Role of Intelligent Transport Systems (ITS) in Providing Sustainable Transport and Environmental Solutions

Neil Perks BSC MIHT MAPM, ITS and Transport Planning Development Manager – Transportation, AECOM

14/f, Southern Securities Building, 2016 Jianshe Road, Luohu District, Shenzhen, China
Mobile +86 13923700274, Tel +86 (0) 755 82215675, Fax +86 (0) 755 82215463
E-mail neil.perks@aecom.com

Within the sphere of engineering science, computer and microprocessor technology is playing an ever-increasing role. This is nowhere more apparent than in the fields of vehicle, transport and traffic management, where new technology and innovation develop at an ever-increasing pace.

Intelligent Transport Systems have, and will continue to, embrace "state of the art" technology with the aim of providing sustainable solutions in the transport and environmental sectors, whether this is on road, rail or air or even outside the transport sphere altogether.

By utilizing innovative technologies/techniques in such areas as integrated software management, wireless communications, data information and dynamic operational systems it is possible to design and implement a stand-alone transport system which can reduce the environmental impact of transport and encourage the modal shift from private to public transport.

Intelligent Transport Systems are, by their very nature, sustainable in form; usually providing electronic solutions to replace or reduce the need for major infrastructure works. They can be used to unobtrusively implement local policy objectives, whether they be aimed at maximising the road space or restricting access to the existing road space and are flexible and adaptable to the changing environment. They can provide "stand alone" solutions or work harmoniously with other forms of planning and engineering to enhance the environment and improve the quality of life.

This presentation looks at the transport issues prevalent on todays highway network and seeks to show how Intelligent Transport Systems can be utilised, as a tool, to address these issues and promote sustainable solutions. It also looks at a number of real world case studies to highlight the real benefits of Intelligent Transport Systems in the public transport sector.

There are many problems on the current road network, generally caused by high traffic flows, poor management and substandard alternatives. This leads to:

- Traffic Delay and Congestion

- Deterioration in Transport Services

- Accidents

- Pollution

- Environment

- Frustration and Stress

There are a number of potential solutions to these issues, and all can be utilised in the appropriate situation, but generally a solution will embrace a number of these. Potential solutions include:

- Building more roads

- Improving existing road network

- Public transport improvements

- Quality bus implementation

- Forcing modal shift

- Implementing traffic management measures

- Intelligent Transport Systems

Intelligent Transport Systems can be used in a number of situations, and can be used either alone, or to enhance other solutions, often minimising the environmental impact.

So what are Intelligent Transport Systems?

A reasonable definition would be:

The application of computer and communications technology for the improvement in efficiency and safety of the transport network.

Although we talk about "Systems", probably a better way to think about the term "ITS" is as Intelligent Transport Solutions !!!

So what do Intelligent Transport Solutions provide?

- A Tool for effective traffic management, transport, planning, architecture, mining, aviation and anything else you can think of

- Technology which is complimentary to conventional traffic management

- Environmentally friendly and sustainable solutions

- Extremely cost effective solutions

- Flexible and adaptable solutions

- Wide ranging applications

- Rapid technological advancement

- A tool with infinite possibilities

Within the transport arena they:

- Provide cost effective, flexible and sustainable solutions

- Enhance the safety of the transport network

- Maximise effectiveness and efficiency

- Enable the realisation of policy objectives

- Are part of a comprehensive transport solution

- Provide integrated transport solutions

So given that they can be used to assist in solving transport problems on the highway network, what sort of benefits do they actually bring. Below are some typical quotes from post implementation studies when assessing the benefits of Intelligent Transport Solutions.

