ALTERNATIVE SOLUTIONS FOR URBAN TRAFFIC CONGESTION

Mr William ZHANG
Engineer
Transport South Australia
(Transport SA)
Australia
Fax: +61 8 8343 2630
Email: bill.zhang@transport.sa.gov.au

Dr Wen Long YUE
Senior Lecturer, Program Director
Transport System Centre
University of South Australia
Australia
Fax: +61 8 8302 1880
Email: Wen.Yue@unisa.edu.au

Abstract: The objectives of this paper are: 1) to identify the congestion and mobility problems in urban traffic systems. 2) to identify and assess advanced technologies and systems that can improve urban highway traffic operations by achieving significant increases in capacity and traffic flow. 3) discuss key issues associated with implementation of Intelligent Transport Systems (ITS), and make recommendations on how to maximise the benefits of ITS in terms research, development, testing and implementing ITS. In order to meet these objectives, a two-phase research approach was used. In the first phase, a comprehensive review was undertaken on the available advanced technologies, which show potential for alleviating urban congestion. In the second phase, a detailed assessment was carried out for the three technologies selected for further investigation on the basis of the first phase's evaluation. The paper focuses on the application of new technologies to the individual automobile driver travelling in urban areas. The role of public systems in reducing urban traffic congestion is fully recognised and the use of Intelligent Transport System (ITS) technologies in improving their operations is also discussed in this paper.

Key Words: Intelligent Transport System (ITS), Traffic Congestion, Traffic Management

1. INTRODUCTION

Urban traffic congestion is a significant and growing problem in many parts of the world. Moreover, as congestion continues to increase, the conventional approach of "building more roads" doesn't always work for a variety of political, financial, and environmental reasons. In fact, building new roads can actually compound congestion, in some cases, by inducing greater demands for vehicle travel that quickly eat away the additional capacity. Against this backdrop of serious existing and growing congestion, traffic control techniques and information systems are needed that can substantially increase capacity and improve traffic flow efficiency.

Application of ITS technologies in areas such as road user information and navigation systems, improved traffic control systems, and vehicle guidance and control systems has significant potential for relieving traffic congestions. Traffic congestion and the cost of providing mobility are compelling issues to planners, decision makers and members of both the business community and the general public. Transportation, and the degree of efficiency with which it is accomplished, affects us all. Therefore we are constantly in search of solutions to our transportation problems that will give us not only increased mobility, but also greater economic productivity and a cleaner environment. While new road construction can temporarily relieve congestion, in the longer term it simply encourages further growth in car traffic through increased travel and a switch away from public transport. Beside this, finding suitable corridors in our cities for major roadworks is becoming more and more difficult, and many of the recent major projects involve tunnels to minimise environmental disruption and community opposition, thereby raising costs.

In the past decade, a new wave of Intelligent Transport Systems (ITS) has emerged around the world to provide additional tools to help solve our transport problems. Intelligent Transport Systems can produce major benefits in reducing congestion, accident and environmental impacts, and can make significant improvements to the efficiency of commercial and public transport fleets, and to inter-modal integration. ITS can also reduce the need for expensive new transport infrastructure by maximising the efficiency of our existing facilities.

2. THE IMPACTS OF TRAFFIC CONGESTION

2.1 Background

All around the world, developed and developing countries are discovering that road traffic congestion is no longer simply confined to commuter trips in urban areas. It affects the movement of people and the flow of goods to market. In both rural area and intercity corridors, incidents, maintenance operations, detours, and congestion on tourist routes, among other causes disrupt traffic. To the traveller, congestion means lost time, missed opportunities, frustration, and waste of personal resources. To the employer, congestion means lost worker productivity, delivery delays, and increased costs. Speed, reliability, and the cost of urban and intercity freight movements are increasingly affected by congestion. The causes of congestion can be categorised as either recurring or nonrecurring. Recurring congestion is the predictable delay caused by high volumes of vehicles using the roadway during the same daily time periods (eg, peak commute periods, holiday periods, or special events) and at critical locations (intersections, interchanges, major long-term construction areas, or toll plaza areas). Nonrecurring congestion is unpredictable delay generally caused by spontaneous, unplanned occurrences such as traffic accidents and incidents, emergency maintenance, or weather conditions.

