Traffic management systems (TMS)

Introduction

Traffic management systems (TMS) use a variety of technologies to manage traffic flows and the effects of congestion on the roading network. TMS does this by addressing the traffic management effects of crashes and slow-moving or queuing vehicles, planned events and extreme weather.

TMS includes ramp signalling, dynamic lane management, variable speed limits, incident detection, vehicle-activated signs and adaptive traffic signal control. Many of the systems are integrated to gain maximum benefit.

Managing the allocation of road space in order to optimise existing infrastructure is an important concept that is becoming increasingly relevant, as it is not feasible or cost effective to continue to accommodate the growth of urban traffic by constructing additional roads. It is widely acknowledged that a large part of added road capacity is often quickly absorbed by 'induced' demand.

Objective

This objective of TMS is to smooth out the flow of traffic on the road network in order to make optimal use of existing capacity and reduce the impact of unexpected and other events.

Benefits

Benefits of implementing TMS include:

- improving journey times by smoothing out traffic and reducing stop/start conditions
- minimising congestion and therefore harmful emissions
- assisting safety through advance warning of dangers
- providing more reliable journey times
- incident management.
Tools for traffic management systems

TMS measures can be applied in urban, peri-urban and rural areas, as appropriate. TMS is often used on the state highway network, and is likely to operate across different organisational boundaries.

Roading authorities wanting to introduce TMS should work closely with the NZTA, regional authorities (including cross boundary), the police and wider emergency services, passenger transport operators and other stakeholders in order to consider wider network implications.

In addition to this, planned measures by the local road authority that may displace extra vehicles onto the state highway network will need to be assessed in terms of their implications for TMS applications on the state highway system.
Automatic incident detection (AID) tools are designed to reduce the time taken to identify and react to incidents on the network. If combined with other TMS and traveller information systems (TIS), it can improve network efficiency by minimising congestion. It can also help reduce response times for emergency vehicles and minimise the chances of secondary crashes occurring.

Automatic incident detection (AID) is usually implemented through the use of sensors or detectors and aims to detect traffic incidents along major roadways. Sensors are usually divided into two categories: intrusive (buried within the road) and non-intrusive (not buried within the road).

Intrusive sensors, such as inductive loop detectors (ILD), are installed at regular intervals along the road and gather information on each vehicle in order to detect abnormal changes in traffic movements, and thus identify incidents.

Non-intrusive technologies, such as video incident detection (VID) or closed circuit television (CCTV), are installed on poles or overhead gantries and detect incidents through observation of changes in the general traffic flow.

Other technologies such as microwave detectors have been used in place of ILD to detect the speed of vehicles. The detectors are spaced every 100m and identify incidents by observing a sudden drop in speed, as opposed to a gradual decline in speed over a longer time.

Camera used for automatic incident detection.
Ramp signalling/metering

Ramp signals are essentially traffic lights at motorway on-ramps that manage the flow of traffic onto the motorway during peak periods. When lights are red, vehicles stop and wait for the green signal. When lights turn green, two cars (one from each lane) are able to drive down the ramp to merge easily with motorway traffic. Ramp signals run on a quick cycle, with only a few seconds between green lights. Ramp signals do not have to operate all the time and can be switched on when necessary, especially during morning and afternoon peaks and other busy times.

Ramp metering can be a cost-effective tool in improving the throughput of a motorway and overall road network. It is most effective when applied system-wide along a corridor that balances the need to maximise motorway throughput with effective queue management.

There are a number of equity issues that need to be taken into account when ramp metering is installed. For example, if a minor road meets a major road, and the major road is operating at capacity, it might be most efficient (in terms of minimal total delay) to give 100 percent of the green time to the major road and 0 percent to the minor road. However, traffic signals alternate back and forth to ensure equity of road users, so that travellers on minor roads do not have an excessive wait. A similar limit on individual delay, even at the expense of overall motorway efficiency, may be necessary for ramp meters to be equitable.

Ramp metering has some disadvantages, eg it may result in longer waiting times to enter the motorway. Another issue that relates to the on-ramp design is the distance from the signals to the motorway. Some on-ramps have such short distances between the signals and the motorway that a suitable merging speed cannot be reached. In situations like this, ramp signals can result in more congestion.

While ramp flow meters can help at the margins by delaying the onset of motorway breakdowns and the recovery of freer-flowing conditions, which makes the motorway flow smoother, ramp flow meters cannot eliminate congestion entirely. It has been found that ramp meters are particularly helpful for longer trips.

Ramp signalling has been successfully used for over 40 years in some countries, including the United States, Germany, Canada, Belgium and England.
Variable message signs

Variable message signs (VMS) can be used to alert drivers to traffic incidents ahead, congestion, events, parking availability and weather conditions.

