Intersection improvements through back to basics techniques

Introduction

Traffic signal intersections are a significant piece of transport infrastructure. It is important that their operation is optimised as far as possible to reduce congestion, consumption of fuel, and to improve safety.

A key objective of the Government Policy Statement (GPS) states:

"Improvements in the provision of infrastructure and services that enhance transport efficiency and lower the cost of transportation though better use of existing transport capacity" (Ministry of Transport, 2009)

Improvements can be made to intersections efficiently and without significant or any capital expenditure through optimised traffic signal timings or amended road markings to make best use of the asset. Details are provided of some of the key issues surrounding the poor operation of traffic signals and some possible solutions that are available by applying basic traffic engineering principles which are often over looked.

Conclusion

Improvements to traffic signal intersections can be made without investment in physical alterations by applying basic traffic engineering theory.

Benefits include:

- Improved optimisation and traffic behaviour
- Enhanced value of infrastructure
- Improve safety through more efficient operation and reduced red light running
- Benefits to non-car users.

The options described will not be applicable to all intersections and changes should only be made after sufficient observation at various times of day and over a period of time to fully understand how motorists and other road users use the existing intersection.

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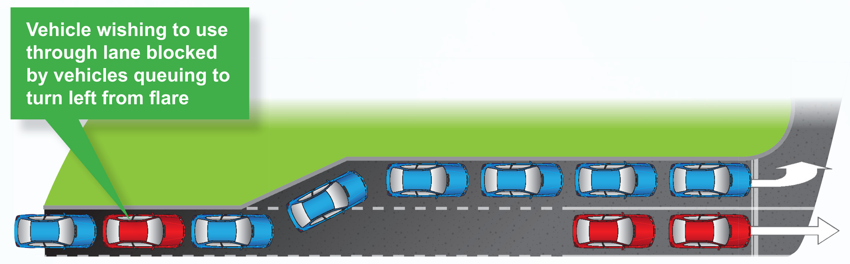
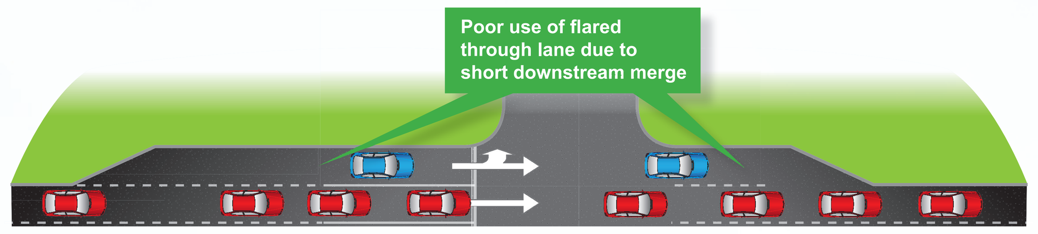
Issue 1 Use of Available Road Space

Motorists can only use the road space that is provided to them. Intersections are therefore often flared to provide a greater number of lanes. It is only when these are all fully used that capacity is maximised. All too often the lanes that are provided are only partially used or not used at all (Royce, Jurisich and Dunn 2006). Reasons include:

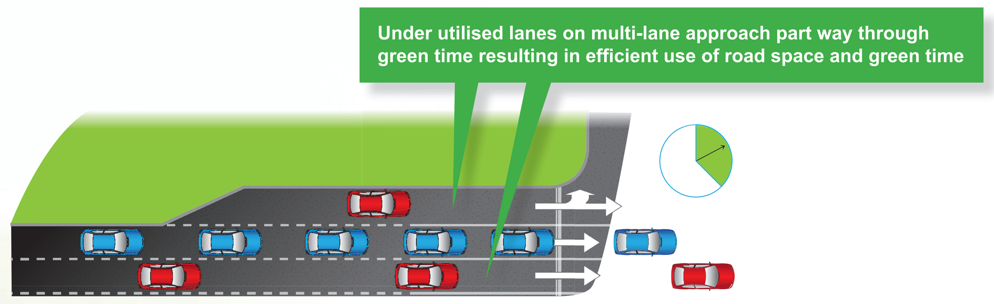
- Access to short lanes blocked by queues in adjacent long lanes
- Short lane queues blocking access to longer lanes



- Reluctance to use lanes due to short merge or departure lanes



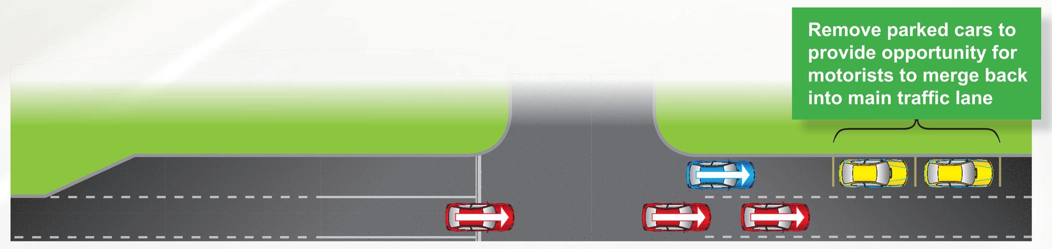
- Poor design of road markings for traffic turning movements
- Long traffic signal cycle times / green times resulting in vehicles only using short or duplicate lanes in the first part of the green.