2.2 Identification of Congestion and Mobility Problems

Before strategies for managing congestion and improving mobility (ie, the movement of people and goods, defined in terms of travel time, efficiency, transit passenger crowding, safety, and cost) can be developed and evaluated, we must first identify the causes of current congestion and mobility problems forecast their magnitude in the future. Existing congestion and mobility problems and projections of where and when future problems will likely occur will be assessed in terms of travel speeds, travel times, delays, and transit passenger crowding. Once the congestion/mobility problems and their locations are identified, alternative improvement strategies to deal with them, both in the near term and in the long term, will be developed.

2.3 The Consequences of Congestion

Put simply, traffic congestion means there are more people trying to use a given transportation facility during a specific period of time than the facility can handle with what are considered to be acceptable levels of delay or inconvenience. Delays at particular locations in a transportation network are certainly aggravating to those using the system, but these delays are part of a much larger picture of how a transportation system allows people and goods to move around a metropolitan area.

To some, congestion is not a problem. It is considered to be one result of economic prosperity and one that we will have to learn to live with. proponents of this viewpoint argue that our expectations about convenient travel will simply have to change. Others argue, however, that the consequences of congestion are much more serious to a community.

2.4 Relieving Congestion through Management and Advanced Technologies

A growing body of evidence proves that simply expanding the road infrastructure cannot solve traffic congestion problems. Therefore, many countries are working to manage their existing transportation systems to improve mobility, safety, and traffic flows and to reduce demand for vehicle use. Experience and technical research have demonstrated that, when properly applied, measures taken to manage the existing transportation system can have a profound impact on trip-making behaviour and traffic congestion. One of the major advances in transportation during the past decade has been the application of advanced technologies in the operation of the transportation system. Known generically as "Intelligent Transportation Systems"(ITS). These technology applications are becoming an increasingly important tool in the congestion reduction and mobility tools. A wide array of ITS technologies for motorised and non-motorised transport as well as economic and administrative policies has been used successfully around the world to manage congestion and influence travel demand.

All of these measures, which are referred to collectively as congestion management, are designed to improve the operating efficiency of the existing transportation system - its infrastructure, modes, and services - in three ways:

- By increasing the use of alternative transportation modes including public transport, car parking, and bicycling/walking.
- By altering trip patterns through the application of measures such as land-use policies, alternative work-schedule arrangements, telecommuting, and pricing.
- By improving traffic flow through measures such as route guidance systems, traffic signal improvements, and incident management.

As we become more concerned about enhanced efficiency of the existing transportation system, ITS will become an important focus for the planning process. As part of this ongoing process, the general public and local officials can become educated as to the benefits of making operational improvements to the transportation system.

3. INTELLIGENT TRANSPORT SYSTEMS IN OVERSEAS AND AUSTRALIA

3.1 Background

In Australia, currently over $4 billion (Australian dollars) worth of major road and freeway projects are under construction in Sydney, Melbourne, Brisbane, Perth and Adelaide. These include:

- The $650 million Eastern Distributor in Sydney
- The $2 billion CityLink project in Melbourne, connecting the Tullamarine, Westgate and SE Freeways
- The $750 million Pacific Motorway linking Brisbane to the Gold Coast
- The Graham Farmer Freeway in Perth
- The $76.5 million Stage 2 Southern Expressway in Adelaide.

Further major projects are also planned, such as the M5 East in Sydney, and the new road programs recently announced for Perth. Despite this expenditure, urban congestion is expected to continue to rise at up to four times the level of growth in traffic, currently running at 2% p.a. (Cox 1997). Intelligent Transport Systems (ITS) is a world wide initiative aimed at making our transport system safer, less congested, and less polluting. The developments of ITS have come about through extensive and vigorous programs which have been established in the US, Japan and Europe. On a smaller scale, there is also ITS activity in Australia.

3.2 Europe

In mid 1980s, the European ITS program was given a major boost by a legislative act. There has not been a single coordination vision in Europe, however, there have been two long running programs, PROMETHEUS and DRIVE, which have set the agenda for ITS in Europe. In the last 5 years, the development of ITS has been growth rapidly in Europe and more powerful ITS systems have been developed and utilise in the transportation systems, such as Surf 2000, Countdown and DIS, etc.

PROMETHEUS: It was a EUREKA research project with the major participation coming from the motor car industry. The major emphasis was on the development of vehicle based systems. The idea is for vehicles to communicate between the infrastructure and themselves in order to provide a safer and faster journey in urban arterial road network, hence reduce traffic congestion.

