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Variable Speed Limits – ITS Case Study

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Saab ITS

Saab ITS is a specialist ITS company that designs and delivers some of the most complex and demanding Intelligent Transport Systems in the world today. Based in Brisbane and backed by the worldwide resources of Saab Technologies, Saab ITS applies solid design, development and delivery methodologies to ensure that customers have the latest technologies delivered on time and on budget. Projects we are currently delivering include a real time passenger information and bus priority system using GPS and digital GPRS radio in Auckland and the Tidal lane control along Coronation Drive in Brisbane.

Saab AB also owns the Swedish ITS company, Aerotech Telub who have successfully installed Variable Speed Sign systems on freeways around Stockholm.

Variable speed limits

What are they?

The altering of speed signs along freeways such as the F3 and the Hume Highway is just one example of using Intelligent Transport Systems to improve safety and to get more out of existing infrastructure. Intelligent transport systems can exist in many forms with the more glamorous forms evidenced in the leading edge of in-car systems. I understand that representatives from ITS Australia have already given an overview on Intelligent Transport Systems and I will be using that background presentation to reduce the scope of this discussion.

Restricting our discussion to just variable speed limit systems certainly helps focus the attention on one aspect of ITS. However ITS is technology based and like many technological solutions there is often more hype than delivery and even in one narrow

area of ITS it is important to cut through the hype and to use the best of what there is here today rather than to gamble on what may be here tomorrow.

That is not to say that we should not be creating new systems or demanding higher capabilities and standards from our existing ITS industry. Rather it means that we should be very pragmatic about where to spend our money and effort. For instance it is technically possible to receive information from a radio broadcast or from a roadside beacon and use this to indicate to a driver the current speed limit or even limit the top speed of the vehicle to this speed. Practically though, this technology requires almost universal installation in vehicles to be a viable system. There is no doubt that the technology will exist in some vehicles in the next couple of years but it will be decades before it is commonly accepted.

As a supplier and developer in the ITS industry it is our job to deliver on the promises and for this reason I will confine this discussion to ITS technologies that can be realistically implemented today or in the next few years.

Do we need Variable speed limits

It is all very well to be able to change the speed limit along the road at will but do we really need to. In areas that exhibit a continuous problem it could be argued that the speed limit should be permanently reduced or that the road should be upgraded.

Variable speed limits may not be needed if variable message signs offer sufficient messages and these are provided frequently enough. However the cost of a large variable message sign at around $130,000 will probably preclude their wide spread adoption.

Why apply

Before considering the technological solution to variable speed limits we should look at what we are trying to achieve. I believe that this can be split into safety and efficiency.

Safety

Safety on our roads is very important. There are lots of statistics showing how appropriate safety measures can reduce accidents, injuries and the cost to the community. I will not delve into these here. Certainly having appropriate speed limits are a major factor in maintaining road safety. Experienced traffic engineers set the current limits after taking into account the road geometry, traffic volumes, land use patterns and typical weather conditions.

The use of variable speed limits will direct traffic to slow down when conditions deteriorate or even increase the road speed under good conditions. Applying different limits to different vehicle types would allow for control of slower heavier trucks without penalising car drivers. Automatic systems might alter speed limits depending on the weather, time of day, current traffic patterns and incidents or road works. In Sweden variable speed limits were introduced as part of their "Vision Zero" initiative and respond to weather conditions. These are advisory only but have shown a decrease in the average speed by 10% with increasing headway. Particularly important in areas where ice is a major traffic hazard.

Along the F3 factors such as smoke from bush fires and wind gusts may also be an issue affecting safety. By reducing a local speed limit safety can be significantly enhanced.

Efficiency

When talking about efficiency I am really talking about efficiency in our spending dollar. With the significant investment already made in road infrastructure it is often desirable to limit the wear and tear caused by some vehicles (mainly trucks) by reducing the speed of certain types of vehicles. Current technology can be applied to make surgical strikes at specific road users pinpointing only those road users that might cause problems such as overweight vehicles or vehicles that are not fitted with road friendly suspension. There are a number of technologies already being applied to this aspect of road use and many of these are addressed in the intelligent Access Project being undertaken by Austroads.

