Reducing the response times of emergency vehicles in Queensland

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Abstract

To address a growing and ageing population in Queensland and increased demand for emergency services, Transmax and the Queensland Government partnered to develop the successful Emergency Vehicle Priority (EVP) solution. EVP is a dynamic ITS solution that automatically interrupts normal traffic signal operations, providing a green traffic signal to emergency vehicles in advance of their arrival at an intersection. The benefit of this technology is that it helps reduce emergency vehicle travel times whilst enhancing the safety of front-line officers, other road users and the broader community.

The technology was trialled on the Gold Coast in Queensland in November 2012. The 20 EVP-enabled emergency response vehicles received more than 650 green traffic signals per week supporting in excess of 120 EVP-assisted incidents a week. Analysis indicated improvements in travel time of up to 20% along major routes with no measurable impact on congestion. A roll-out of the technology to other areas of Queensland commenced in 2014 and trial results have shown similar levels of travel-time improvements. There are 150 planned new EVP-enabled intersections at Bundaberg, Townsville, north-west Brisbane, the Gold Coast and Logan. In the first week of September 2014, EVP-enabled ambulance and fire vehicles received more than 2,500 green traffic lights during more than 600 Priority 1 events.

At the 2014 ITS Australia National ITS Awards, Transmax – along with Queensland Government Partners – won a national award in the Government category for Emergency Vehicle Priority (EVP) on Samford Road in Brisbane.

Introduction

Survivability in life-threatening situations is directly linked to the response time of emergency services. Despite legislation allowing emergency vehicles to progress through red traffic signals, safety procedures and waiting queues of vehicles necessarily slow the progression of these vehicles through the intersections as they must ensure cross-traffic has stopped to allow them to safely proceed. In the specific case of cardiac arrest, traffic delays of as little as three minutes can halve the chances of a patient’s survivability (see Figure 1). EVP safely delivers green traffic signals to emergency vehicles to allow their unimpeded passage through controlled intersections.

While there are other systems that provide green traffic signals to emergency response vehicles in defined circumstances, STREAMS EVP is the first known system in Australia to provide an intelligent, network-based system that automatically manages traffic before and after the emergency response vehicle passes.

In addition to addressing the need of emergency response vehicles to quickly and safely move through the network, EVP is designed to minimise disruptions to traffic and to seek a return to normal traffic conditions quickly after the emergency response vehicle has passed.

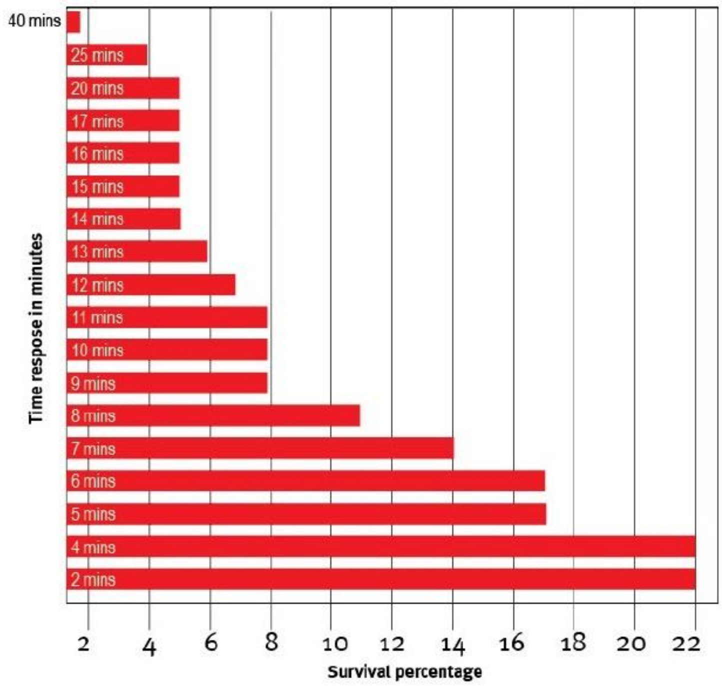

Figure 1. Survivability of cardiac arrest [1]