DRIVE: The emphasis of the DRIVE program was compatible with PROMETHEUS, with concentration on overall system issues. Taken together, these two programs have resulted in many different projects. There are seven functional areas of the DRIVE program:

(a) Traffic Demand Management
(b) Travel and Traffic Information
(c) Integrated Urban Traffic Management
(d) Integrated Inter-urban Traffic Management
(e) Freight and Fleet Management
(f) Public Transportation Management

Surf 2000 - Urban Traffic Control System (Paris, France): The Paris network has been divided into geographic zones, subzones and intersections. In a zone, approximately 40 intersections are located. Surf 2000 focuses both on macro-regulation, global actions to optimise the overall network, and on micro-regulation, including local actions on intersections. The application of the Urban Traffic Control System has generated a number of benefits. The number of stops and the amount of congestion have decreased, which improved the overall traffic continuity and resulted in less fuel consumption. The pedestrian safety and comfort has increased, due to adapted traffic light regulation and reduced waiting at traffic lights. Bicycles are better taken into account as full road users, bus services are better on schedule and if not the customer is informed. Calculations have shown that 15 millions of hours less were spent in the traffic, saving the community more than a billion FF per year.

Countdown: Real-time Bus Stop Information (UK): Countdown is London Transport Buses' real-time information system for bus passengers. Having completed successful trials, Countdown is now being expanded to cover the whole of London. All bus services in London are planned and procured by LT Buses, with individual routes specified and offered for tender to private bus operators. Countdown has been installed at 400 bus stops (2% of total in London) and 1,000 buses (15% of total) on 50 routes (10% of the total of route kilometres). 80 million passengers per year are informed by the system. Countdown comprises the following elements: Automatic Vehicle Location, radio communications, a central computer cluster, a database file server, garage workstations and bus stop signs.

DIS - Dynafleet Information System: Freight and Fleet Management: The DIS system consists of vehicle equipment (soft- and hardware) and an office system (software). The vehicle equipment is integrated with several electronic systems of the truck, which makes it possible to gather and analyse tachograph and engine data. This information is available to the driver via the display on his dashboard, that can also show the vehicle's position on different maps and display RDS-TMC data. All text messages and orders are stored in an electronic mailbox. In the office, the dispatcher has a Windows-based system at his/her disposal that shows the location of the vehicles on different maps and the status of their current assignments.

3.3 Japan

RACS: RACS consists of a network of roadside beacons that are able to communicate with vehicles fitted with the appropriate transponders. The beacons are linked to a System Centre and are able to provide information to the vehicle. Each vehicle using the system has a map, allowing display of the streets in the close vicinity. The system can be used for route guidance, emergency communications, automatic tolling, and collection of information on the status of traffic.

VICS : The VICS system integrates RACS, as well as a number project called AMTICS. This is also run as a private-public partnership with representatives of motor manufacturers, electronic manufacturers, and government organisations. This is likely to be basis for much of the future development of ITS in Japan.

ITGS: Current route guidance systems calculate a vehicle's position (using GPS) and then provide the user with the route to the specified destination, hereby relying on digital maps on CD-ROM. The ITGS system complements this by taking into account current traffic conditions to determine the best route and avoid traffic jams, blocked roads and accidents.

3.4 The United States

Development of ITS in the United States is mainly coordinated by ITS America. This is an organisation composed of representatives of the motor car industry, the Federal Highway Administration (FHWA), state road authorities, electronic companies, system houses, and universities. This organisation is a public-private partnership with the aim of coordinating private and public investment in the area of ITS. American activities in ITS are divided into five functional areas: Advanced Traffic Management Systems (ATMS), Advanced Travel Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Commercial Vehicle Operations (CVO), and Advanced Public Transportation Systems (APTS):

Advanced Traffic Management Systems (ATMS): Advanced Traffic Management Systems involves the use of advanced technologies to manage the traffic on the transportation network. An important element of ATMS will be sophisticated traffic control systems, which will phase all the traffic lights in a particular area providing such functionality as a "green wave" to vehicles. ATMS will also include other systems such as freeway ramp metering and incident management systems.

Advanced Travel Information Systems: These systems provide information directly to the traveller. An important service will be route guidance, where the driver is informed of the best route to travel in order to reach a particular destination. As well it will be possible to receive other useful information such as nearby restaurants, parking space availability, and other geographically relevant information.

Advanced Vehicle Control Systems: This is the most ambitious of the functional areas. Ultimately it will involve having the vehicle controlled by computer, so that the vehicle can be driven along the highway with no human intervention. In the short term, this functional area will involve collision warning systems and intelligent cruise control. Car manufacturers are already demonstrating examples of the latter system, with test cars being able to maintain a constant distance from the car in front.