There are three broad categories of information that can be displayed via VMS:

- control (eg lane and speed control)
- warning (eg weather conditions, incidents, congestion, road works, road closures)
- information (eg useful traffic/weather information, network messages, safety messages).

The benefits of providing real-time travel information include:

- reducing driver frustration
- allowing drivers to choose to use alternative routes
- reducing congestion
- improving safety.

Variable Message Sign in Auckland.
Variable speed limits

Variable speed limits (VSL) and advisory speeds are designed to 'smooth traffic flow' by introducing a temporary speed limit based on traffic volumes and thus delay the start of congestion conditions. Other outcomes include enhanced safety and reduced vehicle emissions.

VSL systems primarily aim to reduce incidents by managing the posted speed limits for congested or hazardous situations.

The benefits of VSL systems are that they:

- improve journey times
- smooth traffic flow by minimising vehicles stopping and starting
- reduce accidents
- produce environmental benefits through fewer emissions.
Tools for traffic management systems continued

**Lane control**

Lane control aims to enhance the efficiency of the highway through ensuring best use of existing road space. Several types of lane control can be implemented, including:

- tidal flow operations for peak periods
- part-time running lanes
- lane management for specific vehicle types, eg bus priority lanes
- lane management systems, eg overhead lane control matrix signs
- dynamic road markings.

Lane control with movable barrier – Auckland Harbour Bridge
Tools for traffic management systems continued

Adaptive traffic signal control

Adaptive traffic signals can improve network efficiency by optimising signal timings and balancing traffic flows. This is achieved through automatic updating of cycle times that highlight changes in traffic distribution and volumes.

Adaptive traffic signal control enables traffic signal controlled junctions to interact with each other. Such tools include the Sydney Coordinated Adaptive Traffic System (SCATS).

Adaptive traffic signal control systems seek to optimise traffic flow by considering traffic flow at multiple sites rather than a single junction’s performance. This area-wide approach can bring significant traffic management benefits, including reduced congestion and faster, more reliable journey times.

Where to apply these tools

<table>
<thead>
<tr>
<th>Tools</th>
<th>Centre</th>
<th>Urban</th>
<th>Suburban</th>
<th>Rural</th>
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<tbody>
<tr>
<td>Automatic incident detection</td>
<td>★★★ ★★</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
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<tr>
<td>Ramp signalling/metering</td>
<td>★★★</td>
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<tr>
<td>Variable message signs</td>
<td>★★★</td>
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<td>Variable speed limits</td>
<td>★★★</td>
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<td>Lane control</td>
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This table is an indication only. Individual projects should consider the unique features of the local environment.
Case study – traffic incident monitoring: Auckland’s motorways

The Advanced Traffic Management System, a sophisticated traffic incident monitoring and management control centre, was introduced in Auckland in 1999. The system operates on sections of the motorway network – Northern, North-Western and Southern – and provides enhanced safety and traffic information to the travelling public and enables rapid coordination with emergency services to achieve faster clearance of crash sites and other incidents.

The 24 hour a day/seven day a week system uses the latest technology, including:

- 7 variable message signs to inform motorists of road conditions, breakdowns, traffic incidents or bad surfaces
- 35 pan/tilt/zoom cameras that monitor some 32km of motorway
- 84 lane control signals on 20 gantries to guide traffic flow across the Harbour Bridge
- moveable lane barriers.

The Sydney Coordinated Adaptive Traffic System (SCATS) software package is an area-based traffic management intersection control system that responds to changes in traffic flow and conditions by adjusting the phasing at each traffic light cycle in real time.

In July 2003, the regional integration of traffic management was enhanced through the linking of Auckland city’s SCATS system, which coordinates traffic signals on local arterial roads. The linkage of the four SCATS systems to the Auckland Traffic Management Centre (ATTOMS) provides access to 61 closed circuit television (CCTV) cameras. The integration of the two systems now provides a more coordinated approach to the management of traffic over a wide area of Auckland.
Case study – Wellington Advanced Traffic Management System

The primary purpose of the Petone to Terrace Tunnel Advanced Traffic Management System (ATMS) is to improve safety and incident response times, and effectively manage traffic on this section of state highway.

Following the introduction of an ATMS on Ngauranga Gorge, the state highway network has experienced significant benefits, including a reduced crash and incident rate through the controlled sections and improved incident response times. The NZTA has embarked on a programme to extend the system to other parts of the Wellington state highway.

The key strategic goal of this project is to operate the Petone to Terrace Tunnel state highway corridor in a way that contributes to an integrated, safe, responsive and sustainable transport system.