Initial Trial

In 2008, the Bundaberg fire, ambulance and police services participated in a proof-of-concept trial to explore the benefits of EVP. Eleven traffic signal installations (later extended to 18) were configured to enable EVP capability. This trial was conducted to test the capacity of signalised intersections to provide priority for four emergency response vehicles fitted with dedicated, on-board, automatic vehicle locator devices. Manual activation of the EVP system was required by the front-line officers who had to inform the system of the route on which they were travelling. The system then automatically tracked their progress along the selected route and intervened at downstream traffic signals as the emergency response vehicle passed fixed waypoints ahead of each intersection. Any deviation from the pre-selected route terminated the EVP assistance. An independent analysis of the proof-of-concept identified a reduction in travel times for the participating emergency response vehicles.

Pilot Project

Following the Bundaberg trial, the Queensland State Government approved a pilot project for Transmax to design, develop and enhance EVP capabilities. The pilot had the following principal objectives:

- Flexible development to support scalability and expansion to other potential users
- No change to business processes for front-line emergency staff (i.e. no manual selection or initiation of routes)
- Minimal change for road operations staff
- Use of existing systems and equipment where possible.

While the initial proof-of-concept limited the scope of change to the ITS itself, the pilot project was to utilise an expanded scope of integration across the emergency vehicle's existing location devices and computer-aided dispatch (CAD) systems as well as the necessary components within the ITS.

Southport (Figure 2) was selected as the preferred location due to:

- The Gold Coast Hospital servicing a large number of life-threatening conditions and injuries and therefore, potentially benefitting significantly from an EVP system
- Local ambulance stations being amongst the busiest in the state
- Increasing demands for emergency services in the area
- High local traffic volumes allowing for significant improvements through an intelligent EVP system.