- **Parking Guidance System** "reduced the average time spent searching for a space by 50%"

- **Controlled Motorways** - "sustained reduction in injury accidents of 28%"

- **Public Transport Information Systems** - A "20% increase in patronage in first 12 months"

- **Dynamic Urban Traffic Control** – "15-48% reduction in delay"

- **Urban Corridor improvement** – A "27% increase in traffic capacity within existing highway boundaries"

- **Dynamic Bus Bay Allocation System** "Bus station land take reduced by 50%"

- **Ramp Metering** – "Journey Times reduced by 9%"

- **Incident Detection** – "Response time reduced by 80%, annual saving of 24 Million vehicle hours"

- **Motorway Speed Management** – "30% reduction in Accidents", "15% increase in capacity"

These are just a few of the benefits which can be accrued through the use of technology throughout the transport network.

Now we will look more specifically at the issue of public transport.
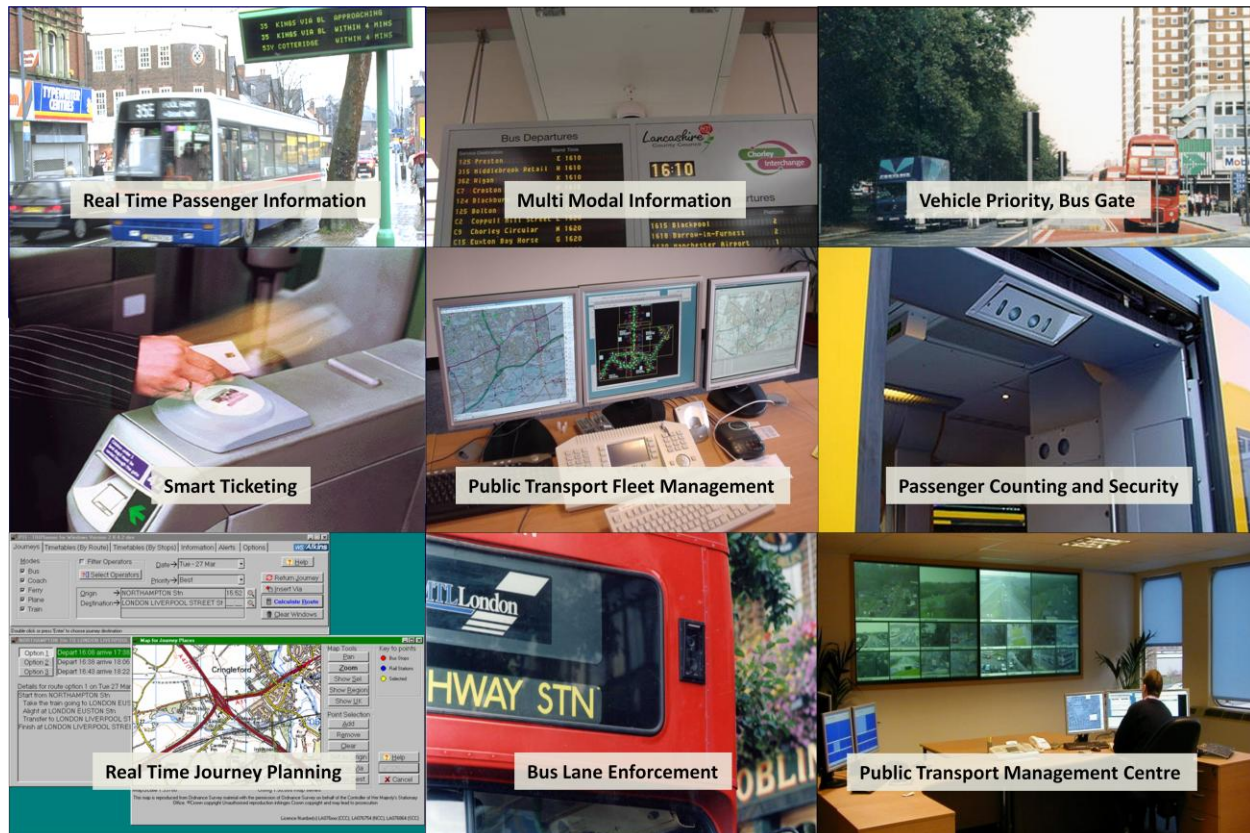
Intelligent Transport Solutions can be used in a multitude of ways as shown in the diagram above; they are used to improve the safety and management of the public transport service, enhance the passenger experience, provide important planning information and improve the operation of the bus fleet by improving reliability and punctuality.

