AUCKLAND'S SIGNAL PRE-EMPTION AND REAL TIME PASSENGER INFORMATION SYSTEM

By

Vadi Vencatachellum
MIPENZ, Registered Engineer
Senior Transport Planner
Auckland City Council

AUCKLAND’S SIGNAL PRE-EMPTION AND REAL TIME PASSENGER INFORMATION SYSTEM

Under a $7million contract, SAAB ITS Pty. Ltd. is supplying and installing an intelligent transport system for public transport in Auckland City. The very complex technical aspects of this project challenged the contractor to create solutions that would meet the performance specification of the contract. This paper outlines the steps leading, it is hoped to the operation of the first stage of Auckland’s Signal Pre-emption and Real Time Passenger Information System later this year.

1. Introduction

Since 1998, Auckland City Council has had a working real time passenger information system providing information at 4 bus stops and signal pre-emption at 8 intersections along 2 major bus routes. This system used transponders on buses and detector loops in the carriageway to locate buses and predict their real arrival time at bus stops equipped with variable passenger information display signs. Because of concerns about the increasing costs of expanding the existing system, lack of competition for system supply and the desire to review alternative technologies available, the Council decided to delay implementation. In 1999 the Intelligent Transport System (ITS) consultant PPK Pty Ltd was engaged to carry out a ‘Positioning Review Study’ [1] of available technologies and existing systems, and their benefits and risks. A proposed action plan was developed by PPK to drive the future implementation of a system within the Auckland region, addressing issues including system functional design, system delivery, management, maintenance and future system development.

The development of the system specification was overseen by a regional group of officers representing the region’s roading authorities, passenger transport operators and the Regional Council. The specification envisaged a Signal Pre-emption/ Real Time Information System (SP/RTPIS) based on automatic vehicle location, providing the following primary functions:

- An interface with the Sydney Coordinated Adaptive Traffic Control System (SCATS) to manage key traffic signals to the advantage of bus services by providing an early or extended green signal phase to approaching buses (signal pre-emption)
- Accurate prediction and display of bus arrival times at selected stops. (Real time passenger information)
- Monitoring of passenger transport services, for use by the Regional Council, road controlling authority and the bus companies.

In December 2000 Auckland City called for expressions of interest for the supply and installation of a signal pre-emption and real time passenger information system to cover the City’s major suburban and central area bus routes. The evaluation of 18 expressions of interest received led to 5 respondents being invited to tender. Following a detailed and rigorous evaluation process, the preferred tenderer SAAB ITS Pty Ltd was selected.

This paper outlines the steps that have led to the upcoming implementation of the first stage of the Auckland City contract and the future directions of this project.

2. Tender documentation

Auckland City's technical consultant for this project, Parsons Brinckerhoff (formerly PPK) led the development of the tender documents. It is notable that the development of specifications and the tendering process was overseen by a Project Control Group convened by the Regional Council and comprising representatives of the region's City Councils, transport providers, and Transit New Zealand. The project is the first stage of a regional push to implement signal pre-emption and real time information in Auckland.

The documents prepared for the short-listed tenderers consisted of:

- the general conditions of contract based on the Australian Government Information Technology Contract (GITC)
- system specification and
- special conditions of contract.

GITC was selected and adjusted for New Zealand conditions because there was no equivalent document in New Zealand. PB prepared a functional specification rather than a prescriptive document, which allowed tenderers to offer different technical solutions provided they met the mandatory client (Auckland City) requirements. The special conditions of contract protected the interest of the client against the potential risks such as non-performance by the tenderer or failure by Council to secure the required level of external funding for this project.

3. Project Scope

The scope of this project includes the supply and installation of 204 real time passenger information signs at selected bus stops and the provision of signal pre-emption at 174 intersections within Auckland City. By virtue of most routes in the Auckland region travelling through parts of Auckland City, the project will equip most buses in the urban passenger transport fleet with Automatic Vehicle Location equipment. A particular challenge presently being addressed is that the fleet is growing. At the time the contract specification was settled in early 2001, the fleet comprised of 737 buses and by the end of 2003 it is expected to reach 850 buses.

To reduce risks to Auckland City, this project is to be implemented in three stages over a period of three years. Table 1 below summarises the scope and staging of this project. The management of potential risks in this project is discussed in section 7.

