25-YEAR INTEGRATED TRANSPORT MASTER PLAN
Annexure K: Intelligent Transport Systems

November 2013

Final
GAUTENG INTEGRATED TRANSPORT MASTER PLAN (ITMP25)
INTELLIGENT TRANSPORT SYSTEMS PLAN

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1. BACKGROUND

Transportation plays a critical role in the whole of the South African economy, contributing to poverty reduction by enabling the productive activities that create effective economic growth, and by providing poor people with access to economic opportunities and social services, and a means of participating fully in society. A Gauteng ITS Plan assist with the planning, funding and deployment of ITS technology which will facilitate the integration of transportation systems and promote best possible utilisation of existing and future transportation networks.

This ITS Plan is the contribution of the ITS work stream, but has a close relationship with five other work streams, namely:
- Travel Demand Management (TDM)
- Public Transport Planning (in particular, Public Transport Information)
- Non-Motorised Transport (NMT)
- Freight Logistics
- Environment

1.1 Purpose of this Document

This document forms part of the 25-Year Integrated Transport Master Plan (ITMP25), providing a strategic ITS outlook in response to the needs of the transportation stakeholders, in both the public and private sectors.

The document sets out the role of ITS in supporting delivery of Gauteng Province transport objectives, including a number of recommended actions by the Gauteng Department of Roads and Transport (GDRT). However the GDRT cannot deliver the benefits of ITS in isolation and this document highlights a co-ordinated approach and emphasizes the need for collaboration among different authorities and spheres of government.

While the focus of this document is on a 25 year plan a short term 5 year implementation plan is described, which highlights a number of quick-win deliverables.

This document examines the status quo of ITS deployment in Gauteng. This review is done at the hand of user needs which relate to different ITS solutions. Integration between new and existing systems is also contemplated.

Finally the document highlights appropriate actions so as to yield an Implementation Plan.
1.2 Purpose of the ITS Plan

"We cannot solve problems with the same thinking we had when we created the problems."
Albert Einstein

A strategic plan is the result of planning activity of an organisation in which the top level management’s role is most critical, as opposed to planning done at lower levels, which is more operational in nature. Strategic planning focuses on doing the right things (effectiveness) while operational planning focuses on doing things right (efficiency).

The strategic Plan is also the active formulation of a strategy, providing:
- a statement that guides a set of activities, which are aligned with the mission, in order to achieve the overall vision
- a description of the business at hand
- direction
- a final resolution requiring continual review but not sweeping changes
- a tool for long term planning.

But, while these statements give a general introduction, which assists in preparing a strategy, they don’t describe a complete change from “business as usual”. For a Gauteng ITS Plan to be innovative and effectively direct the deployment of ITS in Gauteng, it must reflect on the following 3 critical issues:
1. What is the most serious challenge facing the successful deployment of ITS in Gauteng?
2. What strategy would overcome this challenge?
3. What set of coordinated actions are required to implement this strategy?

Technology plays an indispensable role in society and provides for many opportunities to support and enhance the quality of the eventual Integrated Transport Master Plan. Intelligent Transportation Systems have been deployed in most of the major international metropolitan areas for a few decades, and the benefits of these ITS deployments are well documented. Many ITS installations have seen the light in the larger Gauteng area, including technology applications on public transport systems as well as freeway management systems.

However, it is imperative that the focus is not technology specific but rather on functionality and that a framework be established for the effective deployment of technology in the transportation environment. Hence the need for a provincial ITS Strategic Framework.

This ITS Plan is intended to guide technology deployment in a way that minimises risk for the implementation agency, as well as providing maximum integration opportunities with other systems. It is therefore the first step in the development of an ITS Implementation plan, as depicted in Figure 1 below.
1.3 Introduction to Intelligent Transport Systems (ITS)

ITS refers to transport technology applications which provide a variety of tools to better manage transportation infrastructure.

Intelligent Transportation Systems (ITS) apply various technologies, such as communications, computers and information processing, storage and dissemination, to improve the efficiency and safety of transportation systems and to reduce the harmful effects on the environment. It includes such features as improved traffic management, reliable traveller information, improved incident management and response, and more accessible and reliable public transport. Consequently it is a field that is characterized by multi-modal, multidisciplinary, multi-agency, and multi-jurisdictional involvement. Systems integration ensures that these systems and other diverse technology components operate seamlessly together.