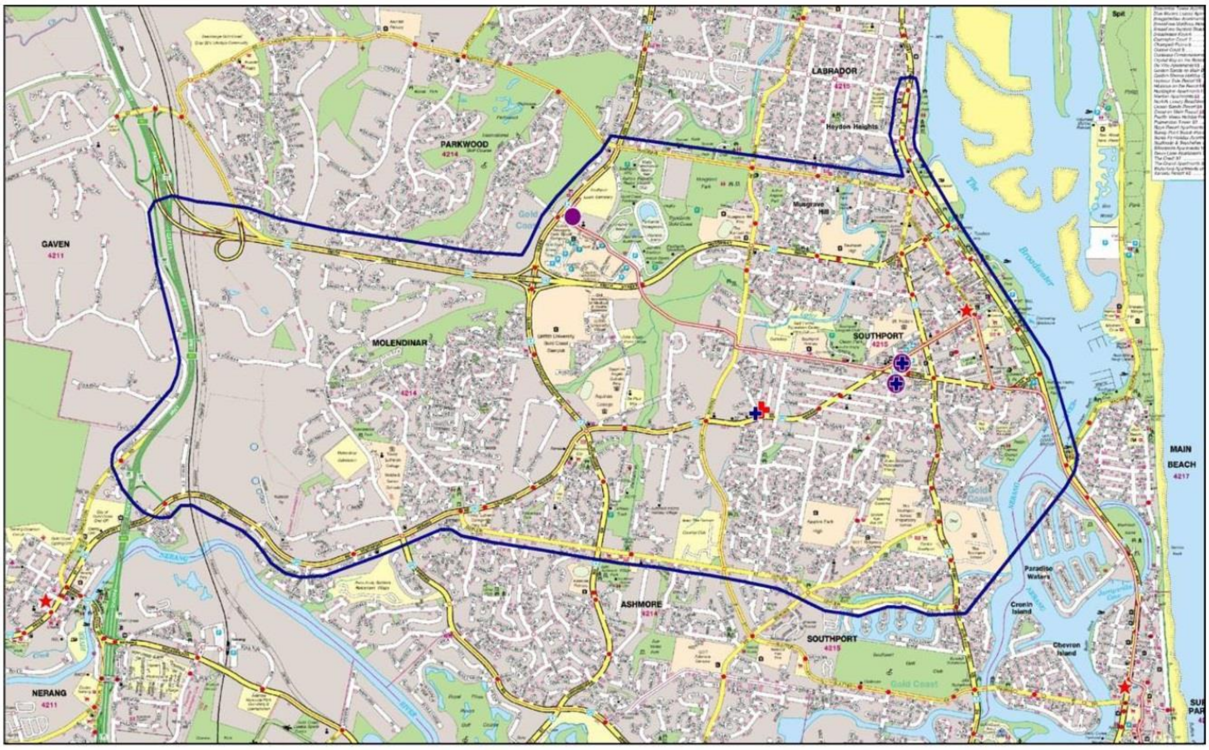

Figure 2. Southport Pilot Area

EVP Pilot System Design

Overview

The developed EVP system is an intelligent transport solution that provides target emergency response vehicles with priority access through the controlled road network. It is designed to use existing infrastructure to minimise installation and maintenance costs (not requiring additional hardware to be installed at intersections) and utilising in-vehicle equipment (mobile computers and GPS) often installed in emergency response vehicles. The system is broadly split into two separate subsystems that communicate through a well-defined formal interface:

- The Vehicle Tracking and Intervention Request (VTIR) subsystem (delivered by the Department of Community Services [DCS]) was designed and built across a number of components including: in-vehicle software; vehicle communication; state management;

route and ETA processing; and traffic signal communication. The VTIR tracks emergency vehicles in real time, calculates the estimated time of arrival at intersections, and sends requests to the STREAMS (Transmax ITS) traffic control system.

- The Traffic Signal Intervention (TSI) subsystem was designed and built into the existing ITS. It arbitrates requests received from the VTIR system against other traffic management requests and, where appropriate, manages traffic signals to service requests.

This relationship is depicted in Figure 3.

