Intelligent transport systems (ITS)

Introduction

The term Intelligent Transport Systems (ITS) refers to any technology applied to transport and infrastructure to transfer information between systems, and to transport users, for improved safety, efficiency and environmental outcomes. This is a fast evolving field that includes stand-alone applications such as traffic management systems, information and warning systems installed in individual vehicles, as well as applications involving vehicle to infrastructure and vehicle to vehicle communications. Many ITS applications combine some or all of the above with Smartphone applications and GPS devices to enable transport users to make informed decisions.

ITS actively manages traffic flows and the effects of congestion on the roading network by addressing the traffic management effects of, for example, crashes and slow-moving or queuing vehicles, planned events and extreme weather.

Examples of ITS include 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 ITS is to minimise the impact of unexpected and planned events and smooth out the flow of traffic on the road network in order to make optimal use of existing capacity and enable users to make informed decisions about travel mode and route.

Benefits

| Safety | ITS can greatly improve road safety by giving drivers advance warning of dangers ahead such as crashes and poor weather conditions. |
| Reliable journey times | ITS can provide consistent journey times by smoothing out traffic and reducing stop/start conditions. |
| Congestion reduction | By effectively controlling access to potentially congested parts of the network, ITS is able to keep traffic free-flowing. |
| Efficient allocation of space | ITS enables road controlling authorities to make best use of existing space on the network by actively managing lane use, optimising signal timings and balancing traffic flows. |

Strategic interventions for ITS
Application of ITS

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

Roading authorities wanting to introduce ITS should work closely with the NZTA, regional authorities (including cross boundary), the police and wider emergency services, passenger transport and freight operators and other stakeholders in order to take account of 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 ITS applications on the state highway system.

_Auckland Traffic Management Operations Centre_
Strategic interventions for ITS contd

Active Network Management

Automatic incident detection (AID)

Incident detection 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.
Active Network Management

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.
Strategic interventions for ITS contd

Active Network Management

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.
Traffic management systems (TMS) – page 6

Strategic interventions for ITS contd

**Active Network Management**

**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](image)

**Active Network Management**

**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.
Strategic interventions for ITS contd

**Charging and Payment Technologies**

**Electronic tolling**

The key advantage of electronic tolling is that drivers do not need to slow down or stop to pay their toll. Cameras mounted above the toll point capture the vehicle’s registration plate number and the system calculates the correct toll due depending on the type of vehicle involved.

In the case of the Northern Gateway Toll Road, if the vehicle is linked to a toll account, the toll is automatically deducted. If not, vehicle owners can pay online, by phone or at a self service kiosk.

**Traveller Information Systems**

**Smartphone apps and web-based journey planning tools** can provide transport users with a raft of useful information both before they set out and once they are on their journey. Real-time public transport arrival times, journey planners, weather reports, route information and incident reporting are all readily available.

**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 (e.g. lane and speed control)
- warning (e.g. weather conditions, crashes, congestion, road works, road closures)

Providing real-time travel information helps to reduce driver frustration, improve congestion and improve safety.

Variable message sign in Auckland.
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.
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Case study – Wellington Active Traffic Management System

The three kilometre section of SH1 between Ngauranga Gorge and Aotea Quay is the most congested part of Wellington’s motorway network. Traffic build-up during morning and afternoon peak times means long queues, low traffic speeds and hugely variable travel times along this section of SH1, as well as on the surrounding state highway and local road network.

As the image above shows, this area gets congested for a number of reasons including the capacity of the local roads, merging traffic, train crossings, the location of the ferry terminal and several sets of traffic signals.

Many of the current issues will be alleviated by making this stretch of road New Zealand’s first ever “fully-managed motorway”. An Active Traffic Management System (known as an “ATMS”) will use electronic message signs to display varying speed limits and lane controls. This will help keep traffic moving smoothly and improve travel times and safety.

This project will have a number of benefits for drivers coming in and out of Wellington, including:

- Less congestion
- Better road safety
- More reliable travel times
- More efficient freight movement through the region, and
- Improved access to Wellington’s port, CBD, interisland ferry terminals, airport and hospital
Case study – SH2 Bluetooth ITS trial

A trial using wireless communications technology to deliver real-time traffic information has been launched by New Zealand’s Ministry of Transport and ITS consultants AraFlow.

The Co-operative Intelligent Transport Systems trial will investigate whether providing accurate real-time information about traffic conditions to participating commercial transport operators improves the productivity of freight movements.

Ministry of Transport Chief Executive Martin Matthews says “We are testing whether this information allows better travel planning decisions, saves money by avoiding congestion and road traffic incidents, and reduces the time required to transport goods”.

Running until April 2014, the trial will involve commercial vehicles travelling on State Highway 2 between Auckland and Tauranga, and along selected alternative routes.

Bluetooth traffic sensors will collect anonymous data on average speeds between fixed points, overall journey times, traffic incidents and congestion. The real-time data collected will be fed back to drivers through dedicated roadside transmitters and in-cab units, and to transport operators through a password protected website.

“This trial is unique in delivering up-to-the-minute data to commercial vehicles, and we are keen to see if this provides advantages over other existing sources of traffic information,” Mr Matthews said.

The purpose of the trial is to see how this method of delivering up to date data to commercial vehicles compares with the other sources of information available.
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 ITS.</th>
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<tbody>
<tr>
<td>Urban design</td>
<td>ITS 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>
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<tr>
<td>Traveller information systems</td>
<td>Traveller information systems inform the user of network conditions. This complements the ITS 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>
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<tr>
<td>Safety</td>
<td>A safer transportation system is a key goal of ITS. This leads to a reduction in motor vehicle crashes. Countries with transport policies aspiring for zero deaths on the road incorporate a high level of ITS methods to achieve this goal.</td>
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## Further information

- Ertico, ITS Europe: *ITS can help improve our daily lives* (including YouTube clip) [http://www.ertico.com/about-ertico-its/](http://www.ertico.com/about-ertico-its/)