Until recently, the building and improvement of transportation infrastructure meant the civil and mechanical construction or expansion of roads, bridges and tunnels, as well as the associated enterprises that provide the vehicles (including public and private transit agencies, trucking, public safety and personal) that travel on the infrastructure. Now, as travel demand steadily increases and the opportunities to build new infrastructure becomes prohibitively expensive because of the high costs and limited resources (including land space), the use of ITS technologies to enhance the effectiveness of existing transport infrastructure and improve operational efficiency of transportation systems becomes increasingly important.
This makes the deployment of ITS technologies to manage the existing transportation network an attractive alternative. ITS provides improvement in traffic management and enforcement, driver assistance technologies, navigation aids, freight management dispatch systems, information for multi-modal commuters, emergency response systems and environmental management. This not only affords users significant reductions in travel costs and time, but saves lives through improved travel safety.

Depending on the application, ITS addresses the need to monitor and react to traffic conditions or to relay traffic related information from the street to the motoring public, commuters or traffic authorities. Whereas traffic related ITS deals mainly with traffic management, enforcement and toll collection, public transport related ITS aims to provide more comfortable, safe and reliable travel to passengers using the service.

As one component of a larger mobility program, ITS refers to the application of data processing, data communications, and systems engineering methodologies with the purpose of improved management, safety and efficiency of the surface transportation network. These ITS technological and management advances can address the following: the overall mobility needs of the region, the travel requirements of transportation network users, and the development, operation, management and maintenance needs of the transportation system providers, both public and private.

ITS provides agencies and their customers a means to address current urban problems, as well as anticipate and address future demand through an intermodal, strategic approach to transportation. The application of ITS allows transport agencies to use modern technologies to better monitor their systems, providing the agencies with more accurate information to make informed decisions on safely operating their systems. ITS also allows agencies to distribute this information to the public, so the public can make smarter travel choices.

Identifying the costs and benefits of ITS deployment is something of a challenge and recent developments in forming worldwide groups to increase the knowledge base in this area have to be applauded. Many investments have occurred with little or no evaluation of their benefits after installation. Many of the benefits of ITS (e.g. safety and security of passengers and drivers, improved driver experience, increased peace of mind, customer satisfaction and trust in travel etc.) have no clear monetary value and hence are often overlooked in assessments. It is important that these benefits are included in evaluations and business cases.

However, through technology, there are areas where real benefit can be measured, such as:

- Public transport vehicle fleet reduction
- Improved travel time on the road network as well as Public Transport systems
- degree of schedule adherence of Public Transport vehicles
- accurate and simplified communication of major mechanical / diagnostic information and travel information on Public Transport, road infrastructure (including traffic signals) and traffic conditions.
- Passengers per kilometre and per hour can be measured through satellite tracking of vehicles and the tap-on / tap-off process associated with EFC, to determine cost effectiveness of the service as well as the most viable routes
- Traffic management systems: sample of vehicles can be monitored to compared modelled delays with actual measurements and determine the real value of traffic management strategies
- improved customer service, with feedback on effectiveness of travel information for passengers to make correct modal choices
The International Benefits, Evaluation and Costs (IBEC) Working Group is a cooperative working group set up to coordinate and expand international efforts, to exchange information and techniques, and evaluate benefits and costs of Intelligent Transportation Systems (ITS). Its work covers a range of important evaluation, cost benefit, and performance management strategies that are designed to encourage and support ITS decision makers to make better informed ITS investments. ITS benefit figures shown in this document have been obtained from the IBEC documentation.

1.4 Problem Statement & Issues

The implementation of ITS is often seen as the panacea to many a transportation problem. However, to ensure that ITS solutions are sustainable and efficient, they need to be implemented holistically – with due consideration given to the three areas to be addressed in an integrated manner i.e. operational, institutional and technical. These areas are further elucidated in the figure below.

![Diagram showing operational, institutional, and technical issues]

- **OPERATIONAL**
  - Traffic congestion
  - Public transport operations inefficiencies
  - Lack of travel information
  - Lack of schedule integration
  - Lack of integrated payment systems
  - Vehicle overloading
    - **ISSUE:** Improve operational integration i.e. data dissemination, congruent processes, etc.