Commercial Vehicle Operations: This involves the use of automatic vehicle location systems linked with computer aided dispatch systems to allow sophisticated management of commercial vehicle fleets. These systems allow more efficient dispatch and scheduling as well as increased driver safety. There are already a number of deployed examples of such fleets. These systems will also have application to publicly owned fleets of ambulances, fir engines and police vehicles.

Advanced Public Transportation Systems: This functional area will involve the development of special purpose public transportation information and control systems. These will provide passengers information on the arrival times of buses and trains, allow smart card payment of fares, and a much higher level of operational efficiency. In addition, it will be possible to use ATMS and ATIS systems to provide higher priority to buses and trams. This area is also likely to see the development of personalised public transportation which will provide a service that is intermediate between buses and taxis, in terms of cost, timeliness, and proximity.

3.5 Other Countries

In addition to these major developments, many other countries have begun to focus on ITS. For examples:

- Canada has been a front runner in terms of ITS deployments such as the Route 407 electronic tollroad project in Toronto involving a government – private sector partnership, red-light camera systems in British Colombia, and the "light infrastructure" approach to freeway management involving the use of low cost communications infrastructure (Crook, 1998).

- Singapore is fitting electronic toll transponders to all of Singapore's 670,000 road vehicles, and 60 gantries have been installed to enable the world's first comprehensive electronic road pricing scheme, which will replace the current manually collected $2 toll for entry into the central business district. This could improve the efficiency of the system.
- Hong Kong is also trailing a full blown electronic road pricing scheme, and has also called expressions of interest for a new integrated ITS architecture linking at all key roads, bridges and tunnels and providing for future passenger information systems. Hong Kong has also introduced a fully integrated ticketing system covering all major public transportation operators using smart cards.
- Brazil is beginning to invest in ITS, including "electronic speed bumps", adaptive traffic control systems, and bus priority - a key issue given the importance of buses in cities such as Sao Paulo where there are 11,000 buses and high levels of traffic congestion.

3.6 Applications of ITS in Australia

The development of Advanced Traffic Management systems, such as BLISS and SCATS, in Australia, is highly regarded. With SCATS operating in thirty cities throughout the world. Below is a list of current status of ITS applications in Australia today.

- Video cameras, loop detectors, ramp metering devices and variable message signs are now increasingly used to detect and manage incidents on our freeways and to provide real-time information to motorists of travel speeds, interruptions to normal traffic flow and alternative routes to avoid congested areas. An example is Melbourne's Drive Time" system initially installed on the South-East Freeway and now being extended to other key routes.
- In 1997, Telstra and Philips released the CarIn navigation guide, using a GPS system and CD-ROM maps to guide drivers through major Australian cities.
- Safe-T Cam systems have been installed at various locations in NSW and Victoria to monitor heavy vehicles to ensure that drivers observe correct speed limits and rest breaks.
- Automated Highway Systems are not currently operating in Australia, however Adelaide is using ITS systems to provide reversible lanes on its Southern Expressway. This system provides for "tidal" flow thus reducing the need for additional lanes, which would be under-utilised in the reverse-peak direction.
- The Victorian Public Transport Corporation is introducing integrated ticketing across trains, buses and trams, and AVL systems will be extended to cover the entire Met Tram fleet making operations safer and more efficient
- Melbourne's CityLink project is one of the world's largest electronic tolling systems. This will provide automatic payment of tolls via an in-car transponder unit. The in-vehicle unit communicates with the roadside equipment thereby avoiding stops at tollgates.
- Terrestrial tracking systems, allowing vehicles to be located remotely, for security purposes and for distress calls. Some taxi companies are also fitted with "may day" devices.
- Brisbane Transport is fitting its 600 buses with small transponders and upgrading its traffic control systems to enable bus priority to be installed along four major arterial roads, and to provide real-time arrival information at selected bus stops. This information

technology feature not only affords a more reliable service but also overcomes one of the key impediments to using public transport - lack of information on bus arrival times and destinations. A similar system has been adopted in Perth for its new "CATS" or central area transit system.

3.7 Summary

Timely, accurate information will be reality available, making it possible to choose alternative modes, times and routes of travel. Electronic payment capability will improve the convenience of transit, parking and toll facilities. Communication and coordination among state and local traffic, police, emergency services, and private towing companies will greatly reduce accident and incident response and clearance time thus reducing delay, secondary accidents and emissions caused by stop and go traffic.