Intelligent Transport Solutions have a major role to play in improving the customer experience and enabling the successful implementation of public transport networks of all transport modes through the provision of a seamless journey experience at transport hubs.

However, in order to maximise the effectiveness of any public transport network we cannot simply operate in isolation from other transport modes; attempting to do this simply leads to more problems for the transport network. What is required is to develop an integrated transport network which will provide the benefits for public transport without causing other forms of transport to impact upon its operation.

So how do we enable this?

What is required is to implement an integrated transport network where all the systems communicate with each other to maximise their effectiveness on the road network. This can be fully controllable by the transport authority to ensure that maximum benefit accrues where it is required.

As an example of this we can look at a typical situation in gaining access to a major city and how, by providing real time information to the motorist, we can influence the use of public and private transport:

Problem:-

A major corridor into the town or city centre is frequently congested, causing long delays to local and long distance traffic.   In order to alleviate the situation local bus priority measures, including bus lanes, have been implemented and a park and ride site located at the entry to the built up area. However traffic continues to pass the park and ride site before reaching the back of the traffic queue, resulting in insignificant mode transfer, and minimal improvement to the on-street traffic and environmental conditions.

Solution:-

Information from a bus passenger information system (RTPI) can be used to estimate bus journey times from the Park and Ride site to the town centre. This information can be displayed on a Variable Message Sign (VMS) located prior to the Park and Ride site. An estimated time for the same journey by car can be ascertained from the Urban Traffic Control (UTC) database. This information can be combined with standard RTPI system and Car Parking Management system Information at the Park and Ride site to persuade motorists to use this facility. The VMS message may look something like the following, with the system derived information shown in bold:-

<div style="background:#0000AA; color:white; text-align:center; width:45%; margin:auto; padding:1em;">

To City Centre

Bus	**10 minutes**
Car	**27 minutes**
Park and Ride	**47 Spaces**
Next Bus	**02 minutes**

</div>

Thus by combining the technologies of:

- Urban Traffic Control
- Real Time Passenger Information
- Car Parking Management and Information
- Variable Message Signing

we have provided meaningful information to the motorist which can assist in achieving the strategic aims of improving the environment and encouraging a mode transfer from car to public transport.

Although this is currently related to transport there is no reason in the future why other areas affecting transport such as weather information and bridge strength measurements should not be included, allowing further automated integration. As the network only specifies an interface it is capable of exchanging any information from whatever source

Having discussed how we can use Intelligent Transport Solutions to improve the transport network, the same technologies and solutions can be used in different disciplines to improve the overall environment, whether through direct responsiveness of the technology or by thinking about the transport element of a city or area at the earliest stages of development. Intelligent Transport Solutions are equally as applicable in industry, ports, rail and airports to name just a few.

Below I have listed a few areas where Intelligent Transport Solutions can be applied for the benefit of the environment and assist in providing sustainable solutions

ITS in City Planning

- Reduced junction land requirements
- Reduced road width land requirements
- Reduced transport interchange size requirements
- Meeting policy objectives
- Improved public transport
- Enhanced living environment
- Accident reduction
- Improved development image

ITS in Environmental

- Reduced pollution levels
- Dynamic environmental monitoring
- Integrated monitoring/management applications
- Activating environmental policy objectives
- Environmental based transport plans
- Modal shift implementation
- Generally environmentally unobtrusive
- Reduction in environmentally unfriendly solutions

ITS in Sustainability

- Improvements in the public transport network
- Extend the life of new or existing infrastructure
- Reduced energy consumption
- Reduced pollution levels

- Improve the living environment
- Managed transport policies
- Reduced land requirements
- Reduced accidents
- Environmentally unobtrusive
- Minimal redundancy or environmental impact

Now we will look at a number of examples where the use of Intelligent Transport Solutions have substantially enhanced the operation of public transport and the associated environment, providing truly sustainable solutions.