- **INSTITUTIONAL**
  - Lack of coordination
  - Lack of institutional arrangements
  - Lack of appropriate skills
    - **ISSUE:** Establish a functional and a credible institutional framework model to improve relational and systems integration efficiency

- **TECHNICAL**
  - Incompatible systems
  - Lack of awareness of ITS technology
  - Lack of standards
  - Vendor driven solutions - propriety systems
    - **ISSUE:** Vendor driven (technology) solutions in stead of systems driven solutions supported by the appropriate technology.
1.5 Role of the Gauteng Department of Roads and Transport (GDRT)

This ITS Plan identifies specific actions that the GDRT has to take to support ITS development and delivery in each policy theme and across the themes in an integrated way. The actions reflect the breadth of its own role, which is set out below:

- **Lead by example**, as a major procurer of ITS technologies and services (through its Agencies), including through direct management of the strategic road network, demonstrations and trials
- **Facilitate and encourage the take-up of proven ITS technologies**, for example by securing the availability of key databases, and more general dissemination of best practice and other guidance
- **Encourage appropriate standards** as an important enabling mechanism to achieve interoperability of technological solutions (for seamless journeys and consistency in information provision)
- **Promote innovation** by researching the potential of new ITS technologies, supporting DTI-led activities, and by monitoring state of the art technologies to identify and understand the policy delivery potential they may offer
- **Promote and enable better regulation**. Government is committed to achieving better regulation, both from the perspective of tackling existing regulatory barriers and ensuring new ones are not introduced. International and South African regulatory frameworks govern only parts of ITS, such as the recent regulations on interoperability of electronic fee collection
- **Influence the policy agenda at local and international levels** by using South African knowledge and expertise
- **Learn from international experience** and apply that knowledge across its activities;
- **Work in partnership**. This is key to success at every level. Working in partnership can be formal (for example when procuring ITS technologies, carrying out research or consulting on regulatory changes). Informal collaboration, including networking activities such as through ITS South Africa, is equally important. Both help to identify barriers and concerns, improve understanding and generate opportunities.
- **Through all of the above**, help to foster an economically successful South African ITS industry and support South African economic growth.
2. ITS FUNCTIONAL AREAS

ITS technologies play a pivotal role for the transport sector and travellers when deployed in the seven ITS functional areas described below:

2.1 Improving road network management

Congestion is an increasing problem across the world and the resulting delays may be caused by volume of traffic, road works or accidents and incidents such as broken down vehicles or abnormal load movements. A major impact is that it causes journey times to be unpredictable and this uncertainty can lead to travellers allowing unnecessarily for exceptional delays in their journey planning.

ITS technology can assist in mitigating congestion and improve network management, in particular:

- Providing the tools and techniques to measure congestion
- Providing systems to manage the existing road network better through in-vehicle systems and the infrastructure
- Supporting delivery of real-time traffic and traveller information
- Providing the means to implement road pricing mechanisms; and
- Increasing capacity of the existing road network.

The following ITS functions form the backbone of an effective road network management system:

2.1.1 Network Monitoring

Congested traffic conditions are often accompanied by a high incidence of rear-end and / or side swipe collisions due to the prevalence of slow moving, stop-and-go traffic. The traffic management techniques associated with ITS can help to reduce the number of collisions in two ways, by:

- improving operational efficiency and reducing congestion, which reduces overall collisions and improves safety.
- clearing incidents as soon as possible and informing motorists of traffic conditions ahead, thereby reducing the likelihood of secondary collisions occurring in the congested traffic stream.

Network monitoring requires that monitoring devices be installed in strategic locations throughout the transportation network to measure and record traffic flow, travel times, accidents and other security incidents, monitor ITS field equipment as well as the effect of traffic congestion on the environment. The detectors and cameras should be connected to a Traffic Management Centre (TMC) where data can be stored and images viewed. The vehicle detectors could be used to automatically select traffic signal timings (real-time traffic responsive control) and to detect incidents on the expressways. Environmental sensors should also be installed to monitor the impact of traffic conditions on air quality.

Network monitoring provides quantitative data from field detectors and qualitative data from video cameras. The use of temporary / portable CCTV equipment (using wireless communications) is important for those locations not adjacent to fibre optic network.

This multi-functional tool can significantly enhance the potential of an area by providing many positive benefits to road users at the selected sites:
• major incidents and congestion are effectively monitored and managed. Rapid and accurate incident detection can provide significant reductions in delays due to incidents. In addition, the chances of secondary incidents or accidents occurring are reduced, providing significant improvements to road safety.
• rapid overview of network conditions provides up-to-the-minute information for traffic management services and the road users via the media.
• CCTV cameras support traffic management from the Traffic Management Centre, with online updating of signal timings in response to unforeseen events or incidents on the network (such as breakdowns and accidents).
• the system can be used for automated law enforcement
• surveillance at public transport stops and facilities as well as along the routes will assist in creating a safe and secure environment.