4. BENEFITS AND COSTS OF ITS

4.1 Background

ITS deployment has begun in earnest and is proceeding at a rapid rate in North America, Europe and Japan. Australia has already enjoys many of the benefits of sophisticated signal coordination systems.

The benefits and costs associated with transportation improvements can vary by type of improvement being implemented, the context in which the project is being placed, and who is defining the benefits and costs. There are three major categories of benefits and costs that should be kept in mind when considering particular projects or program implementation:

- **Private benefits and costs:** Benefits or costs experienced by persons or private firms using facilities.
- **Social benefits or costs:** The sum of benefits or costs to persons.
- **Societal accounting:** Taking account of private benefits or costs in such a way that all impacts on individuals are captured, not just the impacts on those directly involved in some activities.

4.2 Costs

In Australian major capitals, urban congestion already costs motorists over $5 billion annually in travel time and vehicle operating costs, and the value of travel time spent on urban roads by private motorists and commercial drivers exceeds $20 billion each year. The estimation of costs is often more complex than simply adding the amount of dollars needed to construct a project.

Importantly, monetary costs should be considered over the entire life cycle of a project to obtain a better picture of how much a project will cost when considering not only actual construction, but also operations, maintenance and rehabilitation. Total social costs of a project might include costs associated with congestion, air pollution, noise and water pollution, loses of biological diversity, accidents, and energy consumption.

4.3 Benefits

According to e-Transport - the National Strategy for Intelligent Transport Systems (Austroads, 1999), the deployment of new and expanded ITS systems in Australia is estimated to generate additional annual benefits of $2.4 billion by 2015, over and above the benefits from current systems. Measured in net present value terms the cumulative additional benefits are estimated at $8.0 billion over the next 15 years. Accelerated deployment of ITS would significantly increase these benefits by $6.4 billion, and making $14.4 billion in total as shown in Figure 1.

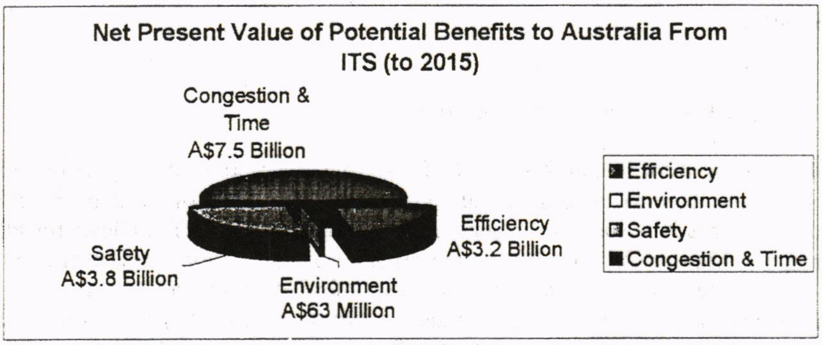

Figure 1. Net Present Value of Potential Benefits to Australia From ITS (to 2015)

Although, it is difficult to measure the actual benefits of ITS, this is partly due to the difficulty of isolating the ITS effects from others and the fact that many ITS benefits are incremental rather than step-function in nature. However, as the following numbers indicate, the stakes are high:

Table 1. Benefit Measures of ITS

ITS APPLICATION	BENEFIT MEASURE	REPORTED BENEFIT
Electronic Road Congestion Pricing (Major Aust Capitals)	• Overall Traffic • Inner City Traffic • Public Transport Use • Net Overall Benefits	14% reduction 22% reduction 6% increase A$270 million pa
Advanced Traffic Control (Major Aust Capitals)	• Travel Time Reductions • Delay Reductions • Stop Reduction	8-25% 14-37% up to 35%
Route Guidance Systems	Travel time saving	9-14%
Freeway Management	• Travel time saving • Delay reduction	18% 44%
Driver information	Travel time saving	8-20% reduction
Emergency Management System	Response times	10-50% reduction in response times through system coordinated
Transit Management System	• Productivity of vehicles and labour • Efficiency in routing and trip schedule • Transit travel times saving	10-20% increase 20% increase 10-30% reduction

(Booz Allen & Hamilton Limited 1998)

In practice, a number of constraints are associated with ITS applications directed congestion relief, encompassing economic, organisational, political, privacy and equity issues. The merits of direct road pricing, in particular, has often been challenged on each of these criteria.