OUTPUTS	STAGE 1	STAGE 2	STAGE 3	TOTAL
Buses Equipped for Automatic Vehicle Location (AVL)	24	713	-	737
Bus Stop Variable Passenger Information Displays (VPID)	50	99	55	204
On Bus VPIDs	24	-	-	24
Intersections equipped for Signal pre-emption	44	75	55	174

Table 1: Scope and staging of Auckland SP/RTPIS project

Stage 1 involves the installation of equipment on buses operating the Link service and at selected bus stops on the route of this city loop service. This service was chosen for the first stage because it is a complex route with dedicated branded vehicles and the on-going utility of on bus signs, which won't be installed on all buses but are apart of the system.

Stage 2 involves the installation of equipment on the remainder of the Auckland urban bus fleet and at selected bus stops and intersections on the major radial bus routes. During stage 3 the other bus routes operating through the central area and other minor or cross- town services will have bus stops and intersections fitted with equipment. It was anticipated that all three stages could be implemented in three successive calendar years

4. Tender evaluation

Auckland City would not have been able to fully fund this project and therefore relied on two major sources of external funding i.e.Transfund New Zealand and Infrastructure Auckland. Transfund approved the evaluation method i.e. a modified quality/price trade-off methodology. The project budget was set at NZ$7m and all the short-listed tenderers were informed of that fact.

The following attributes, listed in order of decreasing weight, were used to select the preferred tenderer:

- Methodology
- Relevant experience
- Track record
- Technical skills
- Management skills
- Resources

Representatives of the regional Project Control Group undertook the evaluation process. The outcome was scrutinised closely by Auckland City's internal auditors, and legal advisers. Both approved the process used, the outcomes of the tendering process, tender evaluation, and contract negotiations. In February 2002 a contract was signed between Auckland City and SAAB ITS Pty Ltd to implement a SP/RTPIS in Auckland.

5. Explanation of the SP/RTPIS operation and System architecture

The following non-technical explanation of the system operation is based on information supplied in SAAB ITS tender [2]. Figure 1 illustrates how the various components of the system are connected together.

Each bus is fitted with a system called an Automatic Vehicle Location System (AVL), which uses Geographic Position System (GPS) and odometer data to calculate its position with an accuracy of a few metres. Once every second the AVL compares its position to predefined positions (or waypoints) stored for each bus route. When it gets a match, the AVL sends a message to the central control system, announcing that it has arrived at that waypoint.

The central control system uses software, called RAPID2; to calculate the progress of the bus along its route, based on the position messages it receives. It builds up “knowledge” of the average time to transit a route based on messages from all vehicles using that route. It sorts and saves these messages by time of day, day in week and special days so that it is able to compare the progress of any bus with similar services operating under similar conditions.

This combination of real time information and historical knowledge allows the system to predict the likely future progress of a bus along its route. Using that information, the central control system will send information to displays located at bus stops, called Variable Passenger Information Display (VPID). This informs waiting passengers how long it will be until the bus arrives.

The AVL units are programmed with a map of the route they are going to follow. This is used to identify the next stop along the route. Then, information about the stop and associated amenities or attractions can be sent to a sign on board the bus

To assist visually impaired persons, the displayed information is also announced by a loudspeaker, built into the sign. Pushing a button mounted on the pole will activate the audio announcement.

The contract specification envisages that the system will be capable of tracking more than 1000 buses and sending information to more than 1000 signs simultaneously.

In addition to providing passenger information, the system is required to also be capable of detecting when a bus is approaching a signalised intersection on its route and sending instructions to those traffic signals that will reduce the delay experienced. The system is required to integrate with the City’s SCATS system to achieve this.

Finally the system must provide a range of data to the transport planners and bus operators, to allow them to plan, monitor and manage services and traffic more efficiently. This information will be accessed directly by authorised users by ‘logging in’ on an Internet connection from their normal workplace.