Where should variable limits apply

With these underlying reasons behind variable speed limits understood let's look at where these limits might apply. Within the road network it is useful to think of speed control within two broad categories – Local and point to point.

Localised speeds

Here we are talking about adjusting a speed limit at a specific point or over a short distance as a result of localised effects.

This may be as a result of the detection of an incident such as a breakdown, accident or even rocks on the road. It may also be in response to variations in weather such as increasing wind velocities on a bridge or bush fire smoke. Typically these speed limits might only apply over a distance from 1 to 5 km.

If a road is thought of as number of discrete sections all strung together then it is possible that a local speed setting might apply to a number of contiguous sections and thus a sped imit might be in force for 10, 20 or even 50 km.

These limits would apply to all road users and would have the same legal force as all other speed limits signs.

Point to point speeds

Technology now allows us to track specific vehicles over vast distances. A point to point speed limit is concerned with average speeds and can be used to increase safety by ensuring that truck drivers do not falsify logs and drive excessively. The RTA developed Safe-T-Cam which reads truck number plates at several locations around NSW is a good example of what can be developed. This concept can be extended to log all vehicles (both private cars and trucks) and to track individual vehicles. The vehicles could then be classified and individual speed limits set based on the classification.

There may be some privacy issues with this technology but appropriately managed this could be a major contributor to national road safety.

The system could be extended to provide drivers with a personalised ID card that can be read like an e-toll card. This will link the driver to the vehicle and would allow a form of automatic log book eliminating opportunity for falsifying the logs and reducing the pressures on drivers and subsequent driver fatigue issues.

Technical Issues

Advisory or Legal

Variable speed limits can be either advisory or enforceable. To be most effective a combination of both is needed. Current static speed signs are used to define a maximum speed and then to indicate advisory speeds based on road geometry and terrain below that upper limit. This works well and is generally well understood by the public. There is little reason to change this mechanism.

A mandatory speed limit could be set in some instances such as for trucks going down steep slopes or in adverse weather conditions and advisory limits could be set for incident management or other lower level events. As these limits would probably be indicated through the use of variable speed limit signs or variable message signs these signs would need to conform closely to the current Manual of Uniform Traffic Control Devices (MUTCD).

Enforcement

Where a speed limit is to be enforced the mechanism for doing this should be related to the type of limit.

Localised

Localised enforcement of variable speed limits can be done by linking a standard fixed location radar or laser speed camera (using video detection and number plate recognition) to the variable speed sign control system. There should be sufficient delays introduced into the system so that motorists do not register an infringement just as the limit changed downwards.

For efficiency in recording digital images should be stored and these may be transmitted on a regular basis via a digital radio link back to a central point for processing.

This technology is readily available in Australia. However, there are some legislative issues with accepting digital images as proof of violations in some states.

Older technology film based enforcement can be used but this will require more manual intervention and given the remote nature of some of these sites may be considerably more expensive.

Point to Point

Detection of a vehicle at one point and time and subsequently at another point at a different time can allow for average speeds to be determined. This can then be used for infringement detection over the length of the journey.

On the F3 and the Hume Highway the erection of a relatively small number of detection points can deliver sufficient information to be able to monitor speed adherence. It should be able to link this adherence to each specific vehicle and the attributes of that vehicle. This will allow for very refined speed controls such as lower limits for vehicles of one type over another or reducing the limit for vehicles over a certain age.

The data need not be transmitted in real time and can be downloaded to a central computer on a daily basis.

The major limitations on this technology would seem to be gathering the appropriate data, maintaining the database and legislative support for this type of infringement.

There is a national issue here with enforcement and detection across state boarders.

Variety or Big Bang

ITS can be applied in a number of ways to solve specific issues and each implementation can be done independent of the others. For instance a speed control system over a bridge may only need wind speed data to set the most appropriate speed. This system could run totally independent of another speed control system focussed on rocks rolling onto the road in a chasm.