5. IMPLICATIONS OF ITS FOR TRAFFIC CONGESTION

In view of the analysis and evaluation in previous section, three intelligent Transport Systems are therefore selected as prime solutions for urban traffic congestion. They are Advanced Traveller Information Systems, Transit Management Systems and Advanced Traffic Signal Control Systems.

5.1 Advanced Traveller Information Systems

Advanced Traveller Information Systems (ATIS) provide real time driving information to road users to allow them to make informed choices about the route and time of travel which take full account of factors such as congestion and adverse weather. ATIS allows travellers to access a range of Multimodal transportation information at home, work, and other major sites prior to starting their trip. As well as providing information on current network traffic conditions, incidents, road condition reports these systems also provide timely information on public transport service routes, schedules, transfers, and fares; and intermodal connections (rail, bus, tram, plane, subway, etc).
Advantages of ATIS are identified as followings:

(a) Consumers able to make a more informed transport choice;
(b) Encourages use of more sustainable transport modes;
(c) Information, if of sufficient quality, may have commercial value;
(d) Allows better journey planning; and
(e) Decreases the inconvenience of delays and waiting time and therefore increases productive time.

The transportation benefits of ATIS applications relate to improved network efficiencies from travellers seeking optimal (ie, minimum time) routes and enhanced used of alternative (to the single occupant automobile) modes. Therefore, ATIS is one of the ITS application areas where impacts should be viewed from both the short- and long-term perspective.

5.2 Transit Management Systems

Transit Management Systems include the use of advanced navigation, information, and communication technologies to improve the operations of public transportation systems. These systems enhancements to operations have occurred in fleet management, mobility management, traveller information, and electronic fare payment. The type of objectives that Transit Management Systems actions can help achieve include:

- Increase the convenience of fare payments within and between modes;
- Improve safety and security;
- Increase service reliability;
- Minimise passenger travel times;

- Improve schedule adherence and incident response;
- Improve timeliness and accuracy of operating data for service planning/scheduling; and
- Provide integrated information management systems.

More importantly, Transit Management Systems enhance the contribution of Public Transportation Systems to overall community goals by:

- Facilitate the ability to provide discounted fares to special user groups;
- Improve communications with users having disabilities and their mobility;
- Increase the extent, scope and effectiveness of traffic demand management programs; and
- Increase the utilisation of high occupancy vehicles.

The transportation benefits of Transit Management Systems applications occur in two major areas - the reduction in operating costs through more efficient utilisation of fleet assets, and increased transit ridership due to enhanced service reliability and ease of using transit services. The applications have been beneficial impacts on air quality, most likely in the context of pricing or other disincentives to single occupant vehicle use.

5.3 Advanced Traffic Signal Control Systems

Advanced Traffic Signal Control Systems generally provide the greatest payoff for reducing congestion on surface roads. In the context of ITS, this usually means some form of monitoring of traffic flows and a computerised central coordinating function for signal control. The elements of a Traffic Signal Control System include a central office with computer capabilities, a communications network, and local signal coordinators. Such a system can be linked to video surveillance, incident detection/management, and traveller information systems in the context of an overall transportation management system.

There are three major types of signal control that are used in practice. Open network control refers to the coordination of a series of signal along an arterial road. The primary emphasis is on developing a "progression" so that vehicles starting at one end can travel along the arterial without stopping. Closed network control refers to coordinating a group of traffic signals along two or more arterials that intersect. Coordination may occur among all signals in the network or control may be provided for individual groupings of signals. Area-wide system control refers to the surveillance and control of a large portion of the traffic signals in an urban area.

Appropriately designed and functioning traffic signals provide for orderly traffic movement, interrupt heavy traffic at intervals to allow pedestrians and connecting-street traffic to cross, increase the traffic-handling capacity of an intersection, reduce the frequency of accidents.

6. KEY ISSUES ASSOCIATED WITH IMPLEMENTATION OF ITS

6.1 Introduction

One of the key characteristics of the development of ITS technologies and their application to the transportation system has been a conscientious effort to adopt a customer orientation in their design. The fundamental concept in this implementation approach is to understand the needs of those who will use the technologies (or the products that are produced), and to orient the implementation to satisfy these needs.

The implementation of ITS actions often requires the participation of many different organisations and groups, with different actions exhibiting different implementation characteristic and time frames. Therefore, it is critical to integrate ITS with the regional transportation planning process which is itself designed to provide a comprehensive look at the most cost effective solutions to the transportation problems facing a community.