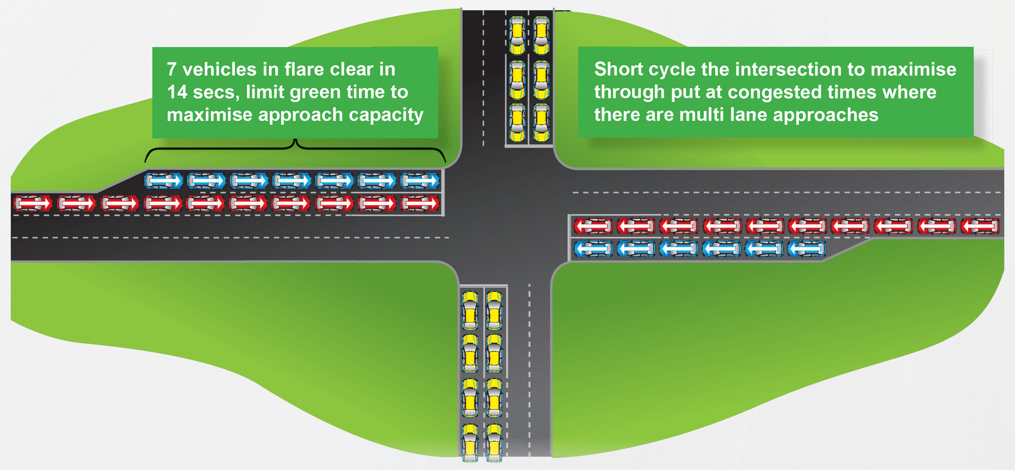
Option 1 Enhanced Use of Short Lanes

Enhanced capacity could be provided through the better use of existing lanes on multi-lane approaches. This could be achieved through:

- Encouraging motorists to make better use of lanes by reviewing the lane markings and directing motorists to more appropriate lanes based on predominant traffic volumes
- Remove constraints at intersections that discourage use of lanes such as parking or by enhancing merge lengths



- Short cycling to maximise the number of vehicles able to use short lanes, particularly effective at intersections that have multiple lanes on several approaches.



Issue 2 Cycle Times

Cycle times at signalised intersections are frequently determined by SCATS with no reasonable fixed upper limit. As traffic demand grows SCATS optimisers keep increasing cycle length often exceeding 120 seconds sometimes reaching up to 180 seconds.

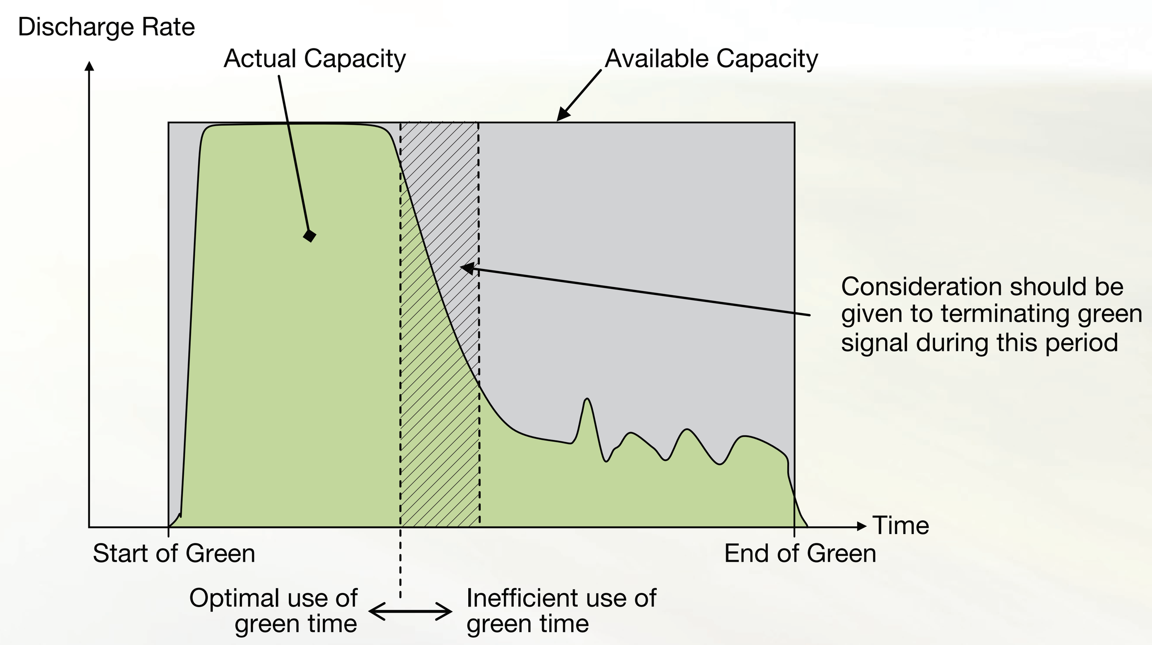
- Longer cycle lengths have limited benefit, for instance increasing the cycle from 120 to 180 seconds results in just a 2% increase in capacity (Federal Highway Administration, 2008)
- Reduced benefit of short lanes as motorists less likely to divert into the lane during the green period
- Increased queuing and delay due to longer red times
- Longer cycle times have been associated with red light running as some motorists may not be prepared to stop due to the anticipated wait time (Federal Highways Administration, 2004)
- Inconvenience for pedestrians with long waiting times, particularly if wanting to cross two arms of the intersection.