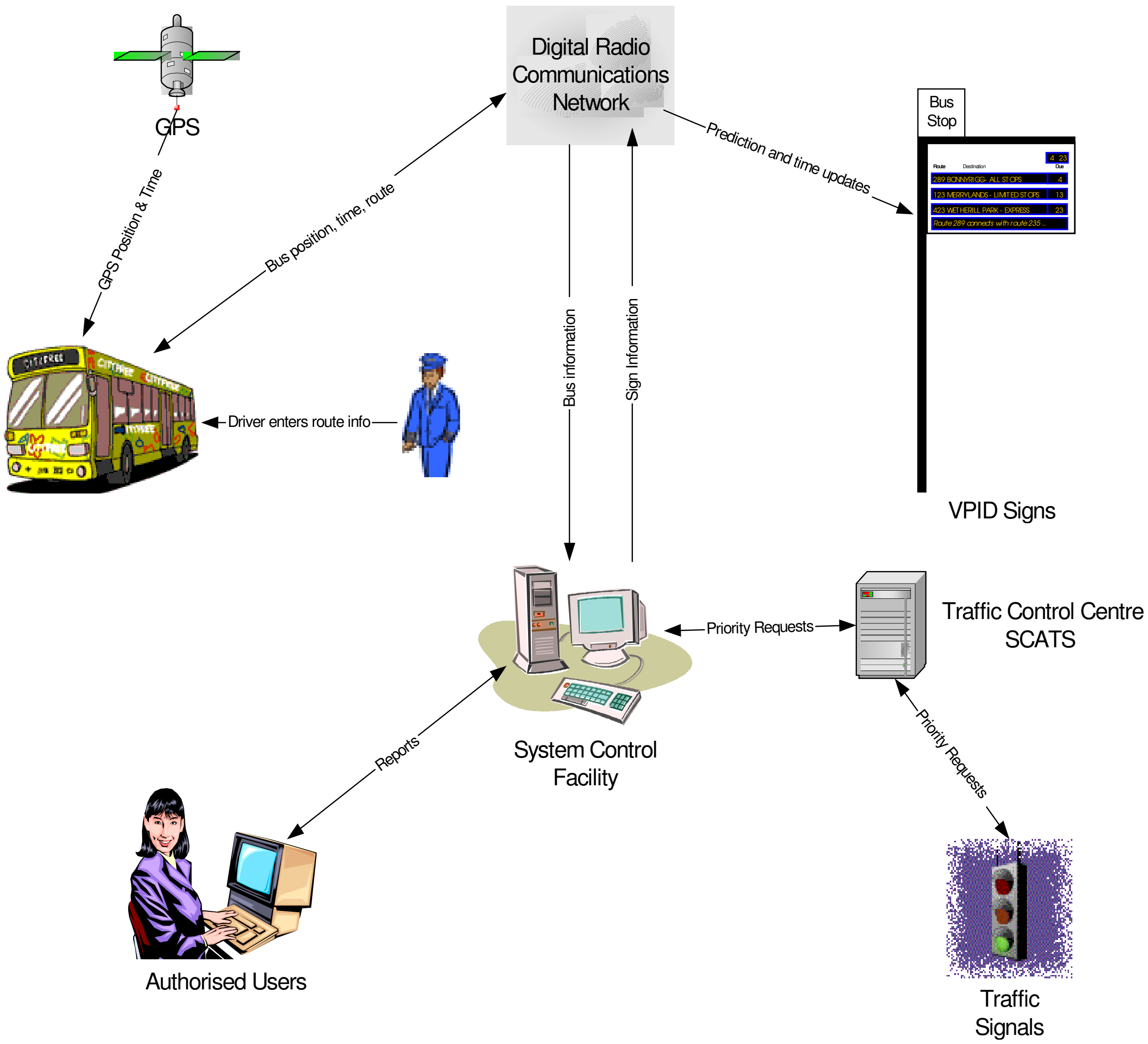

Figure 1: System Architecture

6. Benefits of the system

As part of Auckland City's policy to promote sustainable transport modes, bus priority lanes have been implemented on many of the City's main bus routes. The signal pre-emption and real time information system is viewed as the next step in the policy of providing commuters with attractive choices of transport modes other than the single occupant car.

Implementation of the SP/RTPIS in Auckland is expected to benefit bus passengers, bus operators, the Auckland Regional Council and Auckland City Council. The assessment of the magnitude of these potential benefits for external funding applications was based on three main elements:

- Literature review of similar systems operating overseas
- Review of performance of the previous systems operating in Auckland City
- Computer simulation of a representative Auckland road network with and without signal pre-emption system.

The main benefits of the system include reduced journey times, improved reliability of services and the removal of uncertainties of travel by passenger transport. This will greatly improve the performance and image of passenger transport. The expected increases in patronage is very likely to increase revenue, thereby allowing for more services or a reduction in the amount of public transport subsidies.