It makes a lot of sense for a road operator to be able to access all of the speed systems and variable message signs as an integrated system. In this way they could manage all of their assets to deliver a higher level of service and could for instance set all of the speed limits along a section of road in response to a bush fire that was approaching but had not yet obscured vision.

This does not mean that they should all be one system, indeed I would argue that a variety of interoperable systems from different suppliers enhances competition and can deliver a much better product at a lower price. All of the various systems should be able to operate in concert and as such they should be able to exchange data and operate within a standard framework. Due to the level of parochialism between states the specification of a suitable framework should be at a national level and should flow down from the National ITS strategy. I see that the NSW Road and Traffic Authority (RTA) is already making interoperability a requirement in current tenders – with RTA protocol specified for all roadside devices. This is good for NSW but unless the other states fall in line is it good for the rest of us?

Sensors

Within each of the individual systems there are a range of sensors available to assist in determining the most appropriate speed. These include:

Inductive loops

Normally cut into the road after the surface is laid these can also be located at the time the road is built. Loops can detect vehicle speeds, can count vehicles and in more advanced uses can be used to classify vehicles. They are widely used at traffic signals and in existing incident management systems where they are located approximately every 500m or less along a road.

Weather sensors

A wide range of weather sensors can be utilised depending on local needs. Some more common sensors include:

Rainfall

Direct measures of the amount of rainfall this can also be combined with sensors such as river height monitors to manage bridge access or for roads in flood plains.

Condensation

Can provide information on fog levels near rivers, or in the high country.

Wind

Measures both average speeds and gusts.

Temperature

Can be used as an indication of abnormal conditions in tunnels.

Light

Commonly used to automatically dim variable message signs at night these can also be used to activate other lighting systems.

Video sensors

Significant advances in video processing has resulted in a number of very capable CCTV based sensors able to detect a range of events including:

Traffic both moving, stopped or contra flow

Obstructions such as rocks

Fog or smoke and in some circumstances fire

Radar

Can be used in a similar way to video to detect fallen rocks or stationary vehicles in a defined area. The benefits of a radar solution is that is will work in all weather conditions.

Ice detectors

Not commonly used in Australia much work has been done on these sensors in colder climates to allow motorists suitable waring of icy conditions and to lower appropriate speed limits.

Weigh in motion

Although not directly used to set a speed limit, weigh in motion systems can work in conjunction with point to point systems and enforcement systems to log a specific vehicles attributes.

Communications

Communications forms a key part of variable speed sign systems. Communication systems are often the backbone of an ITS solution and are needed to:

Convey sensor information to a variable speed control system. This data may be vehicle detections from loops, video detection of smoke or fog, telemetry data from weather sensing devices or other sensors.

Convey the speed messages to the signs and appropriate messages to any variable message signs.

Send enforcement images or data capture (in the case of point to point detections) back to the infringement system. This may be summary data such as number plates and detection times or may be specific requests for secure image data.

Convey information to any in-vehicle systems

It is unlikely that a single communications system would be available for all uses. Not only are some technologies just not suitable but in many parts of Australia they may not exist and so the availability of suitable communications infrastructure becomes a crucial factor in how well the ITS can deliver its promise.

Looking at the specific roads in this case study, whilst it would be very nice to have access to a dedicated optical fibre for all communications except transmitting to in-vehicle systems this can not be relied upon. Existing fibre delivers a large bandwidth and should be used wherever possible. However it can not be expected that there will

be fibre located along the road at all times.

There may be opportunity for sharing of fibre with some telecommunication companies where this is already located but it would be difficult to justify the expected high cost of laying fibre along either the Hume Highway of the F3 Freeway.

Within a city obtaining a suitable telephone line is seldom a problem but along the intercity freeways this may be more difficult. Instead a mobile form of data communication may be more suitable.

Given the near total coverage of GSM phone systems along both routes a more suitable alternative might be to utilise the GPRS data capability of these networks to send and receive data.