Wolverhampton Interchange

This is a major regeneration project in the city of Wolverhampton in the UK; the aim of the project being to provide:

- New rail station works replacing tired 1960's architecture
- New Highway infrastructure to improve access
- Replacement of old bus/coach station
- New Light Rail line
- A seamless journey experience between transport modes of Rail, Bus, Metro, Car and Taxi

The overall aim of the Authority was to provide a gateway that the city could be proud of. This was reiterated at the project outset with the statement:

"If people can't tell where they are going, we've failed!"

To meet the requirements a real-time information network was designed which allowed passengers to seamlessly travel between modes. This was achieved through designing an interchange network around the following concepts and requirements:

- information concept based around three information halls: Bus, Tram and Rail
- an interchange system which has a wide range of integrated multimodal information on display
- in the central hall live traffic information is available
- indicators give more information about the mode you are approaching
- interchange is Wi-Fi enabled – real time updates can be sent to mobiles
- information available includes:
  - Real time bus, train, tram arrivals
  - Real time journey planners
  - Real time road traffic conditions
  - Personal real time trip planning
  - Multi-modal fare comparison
  - Guidance between modes

- user reassurance is essential
- consistency of message is essential
- not forgetting the reassurance provided by the human interface

Perth Dynamic Bus Bay Allocation

The city of Perth in Australia is in the process of redeveloping the existing surface bus/rail station to improve the operation and management of its public transport services.

In order to improve the environment for passengers and enable the optimum use of bus services the authority decided to implement an underground bus station which allowed for the creation of public amenities and open space on the surface.

In order to develop this concept, integrated technology was employed to managed the sub surface operation in terms of safety, security, operations and management. Overall over 20 Intelligent Transport Solutions have been developed and integrated, the key being and automated bus bay allocation system which will dynamically allocated incoming buses to a bus bay. Through using this system they were able to reduce land take requirements by over 50%.

A block diagram showing the system layout is shown below.

Bus Bay Allocation System Block Diagram
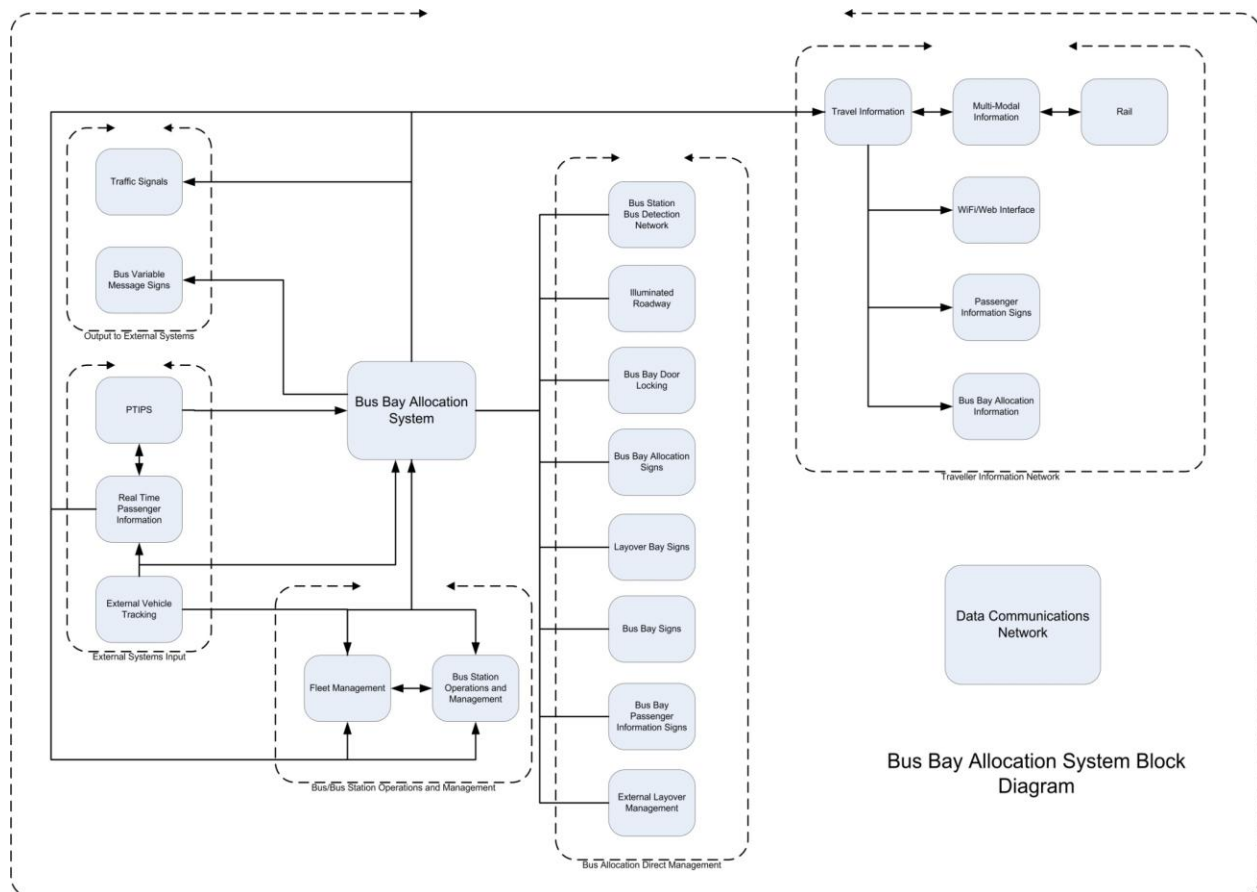
The system itself is linked to all the other systems within the bus station and to the surrounding existing traffic management systems, providing a truly integrated experience.