7. Risk management

7.1 Risk identification

There are some obvious risks in implementing an intelligent transport system, which has not been implemented anywhere on such a scale, although the basic technology behind the system has been proven. A risk analysis was required as part of the funding applications to the external funders Transfund and Infrastructure Auckland. The key risks identified were technical and financial. The management of these risks to ensure successful implementation of all the stages of this project is discussed below.

7.2 Technical risks

The technical risks include the inability of the chosen tenderer to successfully meet the requirements of the project and overcome all the potential challenges. These challenges are discussed briefly in section 8. These risks were managed by ensuring that apart from a very thorough evaluation process, the tenderers had to provide a detailed testing programme, a payment schedule linked to achievements of milestones, performance bonds, unconditional financial guarantee, and parent company guarantee. The Council's consultant Parsons Brickerhoff undertook the review of the technical aspects of the preferred tenderer's proposal for the Council.

PB's review report[3] identified potential technical risks, prioritised them in terms of potential impact on project stakeholders and in each case recommended a course of action. As intended, these were addressed during detailed tender negotiations with the preferred bidder, prior to formally signing a contract with Auckland City.

The detailed testing program submitted by SAAB ITS during tender negotiations comprised of the following tests in chronological order:

- First Article Tests (FAT) where prototypes of individual subsystems such as on street VPIDs are tested to demonstrate the specified functionalities in a bench top simulated environment
- System Factory Acceptance Tests (SFAT) where the manufactured subsystem are tested as a complete system to demonstrate the specified system functionalities off site
- Site Acceptance Tests (SAT) where the complete system is tested on site prior to commissioning.

Auckland City is implementing a system, which would be rolled out across the region in the near future. There is a risk that other Councils in the region might decide to implement a different system. To mitigate this risk a Memorandum of Understanding (MOU) has been signed by the Chief executives of all the territorial local authorities in the region and Transit New Zealand. The MOU ensured that any system installed in the region by these other agencies must be technically compatible with Auckland City's system. These regional stakeholders were also represented in the project control group and on the tender evaluation team.

7.4 Financial risks

For council the financial risks include uncertainty about receiving external funding and the extent of funding received for both capital and operating costs, inability of the selected tenderer to complete all the stages of the project and to remain financially secure. Other risks with financial implications for the Council include the risk that communication costs could be higher than predicted. Transfund may not contribute to all aspects of the operational costs as initially assumed. The staging of the project over three years with the successful completion of stage 1 being a condition of proceeding with the two subsequent stages helped to manage most of these risks. The Performance bonds and financial guarantees from the selected tenderer also provided risk mitigation.

8. Technical challenges

Although the contractor SAAB ITS had purchased the first generation RAPID1 system that was in use in Auckland and Brisbane, the specification and requirements of the new system were significantly more challenging. RAPID1 software in its present form could not simply be modified to meet the new system requirements. RAPID 2 had to be designed from scratch for the Auckland system. Along the way there were a number of technical issues that arose during the design and pre-implementation phases. These issues are summarised below:

- **Geographic Position System (GPS)**
  Urban canyon effect required an odometer-assisted solution. Situations where waypoints are close to each other required a judicious selection of waypoint radii.
- **General Packet Radio System (GPRS)**
  Vodafone's routine rebooting of their GPRS network every morning required software modifications for the VPID's.
- **Link Service complexity**
  The 10-minute peak frequency is not often adhered to due mainly to traffic delays. The system will address this uncertainty for passengers by displaying real time information on the on street VPIDs at major Link bus stops.
- **Signal Pre-emption**
  The priority system being implemented in Auckland will request that either the required signal phase be brought forward by 10 seconds or extend the current phase by 10 seconds to satisfy the bus priority request.
- **On-Street VPIDs**
  The on-street VPIDs at selected bus stops will display the arrival time of the next three bus services in minutes on a countdown system which uses a combination of historical expected times and real time information. Audio information for visually impaired passengers is available at the press of a button mounted on the VPID pole.
- **On Bus VPIDs**
  Buses on the link route will be fitted with VPIDs and audio to announce next stops and attractions. Because the Link services high profile and heavy use by both commuters and tourists, the system designers had to pay particular attention to the way messages are displayed to on-bus passengers.