Signage

There are generally three types of signs used in a variable speed system. Static signs in the same vein as current roadside signs are used to indicate variable speed zones. Variable message signs can be used to convey situational information to drivers, and the variable speed signs themselves. The last two types can be communicated to using dial up telephone lines or a suitable digital radio service. All of these signs are established technologies and are in use elsewhere in Australia. Although the lack of standards means that they all tend to have different low level protocols.

Operational issues

People need the confidence of knowing where the speed limits apply and that they are driving at the correct speed. This implies that if the speed limits can change then the new speed limit will need to be reinforced more often than the previous static limits. Perhaps a variable speed zone needs to be declared and signed before and after the region of influence

If the variable speed limit signs are not turned on (or are not active due to failure of power outages) then the last signed fixed speed zone will apply. On the Freeways this is most likely 100 kph or 110 kph. If there is a case for lowering the legal limit then liability issues may apply if the signs are not functioning. This should be considered in specifying the type of sign and the types of power supplies used.

If differential speed limits apply such as between cars and trucks then this must be reflected in the signage. Having a range of signs may be confusing for truck and car drivers alike. In this case the signs should probably reflect the lower speed requirements and should indicate the vehicle type to which they apply.

Limitations

Although the technology is available to implement variable speed limits on both the F3 and the Hume Highway there are a number of limiting factors other than the cost of the systems that may apply. First, for localised speeds the identification of the most appropriate areas is needed. It is highly unlikely that a cost benefit analysis will indicate that the entire length of the two roads be set up as a variable speed zone. Traffic authorities (in this case the RTA) will need to identify those areas where the greatest benefit could apply. When these areas have been identified the provision of a suitable communications system is then required. GPRS holds a lot of promise but these are commercial services and there may not be the incentive for the telecommunications companies to provide this level of infrastructure support.

With point to point systems there are no real technological limitations and communications can be done from a standard telephone line. However privacy and enforcement legal issues need to be resolved. Also to be truly effective this type of system should be interoperable right across Australia with the same rules in force throughout.

Swedish Case study

A variable speed system has been running for several years on a portion of E22 (European main road #22) in Southern Sweden. It partly consists of 3 lanes (two eastbound and one westbound) and partly only two lanes. This portion of E22 has historically had a high number of accidents. Saab's roll in the project was to develop the system (H/W and algorithms), integrate, and install the system. The backbone of the system is integrated with already existing Road Weather Stations (also supplied by us). The speed limit at various locations is reduced during bad weather or heavy traffic.

The benefit cost ratio of the system is estimated to 8 to 1 and by reducing the speed by 10% it is anticipated that the number of accidents will be reduced by 25-50%.

The average investment cost is AUD 20,000 per km, depending on the number of junctions. Until now the speeds displayed are recommended speed limits, but despite this, the compliance by the motorists have been very high. We anticipate a new Swedish law next year making these speed limits legal mandatory limits.

Conclusion

The technology is available today to provide increased safety on major highways such as the F3 and the Hume Highway. A range of sensors, communications technologies and signage can deliver variable speed limits in response to a wide variety of environmental and road operating conditions. The challenge is to select the most appropriate locations for this technology to be used and to allow a number of functionally specific solutions to be linked in a coordinated manner. National standards are required to allow this Intelligent Transport Systems connectivity to function and funding to enable local solution development to these standards is required.

With point to point limits there is significant scope to monitor and enforce overall limits and to reduce the incidence of over driving and reduce driver fatigue. When implemented over a specific road segment several cordon lines could be established and average speeds calculated between any two points thus improving the granularity of the system and making it more difficult to avoid detection. Political issues that need to be addressed include personal privacy, support for digital video enforcement and tracking of vehicles across state boarders.

Saab is a key player in Australian ITS with experience with Variable Speed Limit systems, advanced lane control and traffic control systems. We have a number of high profile systems being installed in Brisbane and Auckland. And I would be pleased to discuss these projects in detail at another time, perhaps giving you a guided tour next time you are in Brisbane.

I hope that you have found this presentation interesting and informative and would be pleased to take questions.