The Quality Journey "Experience"

Taking a bus journey is more than just a bus ride and requires 4 unique elements:

- Walk to the Bus
- Wait for the Bus
- Bus Journey
- Walk to Destination

If you are to attract people from private to public transport you must address the complete experience. Additionally you must consider the following aspects of the public perception of a public transport journey. Would you like to stand in the rain, walk through an unlit street, wait in muddy ground or stand next to people not of your choosing?

If you are looking to attract people to the bus you have to provide an attractive experience; it may take you 30 more minutes by car, but it's your own space, your own music, and passengers of your choosing. To provide a really attractive bus service you need to consider a number of factors, but particularly:

- Environment
- Accessibility
- Security
- Reliability
- Information

An Integrated Solution such as this requires the implementation of a number of measures in which Intelligent Transport Solutions can provide a major role.

If you are seeking to attract people from cars, then targeting an upper class region would be the best solution, as the room for increased ridership from the poorer areas is limited; this, of course might not sit well with social objectives. An example of this is where Beijing decreased the fare for the subway and succeeded in attracting many previous pedestrians and bus users, but in the process, due to the resultant overcrowding, discouraged many car owners who reverted back to cars, thus actually making the situation worse. So it's not just about attracting more people to public transport, but ensuring it's the right kind of people getting the right kind of experience.

What do we need to do?

- Improve the environment
- Improve accessibility

- Increase service quality through
    - Better buses
    - Staff training
    - Provide and enhance bus shelters
    - Punctuality
- Give a brand identity
- Proactive service promotion
- Provide bus priority and information

An example of this occurred in Ipswich, in the UK, where a major package of measures was applied to a targeted route of car users and the ridership was seen to double within 2 years.

A number of technology measures were implemented including:

- Bus priority
- Real Time Passenger Information (RTPI)
- CCTV security measures
- Fleet management systems

Which all contributed to the success of the project.

One interesting point was that a week after the RTPI system was implemented, people were asked about whether the bus service was improved. Well over 90% felt the service was much better. In reality the service had not changed as some of the systems had not yet been brought on-line, buses were still late. The reason was that there was now real time information on bus arrivals at the stops and people didn't care if the bus was late as long as they knew when it was coming !!!

