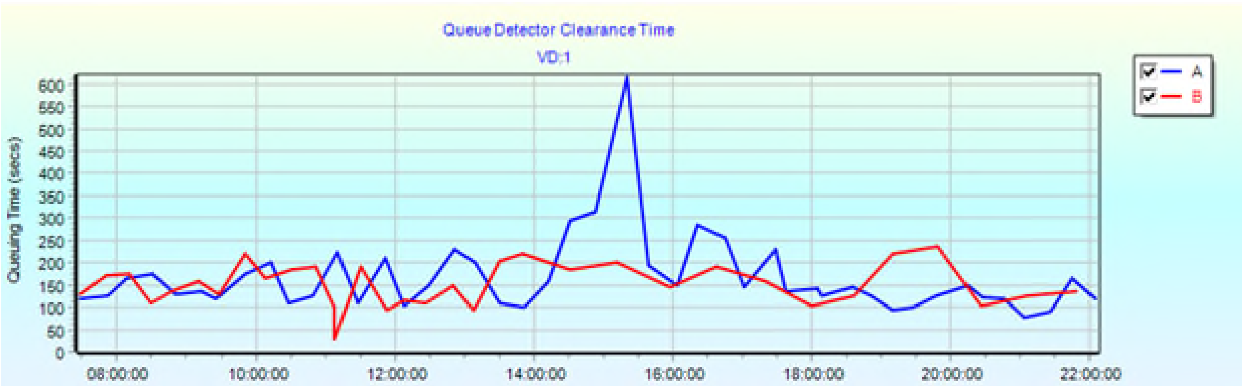


Fig 10: Queue Time in Virtual Detector on Whitehorse Rd between Elgar Road and Station St

Pic 1: PM peak, buses turning from Whitehorse Road into Station Street blocking the through traffic lane (prior to the TRANSnet trial and Pinch-Point Project to add a right turn phase)

A comparison of days in the figure below where A is Mon 27 March 2017 and B is Tue 28 March 2017 is shown.



Queue time spikes on Mon 27 March at 15:15 to 15:30

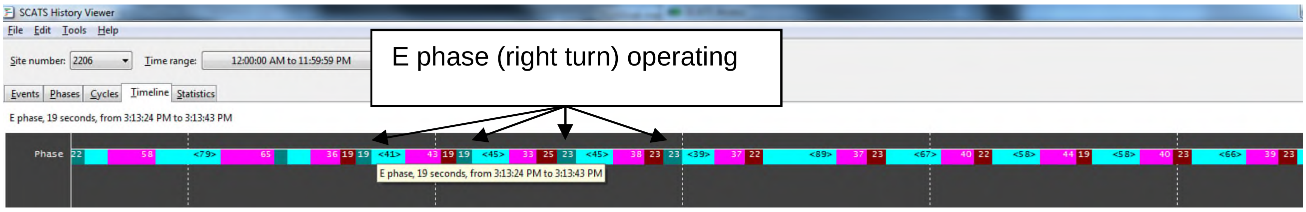


Fig 11: TRANSnet operates the right turn phase (E phase) at Maroondah Hwy/Station Street during the time the delay timer spikes

When the bus was delayed on Mon 27 March, E phase (right turn phase) was activated by TRANSnet during that period. Fig 11 is the signal operation at Whitehorse Road/Station Street from SCATS History Viewer, showing when E phase (right turn phase) was operating.

Journey Times

There are virtual Journey Time detectors where the figure below shows the travel time between Deakin University and Box Hill Interchange.

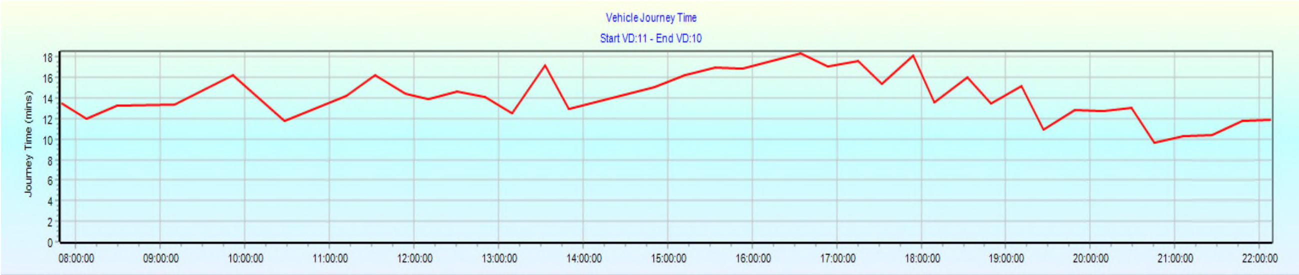


Fig 12: Journey time from Deakin Uni to Box Hill Interchange

CURRENT PROJECTS

The following projects are being developed and implemented:

(a) Tram Route 75 – Testing Dedicated Short Range Wireless Communication with cohda units with algorithms being developed by La Trobe University to predict the arrival time of the tram to fully utilise priority. Door closure inputs are included in the trial. Using the cohda units also provides coordinates for a trial with TRANSnet.

(b) Working with bus companies to use Bustracker data provided by Public Transport, Victoria with GPS data and lateness for all the bus fleet.

(c) Implement a dynamic bus lane by activating electronic signs to advise other vehicles that the lane is for buses only, when a bus is detected.

SUMMARY

Public transport priority is becoming more sophisticated where priority is enabled based on lateness. Providing priority when a bus or tram is delayed or running late is also more efficient as it does not affect other modes and approaches when priority is not required or utilised.

Setting up and configuring of virtual geo-spatial detectors instead of using physical detectors and not having to reprogram signal controllers is another benefit compared to older public transport priority systems. Setting priority via SCATS Action Lists provides greater flexibility with more signal priority options than a green time extension. Any signal operating parameter can be adjusted to favour public transport.

References:

Design of Signal Priority for Trams, 2003, David Nash