Option 2 Cycle Times

Theoretically, as traffic demands increase, longer cycle times are required. In practice this does not necessarily result in greater efficiencies. Lengthy phase times occur resulting in increased vehicle headways and poor discharge rates.

- Green times should be restricted to ensure optimal discharge rate during the green once discharge starts to drop the green should be terminated
- Upper limits on cycle times should be imposed (automatically restricting green phase times) with lower cycle times for intersections with signal controlled pedestrian facilities.

Typical cyclic traffic flow discharge



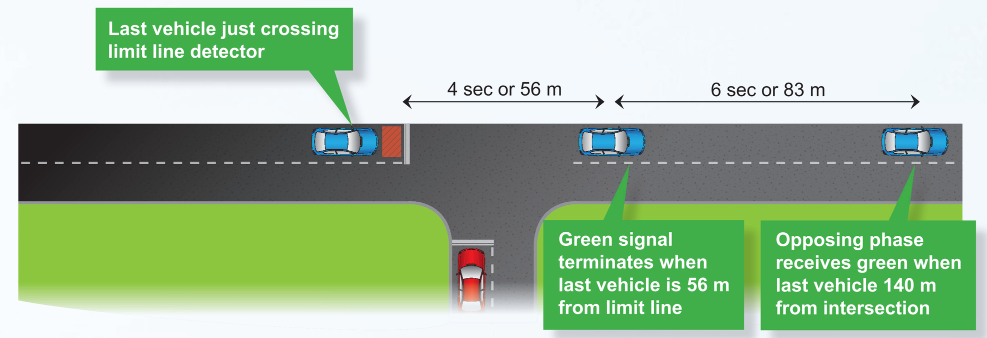
Issue 3 Inefficient Phase Changes

The combined effect of poor use of multi-lane approaches and long cycle times is often inefficient phase changes. By allowing the phase to continue operating during these times results in low utilisation of the green and inefficient operation of the intersection. This can be due to:

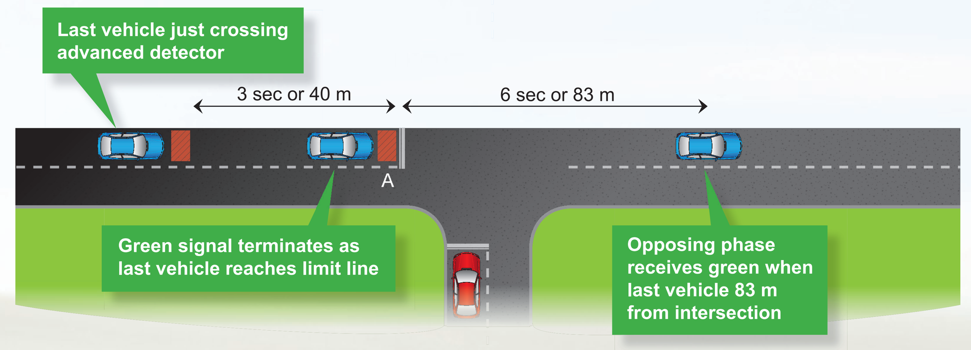
- Short lanes no longer used
- Duplicate long lanes poorly utilised
- Large headways due to vehicles taking time to start up from a queue or travelling at free flow speed.

Option 3 Detection

Most signalised intersections use limit line detectors. These are used by SCATS to determine timings or by isolated intersections to extend green signals. Typically, detectors extend the green by 4 seconds before terminating the phase, if there are no further vehicle demands. This can reduce the responsiveness of the intersection to terminate the phase.



Effects of limit line detection for vehicle travelling at 50kph



Effects of advanced detection for vehicle travelling at 50kph

Advanced detection can be more responsive. A detector at 40 metres from the intersection extends the phase until the vehicle reaches the limit line. This effectively reduces the phase length by 4 seconds. If this occurs on each approach to the intersection, particularly when traffic flows are lower, then the intersection will cycle much quicker, possibly by as much as 16 seconds on a four phase intersection.

Off Peak Operation

Many traffic signals are operated in coordinated networks using SCATS. In low flow conditions, particularly over night or off peak, coordination is not always necessary or desirable.

Dropping the intersection from SCATS to local control allows more responsive phase changes without being reliant on the operation of other intersections or artificially high cycle times.

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