A typical block diagram of an RTPI system is shown below:
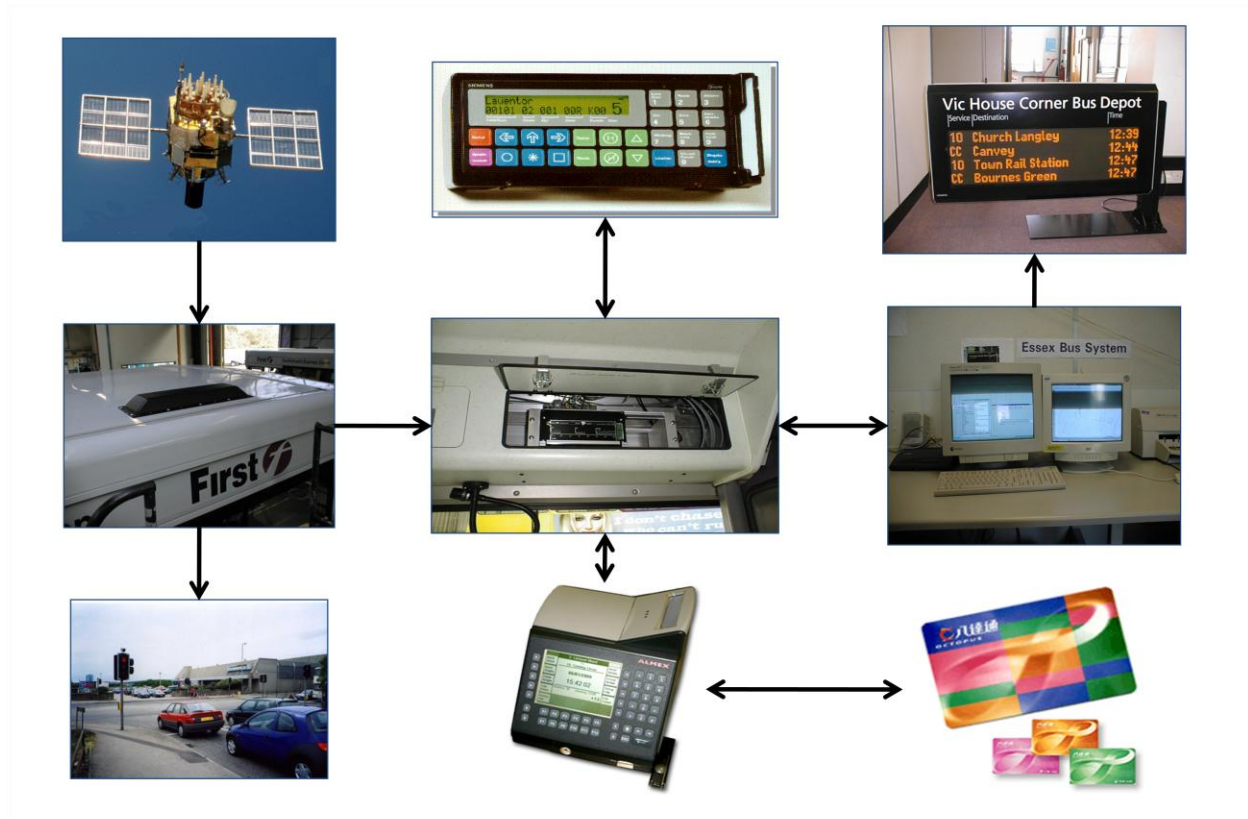
This system was key in the success of the Ipswich project improving the perception of reliability, safety and security, simply through providing real time information. People may not have liked some of the information, but at least they knew the situation.

Case Study : Octopus (Hong Kong)

In 1997 Hong Kong implemented a smart ticketing system to provide a faster and more convenient public transport system. The card, named Octopus is a plastic smart card about the size of a credit card, with an embedded microchip that can be loaded with data, used for transport, telephone calling, electronic cash payments, and other applications, and then periodically refreshed for additional use.