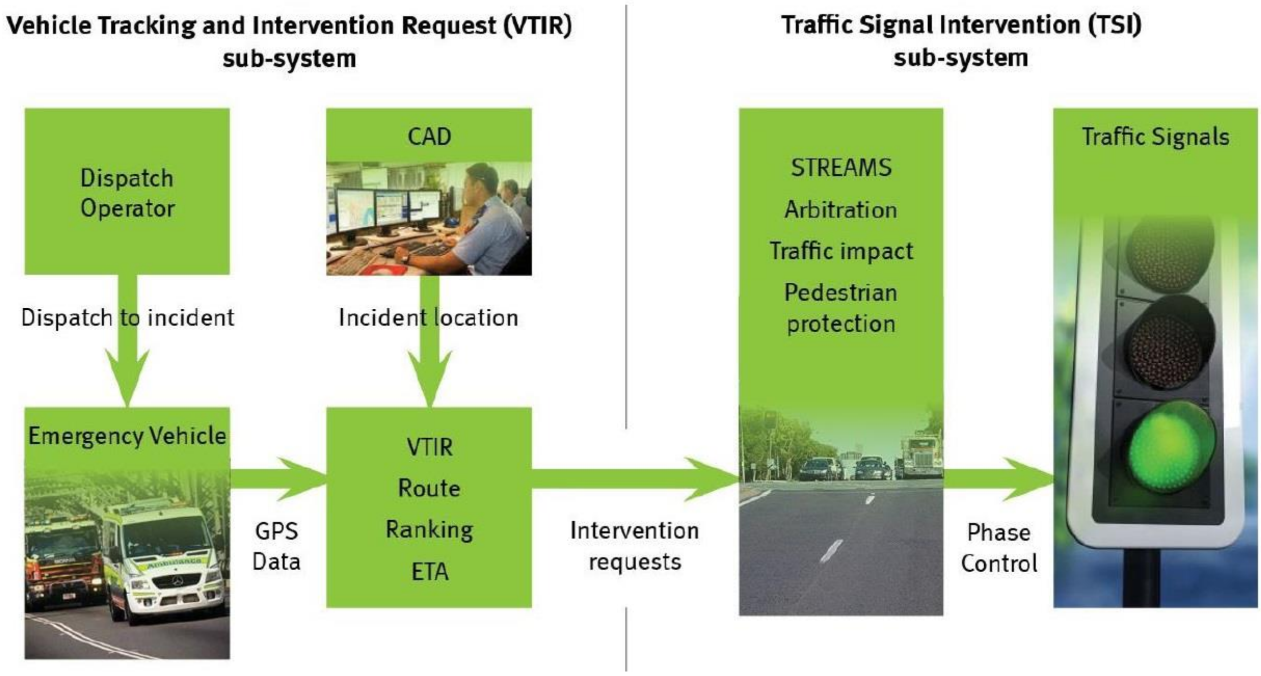

Figure 3. EVP Operational Overview

VTIR

The VTIR monitored the current location of emergency response vehicles, predicted their potential route, and sent intervention requests and ETAs to the traffic signal system to action. It achieved this by combining real-time information from the emergency response vehicles and the associated CAD system and spatial data relating to the road and signal networks to calculate the ETAs for likely intersection approaches.

The subsystem consisted of two components:

- In-vehicle equipment (IVE)
- VTIR subsystem

The IVE was a ruggedized Windows 7 box which was wired in to ambulance and fire vehicles in the pilot area. When an emergency vehicle's lights and sirens were activated, the IVE would send the vehicle's GPS location and bearing information every two seconds over the 3G network to the VTIR system. There was no user-accessible interface for the IVE so no intervention was required from field-officers to activate it.

The VTIR system accepted the messages from the IVE, married this information with Triple Zero Priority 1 emergency call information from ESCAD (the DCS emergency dispatch system) and calculated a potential route to the destination. It then requested intersections along that route that were controlled by the STREAMS system via the Traffic Signal Intervention (TSI) subsystem in TMR. These messages to TSI were also sent every two seconds. VTIR told TSI which intersection it was requesting and the ETA of the vehicle at the intersection. VTIR would then accept messages from TSI every two seconds reflecting the success or otherwise of intervention requests for the respective intersections.

There was no indication to the driver of the vehicle of the state of the EVP system and their vehicle's priority status with intersections on the route to the location. This was a policy decision to reduce the impact on the fire and ambulance front-line officer operational procedures.

Also, no route suggestion was made to the driver; VTIR would calculate the most likely route a driver would take to an event. Any deviations from this anticipated route resulted in the automatic cancellation of intervention requests to those intersections on the original anticipated route. A new anticipated route was automatically calculated based on the current direction of the vehicle resulting in corresponding intersection intervention requests being sent.

If a vehicle deviated from calculated routes more than a predefined number of times then VTIR would attempt to request interventions in the general direction of travel. If a vehicle took longer than anticipated to arrive at an intersection, the request for intervention on that intersection expired and the intersection resumed its normal operation. If two emergency vehicles requested priority at conflicting entrances to the same intersection and STREAMS had not already started the intersection, the highest priority request was served first.

TSI

The TSI delivered the appropriate traffic signal phase to provide a green traffic signal to the emergency response vehicle by the requested ETA while maintaining all safety critical factors. It provided traffic management intelligence to introduce the intervention phase, clearing queued traffic ahead of the emergency response vehicle as well as returning traffic to normal following the passage of the emergency response vehicle.

The TSI subsystem provided for arbitration based on a ranked priority per intersection. The highest priority requests asserted control over the intersection and held out other requests until it was either cancelled or exceeded the maximum permitted request time. This allowed for an orderly progression of vehicles based on priorities defined by the emergency services dispatch.

Once the prioritisation of interventions was resolved, the required interventions were scheduled on the controlled intersections to achieve the shortest possible departure from standard cycling, within safety constraints. These key restraints are shown in Figure 4.