The project will:

• improve management of general traffic flow, in conjunction with the Ngauranga and Petone sections, and traffic signal controls within the Wellington urban network

• achieve improved rapid identification of problems on the highway

• improve targeted response to, and clearance of, incidents

• provide early and accurate alerts to drivers of congested or hazardous traffic and road conditions

• help match traffic speed to network conditions, to improve safety and optimise flow

• provide a sustainable asset and improve the network functionality.
Case study – UK, M42 Motorway, Active Traffic Management

The Active Traffic Management (ATM) scheme is a new pilot motorway scheme that has been put in place on the M42, junctions 3A to 7, to the south-east of Birmingham in the UK. The main purpose of an ATM scheme is to manage congestion, but it can also be used to manage the traffic around an incident.

The M42 between junctions 3A and 7 was chosen because of its strategic importance to the Midlands area in distributing local and national traffic and providing a link between the M40 and M6 motorways. This section of motorway is 17km long. The total observed average daily traffic (ADT) in both directions on the M42-ATM section is approximately 130,000 vehicles.

Controlling the traffic across all lanes, with the right speed for the traffic conditions, enables the traffic to flow more smoothly. This reduces constant stopping and starting, which helps to prevent the breakdown of traffic flow, thus reducing congestion.

The system sets the same speed across the carriageway, which reduces the need for drivers to change lanes. When necessary, the system also sets messages on the driver information signs to inform road users of the road conditions ahead of them. This helps to protect queuing traffic because drivers are aware of slow-moving or stationary traffic ahead.

In the case of severe congestion or an incident in one of the normal running lanes, the hard shoulder may be opened to traffic under controlled conditions. When this stretch of the M42 is not congested and there are no incidents, all normal motorway rules apply.

The key aspects of this ATM scheme are:

• the use of variable mandatory speed limits
• the dynamic use of the hard shoulder during periods of congestion
• the provision of dedicated Emergency Refuge Areas (ERAs) for use when vehicles break down
• the installation of gantries with signals and variable message signs.

The benefits of the scheme include:

• more reliable journey times
• reduced congestion
• enhanced information for drivers
• quicker response times to incidents.

Construction of the scheme started in March 2003. Following a phased introduction, the full operation of four-lane variable mandatory speed limits commenced in September 2006.
Case study – Australia, M1 upgrade project, intelligent management system

The M1 project, officially known as the Monash-West Gate Freeway, is a 75km corridor in Melbourne. Construction of the freeway commenced in 2007.

The Monash-West Gateway carries traffic volumes in excess of 164,000 vehicles a day and traffic on this route has increased at a rate of 3–5 percent each year over the past four years (Vic Gov 2006, cited in Austroads 2007).

The project includes the introduction of an intelligent freeway management system to improve traffic flow and travel time reliability during peak times.

The system includes ramp signals to monitor and control traffic, and on-road signage to communicate to drivers. It is predicted that the introduction of ramp signals on freeway entrances will improve throughput on the freeway by up to 20 percent during peak periods.

The new system also includes a lane use management system to better manage on-road communications. The system will use electronic signs to tell drivers which lanes are currently open and what speed to travel at, and manage the closure of lanes when an incident occurs. The system, once in place, is expected to better manage incidents and return the freeway to normal operating conditions more quickly after an incident.

The benefits from integrated operations comprising ramp metering, speed control, traveller information and contra-flow operations should restore capacity to 2000 vehicles a day.
## Complementary measures

<table>
<thead>
<tr>
<th>Accessibility planning</th>
<th>Improved access to all community employment and education centers is a result using TMS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban design</td>
<td>TMS is a technology based solution and the installation of new technology monitoring and measuring the road requires considerate urban design to maintain a livable community.</td>
</tr>
<tr>
<td>Priority lanes</td>
<td>Using priority lanes in combination with measuring technology is a powerful way to ensure that the lanes are active when they are most required.</td>
</tr>
<tr>
<td>Traveller information systems</td>
<td>Traveller information systems informs the user of the network. This compliments the TMS measures which inform the operator of the network.</td>
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</table>

## Other policies addressed

<table>
<thead>
<tr>
<th>Congestion</th>
<th>Congestion is the target of traffic management systems. By incorporating these technology based solutions severe congestion can be improved.</th>
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<tbody>
<tr>
<td>Economic efficiency</td>
<td>By managing traffic flows an efficient system can be maintained, reducing economic loss from inefficient transport.</td>
</tr>
<tr>
<td>Safety</td>
<td>A safer transportation system is a key goal of TMS. This leads to a reduction in motor vehicle accidents. Countries with transport policies aspiring for zero deaths on the road incorporate a high level of TMS methods to achieve this goal.</td>
</tr>
</tbody>
</table>

## Further information

- Auckland Motorways: ramp signaling

- Active traffic management

- Auckland Traffic Management Unit

- Traffic management systems

- Road Safety Management System