The Multipurpose Octopus Processor is composed of two units: Main Unit (MU) and Remote Unit (RU). The operator can use RU to select route and change fare during difference stages of the journey. Passengers can select sectional fare and deduct payment at MU. Other Terminals are available for specific purposes.

The Octopus journey to a truly integrated ticketing system:

Year	Expansion of Application
1997	The Octopus cards were launched firstly across six public transport systems, with three million cards being sold in the first three months after the launch.
1999	The Octopus reloading service was extended to retail shops. The Octopus Automatic Add-Value Service (AAVS) through banks was launched. The Octopus service was introduced onto maxicabs.
2000	Obtained Deposit-Taking Company authorization from the Monetary Authority of Hong Kong. Non-transport businesses started to accept Octopus services.
2001	Octopus services were extended to trams, Peak Tram, convenience stores, photocopying centres, public swimming pools, sporting venues, etc.
2002	Octopus services were extended to supermarkets, personal care stores, cross-border buses, etc.
2003	Octopus services were extended to exhibition and convention registration, household outlets, Government parking meters, etc.
2004	Octopus services were extended to wet markets.
2006	Octopus card was accepted by all outlets of Fairwood Fast Food in Hong Kong. Users of Octopus AAVS could increase the reload value of their Octopus cards from HK$250 to HK$500. Octopus card was first accepted by 20 Yellow Taxis operated bythe Yellow Taxi Group Limited. Octopus card was introduced to Shenzhen and Macau in some fast food shops.

Octopus Card Deployment

Typically initiated within the mass transit ticket systems, due to their quick transaction speeds, they have successfully enabled an electronic product to replace many small value cash transactions. With 12 million cards in use, the Octopus card system processes 8.7 million transactions per day, at an value of HK$7. On average, an Octopus card has a stored balance of HK$65.

In 2004, 78 percent of Octopus revenue was derived from transport, with 20 percent of revenue derived from retail purchases. This figure is expected to rise closer to 40 percent by 2013, since there are more retail purchases and Point-of-Sale being brought on line.

Octopus Stakeholder Benefits

Stakeholders	Advantages
Consumer	Easy Transit payment Single card for transit and retail payment Speed and convenience of contactless retail payment Perceived decrease in cost for purchases Easier payment than cash
Retailer	Potential for increased sales from increased use of card and increased transaction value Faster transactions Savings from cash replacement
Transit Agency	Increase ridership increased number of transactions Potential for increased revenue from retail transaction fees Faster transactions Cash replacement
Bank	Decrease handling of cash transactions All transactions are carried out electronically

Having discussed the current benefits of Intelligent Transport Solutions, what does the future hold? The interesting thing is that technology never stands still (witness the development of the personal computer); and likewise Intelligent Transport Solutions will continue to develop into ever more efficient, safe, innovative, effective, complex (and simple!!) and cheaper solutions.

Like a personal computer, the question is "Should you invest now" or wait for next year's better model?

Well, next year's model will always be better, but with Intelligent Transport Solutions the standard solution you buy today can be upgradable tomorrow, or whenever you want to upgrade. Bear in mind that Intelligent Transport Solutions are principally electronics and software, so you are not tied forever; it's easy to improve, or amend, to meet changing needs and requirements.

To summarise Intelligent Transport Solutions are:

- Extremely cost effective – compared to alternative solutions
- Flexible – if it doesn't operate quite how you wanted just amend it
- Upgradable – you want the latest, just upgrade, don't throw away
- Expandable – with minimal redundancy (buy basic, expand tomorrow)
- Environmentally friendly – most solutions are unobtrusive, or not seen at all !!
- A Tool – they can be used in isolation or compliment other traditional solutions

- Provide a flexible transport strategy – based upon fluctuating local and national policy objectives
- There are no boundaries with Intelligent Transport Solutions – only your imagination