6.2 System Architecture

With the many different technologies involved with ITS applications, guidance is necessary to develop compatible systems and system connections. A National ITS Architecture should be established, which defines the functions that must be performed, the subsystems that provide these functions, and the information that must be exchanged to support the user services. The benefits of having a common architecture are that ITS products can be applied to markets throughout Australia, and thus reduced costs will accompany more efficient operations through economies of scale and competition. The National Architecture should have communications, transportation and institutional elements attached to it, all of which must work together for ITS to be successful.

6.3 Links Between ITS and Transportation Planning

The mobility and accessibility goals of transportation system changes were portrayed as being affected by three major categories of actions – demand management, land use, and changes to the supply of transportation. ITS as being one of the major types of action that could be considered in the process of improving the condition and performance of a region's transportation system. In reality, ITS actions can be considered as part of the solutions from many prospectives.

Importantly, when opportunities exist, ITS capability should be incorporated into the transportation infrastructure to provide the foundation for future solutions to congestion and mobility problems. The possible products from a strategic planning process might include: (JHK & Associates, Inc. 1996)

Organise the Study Effort and Establish Core Stakeholder Coalition:
- Listing of stakeholders
- Work plan and schedule
- Outreach and consensus – building plan

Develop ITS Vision
- Listing of ITS-related themes or vision statements
- Initial assessment of funding situation and implementation barriers

Define Problems, Goals, and Existing Systems
- Documentation of existing conditions related to strategic plan
- Study area map
- Listing or graphic representation of problems and opportunities

- Listing of ITS-related goals and objectives
- Documentation of existing ITS components in study area

Screen Market Packages

- Mapping of market packages against problems and goals
- (Alternate) Environmental scan of ITS elements
- (Alternate) Strengths-Weakness-Opportunities-Threats analysis
- Scan of ITS elements
- Listing of market packages to be further evaluated

Define Market Package Plan

- List of performance criteria by market package
- Analytical results of market package evaluations
- Documentation of recommended market packages by geographic area

Identify Desired Functional Capabilities

- List of potential system requirements by market package
- Functional requirements definition by sub-system and technology area

Define Regional Architecture

- Charts and decrepitation of logical, organisational, and physical architecture
- List of feasible technologies to support the market packages
- List of recommended technologies for near-term ITS program

Define Operational Strategies

- Project definitions, integrated with other transportation projects where appropriate
- Operations and maintenance plans for the ITS programs
- Potential sources of funds (implementation and operating) by project
- Potential public-private partnerships
- Implementation plan for ITS program(s)

Develop the Strategic Deployment Plan

- Strategic deployment plan, including an action plan
- Potential material for integration into transportation plan

Monitor/Evaluate the ITS Activities

- Monitoring and Evaluation Plan (could be integrated with monitoring activities of the overall planning process)
- Database designs to accommodate monitoring and evaluation data.

Importantly, integration of ITS involved numerous stakeholders and user groups throughout the planning process so that the day-today experiences of transportation users were brought into the deliberations of what priorities should be placed on ITS deployment.

6.4 Commitment, Process and Public Involvement

Tools are not very helpful if one does not know how or is unwilling to use them. One of the ways of gaining support for these actions is involve the public in the discussion and debate that precedes adoption. Some of the successful efforts at adopting transportation programs have exhibited the following characteristics:

- Waging an aggressive campaign to inform the public of what is likely to occur if something is not done.
- Clearly stating what the average citizen will gain from these actions.
- Providing opportunities for citizens and interest groups to participate in the planning and decision making process.
- Actively pursuing business support for the proposed actions.
- Seeking media support in editorials and news reporting.
- Developing a cost-effective program that appeals to as broad a political base as possible.

6.5 Summary

In summary, the goal of ITS implementation is for ITS action to be considered as part of the transportation planning process. When opportunities exist, ITS capability should be incorporated into the transportation infrastructure to provide the foundation for future solutions to congestion and mobility problems.

7. RECOMMENDATIONS

According to the discussions in previous sections, research has shown that ITS not only provides alternative solutions for urban traffic congestion, also all road users and our environment can be benefited in a safer and less polluted transportation system. Therefore, it is essential to expand the development of ITS and for the benefits to be realised. To achieve this, the following strategies and actions are recommended.