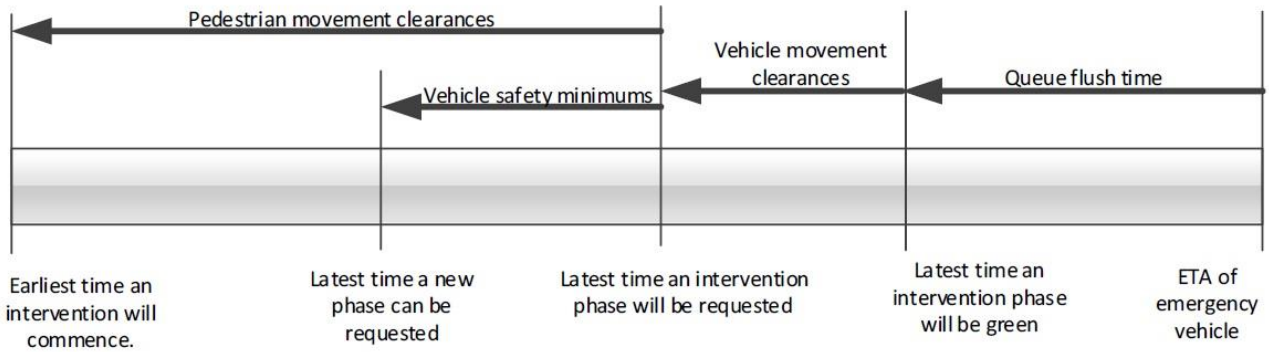

Figure 4. Intervention Timing Constraints

Following the transition of a vehicle through the intersection, clean-up strategies were implemented by the ITS to ensure an orderly and rapid progression back to normal operations.

Results

Overview

Analysis of logged trip data indicated that all 20 EVP-enabled emergency response vehicles benefitted from EVP receiving more than 650 green traffic signals per week supporting more than 120 incidents per week. Analysis also showed improvements in travel time of between 10%-20% along major routes and improvements in response times compared with the same period in the previous year.

Data Collection

Three commonly used routes for emergency response vehicles were identified in the Gold Coast area:

1. Westward on Southport-Nerang Road
2. Southward on Ferry Road
3. Northward on Kumbari Avenue.

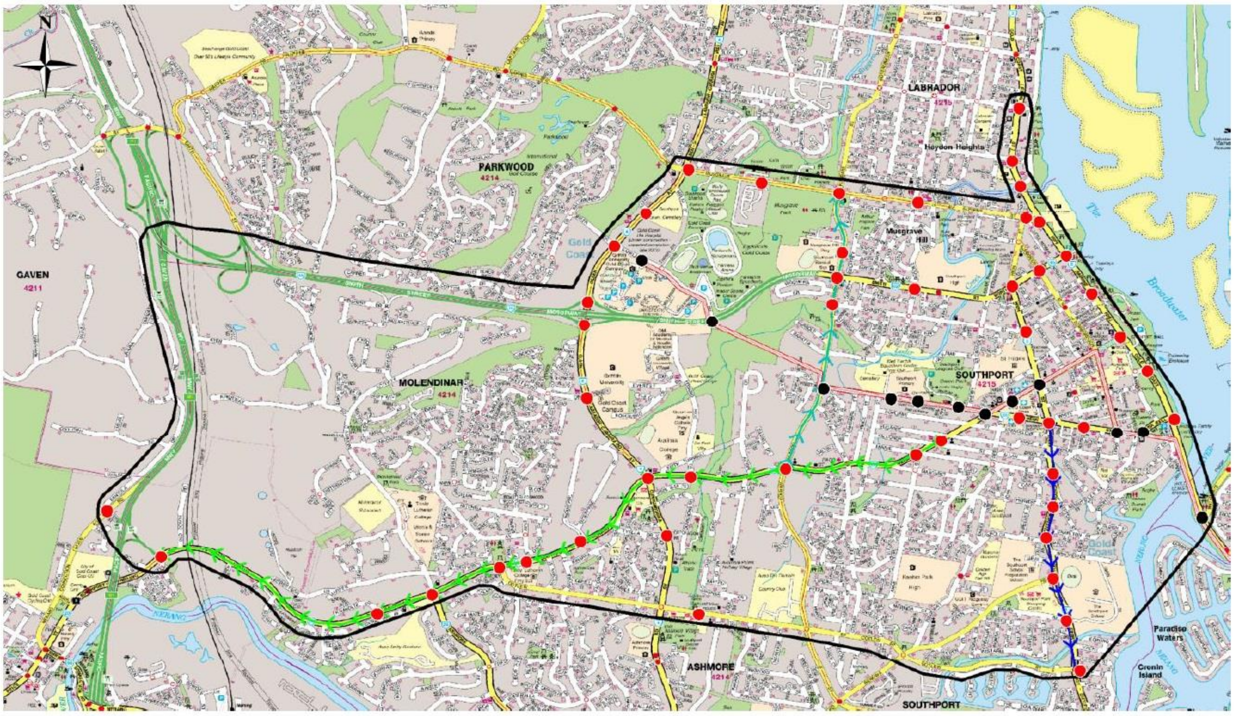

Figure 5. Measured Routes

GPS information from emergency vehicles was collated before and after system implementation to determine the impact of the system. Results are shown in Table 1.

Table 1. Average Trip Improvement

Route	Average Trip

	Improvement
Southport-Nerang Road	11%
Ferry Road	14.5%
Kumbari Avenue	20%

Analysis of general traffic data from before and after system implementation showed no significant differences in congestion.

User Feedback

Positive feedback has been received from paramedics and fire fighters who have been involved with EVP. The most common response when queried is that: "we noticed more green lights but just thought we were lucky". As noted by senior officers, this reflects the seamless integration of EVP into existing business practices and processes.

Further feedback from Queensland Ambulance Service staff has highlighted the issue that they got: "four or five green lights then went outside the pilot area and stopped in traffic".

The Traffic Management Centre (TMC) in Nerang on the Gold Coast manages the traffic and, in particular, STREAMS, where EVP was implemented. The feedback from TMC operators was that the EVP application did not add work to their normal operations.

Expansion to Other Areas of Queensland

Following the successful Southport pilot, trials of the technology in other areas of Queensland have commenced. In Bundaberg (population 71,000), the location of the original trial of first-generation EVP, traffic lights at 32 intersections in the city have been upgraded with seven fire engines and 14 ambulances from Bundaberg and surrounds having EVP technology enabled. In addition, in Queensland, there are 150 planned new EVP-enabled intersections at Bundaberg, Townsville, north-west Brisbane, the Gold Coast, and Logan.

In the first week of September 2014, EVP-enabled ambulance and fire vehicles received more than 2,500 traffic lights during more than 600 Priority 1 incidents.

The Brisbane EVP pilot undertaken on Samford Road in 2014/2015 demonstrated that the system can be used successfully with the SCATS®* adaptive traffic control software system and Transmax is now preparing to configure an additional 300 intersections in the traffic network controlled by Brisbane City Council.

The successful Brisbane pilot also demonstrates that Queensland's EVP technology could be expanded to many other cities as SCATS® is used for traffic signal control in more than 150 cities around the world.

While the EVP solution has been implemented for use by emergency response vehicles, there are many other potential users of this technology such as police VIP escorts, defence vehicle convoys, freight companies with wide loads, and other groups of road users where it would provide community benefit.

Summary

EVP is ultimately about saving lives and helping frontline officers respond as quickly as possible to incidents by getting there without risking the safety of other road users or disrupting traffic.

An increased demand for emergency services is driven by an ageing and growing population in Queensland. Coupled with traffic congestion, this means that smart technologies need to be employed to maintain and improve response times, keep other road users safe, and minimise traffic disruptions.

EVP leverages existing technology to deliver an intelligent transport solution without adding

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complexity to the work processes of front-line officers. The result is faster travel times and a safer work environment for front-line officers (including less stress due to them having to navigate fewer red lights) and with no detrimental impact on network operations or other drivers.

Investment in EVP technology is realising improved front-line communications capability within and between the State Government and regional councils. It is also realising benefits through leveraging existing assets and resources by integrating critical traffic management systems with core front-line information systems to maximise return on the Government's investment in information communications technologies.

References

Fridman, M., Barnes, V., Whyman, A., Currell, A., Bernard, S., Walker, T., and Smith, K.L., (2007), A model of survival following pre-hospital cardiac arrest based on the Victorian Ambulance Cardiac Arrest Register, *Resuscitation, 75, 2*, 311-322.