9. Funding of project capital cost

Following the successful funding application to Transfund New Zealand and Infrastructure funding, the capital cost of this project will be funded as follows:

Transfund New Zealand: $3.2 million

Infrastructure Auckland: $3.1 million

Auckland City Council: $ 0.6 million
Total = $ 6.9 million

The application to funding authorities included a detailed analysis of the benefits and cost of the SP/RTPIS project. Transfund required a detailed analysis of costs and benefits and they assessed the major components of this project under two categories. The signal pre-emption component was assessed under the criteria for roading projects. The real time information component was assessed under their public transport funding criteria. The range of efficiency ratio (equivalent to the usual benefit/cost ratio) was between 5.4 and 9.3 depending on the annual rate of passenger growth assumed as a result of implementing this project i.e. 0% to 2.4%.

Infrastructure Auckland (IA) assessed the application from the view that it is the funder of last resort. The amount granted depended on the funding gap remaining after Council's budgetary contribution and Transfund's grant had been taken into account. Again a detailed analysis of benefits and costs was submitted for assessment. The environmental and regional benefits were analysed in more detail for the IA funding application.

10. Maintenance and operating costs

The estimated annual operating and maintenance cost for this project is around $700,000 which is as expected for a project of this size. Operating costs comprises largely of GPRS communication and power costs. As none of the stages are completed or operating yet, the operating cost is largely based on the best available estimate.

11. Future of system

Stage 1 is expected to be operational by the end of August 2003. It will be followed by an operational trial period of 3 months to demonstrate that the system is reliable, accurate and to assess any enhancements, which would be desirable in the near future.

Following the successful completion of the operational trial, the contractor would be given approval to proceed with implementation of Stages 2 and 3. The external funders would then release the appropriate portion of their grant to Auckland City.

Other territorial local authorities in the region will benefit from the experience of the Auckland City contract when the regional roll out of the system starts. Manukau City, North Shore City and Waitakere City are keen to implement a signal pre-emption/ real time information system compatible with the Auckland System, as agreed under the MOU.

The future expansion of the system within Auckland is also likely to make use of newly available technologies such as Wireless Application Protocol (WAP) phones to make real time passenger information accessible to waiting passengers instead of costly on street VPIDs at every single bus stop. These WAP phones could act as virtual VPIDs and access the required bus information via the Auckland Regional Council's Rideline service. Internet access to this type of information would also be possible in future.

12. Conclusions

Auckland City's SP/RTPIS project presents many technical and financial challenges for both client and contractor. Auckland City has sought to manage risk through a series of actions namely a robust tendering process and a high degree of external review by funders, technical advisers and other Auckland roading authorities.

The contract itself has several “break’ points where contract performance against specification is reviewed. The last of these before the system can go live are the site acceptance tests, which are expected to be completed by the end of August 2003.

The system is now at the stage where the implementation of stage 1 for the Link service is nearly complete.

The Signal Pre-emption/ Real Time Passenger Information System being implemented in Auckland promotes the Region’s and City’s strategic directions for passenger transport. Overall this complex smart technology project will deliver the next stage in the planning for sustainable transportation in Auckland City.

It is expected to deliver outcomes that will attract greater patronage to passenger transport, through reduction in trip times, increased service reliability and improved “quality of travelling experience”.

The primary functions being delivered with the installation of this system include advantages to buses at signalised intersections, accurate predictions and display of bus arrival times and the facility to monitor passenger transport services for use by the regional council, road controlling authority and the bus companies.

13. Acknowledgements

The author would like to acknowledge the permission of Auckland City Council to present this paper and the invaluable assistance of SAAB ITS in reviewing some of the technical information and providing the system architecture diagram for this paper. The views expressed in this paper are those of the author and do not necessarily reflect the views of Auckland City Council.

14. References

[1] Real Time Passenger Information System/ Signal Pre-emption, Positioning Review Study,’PPK Environment & Infrastructure Pty Ltd, December 1999.

[2] Tender for Real Time Passenger Information System Stage 1 for Auckland City Council, SAAB Professional Systems Pty Ltd, 23 May 2001.

[3] Technical Review for Preferred Tender Response, PPK Environment & Infrastructure Pty Ltd, August 2001

APPENDIX 1: GLOSSARY OF TERMS USED IN THIS PAPER

Term	**Description**
Interface	The way an item communicates with the ITS system defined by protocols and message structure documents
Protocol	The set of rules that lets components agree how to communicate with each other, refer also to"Interface"