Raise Community Awareness and Government Support: The present level of awareness of the community and decision-makers of the current and potential benefits of ITS investments is low. At the same time, concerns over issues such as protection of privacy will emerge once awareness of the potential use of ITS technologies spread. Support and commitment by Federal and State Governments is key to facilitating new ITS initiatives.

Establish National ITS Program: A number of large scale and innovative ITS projects in Australia could be promoted as national showcase projects to accelerate understanding of the potential for ITS and Australia's capabilities.

In addition there is an opportunity to establish new pilot projects, which demonstrate significant safety, economic and environmental benefits. These would need to be able to address specific, high priority transport problems in a State or City, and be able to be applied more widely both in Australia and overseas.
A program of nationally selected projects would assist in raising the profile of ITS benefits and generate support for broader applications. The federal Government could therefore give consideration to establishing a "National ITS Program" which would provide support for selected projects whose scale or level of innovation warranted such support. The benefits of such a program are to:

- Raise awareness of ITS and its potential benefits;

- Focus research and development of ITS to key priority areas;
- Develop local capability;
- Accelerate deployment of ITS;
- Accelerate resolution of key issues such as standards etc; and
- Assist local firms to market their products and services overseas.

Expand ITS Capability: To compete in the market, Australia needs to capitalise on the basic technology in place and build more sophisticated and integrated systems and capability to suit local needs. Australia is well placed in the area of systems integration, but our technical capability needs to be able to develop and adapt ITS systems for our needs. An examination of the options for boosting undergraduate, technical and post-graduate training, as well as research and development in ITS is needed urgently.

Encourage Public-Private ITS Partnerships: Deployment of ITS systems is limited by budget constraints in most areas of Government, whether transport departments, road or transit agencies. Private sector involvement in many aspects of transport is increasing, such as new toll roads and operation of public transport.

Public-private partnerships provide an opportunity to pool resources to introduce ITS more rapidly than would otherwise occur. These partnerships need to address wider strategies, to ensure ITS systems developed for particular components of the transport system are inter-operable and readily capable of being inter-connected.

Develop National ITS Standards and Architecture: Nationally and internationally consistent standards are key to progressing the development of ITS in Australia. The United States, Japan and Europe have spent considerable effort in developing national architectures and standards for ITS, and in trying to get their standards adopted as international standards. As a key player in the global ITS market, Australia needs to align closely with international standards. Resolution of key national standards, within a wider international framework, will:

- Facilitate inter-operation between systems;
- Reduce costs; and
- Reduce risks for local manufacturers.

Future Directions: Modest gains in urban traffic congestion are likely to result from the deployment of current-generation traffic management systems. The major gains in improving congestion are likely to be realised when systems designed specifically to improve congestion become available. In the mean time, relatively simple ITS technologies could progressively have a major impact on urban congestion in Australia. These developments are a smart traffic signal coordinated system, a real-time traveller information device, and an automatic incident/congestion detection system.

8. CONCLUSIONS

The investigation of this study emphasises the importance of user needs and reactions to new technologies. These reactions will need careful consideration in future development and implementation of ITS. The implementation issues associated with introducing ITS into Australian urban areas are complex. Government involvement would again be required in the initial stage to promote the concept and ensure that the necessary levels of standardisation and compatibility are achieved.

In conclusion, a major opportunity exists to make significant impacts on congestion problems currently being faced on the urban road network, using intelligent transport system technologies. A national ITS program such as that recommended in this paper will enable that opportunity to be realised in full. Its main effect will be to assure Australia of a lead in world market, and a domestic transportation system optimised to meet the challenges of life in the new millennium.

REFERENCES

1. Booz Allen & Hamilton (Australia) Limited (1998), *Intelligent Transport Solutions for Australia - Technical Report*, Sydney, May 1998.

2. Bureau of Transport and Communications Economics (1996a), *Traffic Congestion and Road User Charges in Australian Capital Cities, Report 92.*

3. Cox, J, *Roads in the Community: Part 1, Are They Doing Their Job?* Austroads, 1997.

4. Crook, P., *The Implications of Intelligent Transport Systems for Road Safety*, ARRB (for Austroads), Vermont South (Vic), 1997.

5. Holmes, C., Jacob, L., Hyles, A., Benjamin, S., *e-transport - The National Strategy for Intelligent Transport Systems,* Austroads Inc., 1999.

6. JHK & Associates, Inc. 1996, *Integrating ITS With the Transportation Planning Process: An Interim Handbook, Federal Highway Administration*, draft, December.

7. Meyer, DM (1997), *A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers*, Georgia, 1997.