The results of the monitoring process must then be disseminated to the motoring public and the agencies that manage the transportation network, as appropriate. The information will enable transportation agencies to plan and respond to increased demand, traffic delays and congestion, incidents, special events, road works and diversions as well as provide information on problems, network status and alternative routing options to the travelling public.

2.1.2 Freeway Management
A Freeway Management System (FMS) comprises a number of integrated ITS elements in order to identify and respond to a freeway incident timeously, remove the injured to safety and direct further traffic away from the affected area, Key FMS field elements include:
• Freeway monitoring via Closed-circuit television (CCTV) cameras;
• Communications System
• Incident detection system
• Electronic Message Signs
• Ramp meters (to throttle the traffic flow from the on-ramp to a congested section of freeway, if necessary).

A regional Traffic Management Centre (TMC) was commissioned more than three years ago in Gauteng, aimed at managing the regional freeway system. Subsequently, the National Minister has requested similar systems to be rolled out the Cape Town and eThekwini Metropolitan Regions. These systems are largely in place and will soon be further extended through the award of a National Contract for managing these systems. These regional TMC’s are key supporting tools providing ITS enabled information services that bring together all the national and local network management authorities. They gather real time information on road network conditions from a communications network, which includes the regional TMC’s, data from various traffic detectors, cameras, as well as information from Police and Traffic Officers. The data collected is being made widely available to support network management and travel information services.

Incident management systems that help to respond to incidents more quickly and reduce incident-related delay may also lead to reductions in the number of collisions by as much as 10 to 50% during peak traffic periods.
2.1.3 **Transportation Management Centre (TMC)**
A Transportation Management Centre (TMC) provides CCTV monitoring of traffic conditions as well as automatic fault reporting from traffic signal controllers, all of which improves response time to faulty traffic signals which reduces the possibility of congestion and improves safety (particularly for pedestrians) by reducing downtime of traffic signals. CCTV can also be used to monitor assets on the street and assist in their timely repair and maintenance (such as manhole covers, street signs etc.) which further improves public safety.

Active and co-ordinated management of large area networks is a key step in tackling congestion. Most traffic authorities feature a large TMC as the hub of all the traffic management activities within their jurisdiction, to control and coordinate the activities of all participants in the traffic management process. The concept of a “virtual” TMC applies a decentralised approach that provides information at remote locations where it is needed, usually in the form of more manageable workstation displays that can be customised to the operator’s requirements. It is thus not necessary for all participating agencies to relocate staff to a central location, as information stored on database servers can be accessed from remotely workstations. Eg. maintenance crews could retrieve maintenance history & inventory data remotely to provide a more effective service with shorter incident response times.

2.1.4 **Urban Traffic Management and Control (UTMC)**
At a more local level, Urban Traffic Management and Control (UTMC) activities build on the use of various traffic management tools (such as SCOOT and SCATS). Cutting edge ITS technology is available to detect both vehicles and pedestrians and to communicate this information to the TMC in order to control the traffic signals and manage traffic flow.

2.1.5 **Traffic Demand Management (TDM)**
The ever increasing demand for road space has required road authorities to seek innovative ways to maximise the use of existing infrastructure and more proactively manage demand before congestion occurs. When a road is at or near its capacity it may be necessary to boost the traffic management and information provision effort with active demand management, through measures such as:

- congestion charging
- road user pricing
- ramp metering (at freeway on-ramps)
- traffic signal optimisation / co-ordination
- HOV lanes / priority at traffic signals

Other measures that are enabled by ITS applications are:

- modal shift (by improving public transport and passenger related information)
- ride sharing
- flexible working hours (or working from home)

Traffic Demand Management is essentially an ITS strategy to increase overall transport network efficiency by encouraging a shift from single occupant vehicle trips or shifting vehicle trips out of peak periods.
Traffic demand management ITS tools, such as road user / congestion charging, can only be effective in reducing private vehicle travel if there is a viable alternative mode, such as a safe and reliable public transport system. As long as the perceived inconvenience of public transport persists, the majority of motorists will prefer to use their car regardless of any form of penalty imposed. Electronic means of charging (such as electronic toll collection) minimise the disruption to traffic flow but these introduce enforcement issues requiring identification and tracing the vehicle / driver.

2.1.6 Parking Management

Metropolitan Councils are responsible for the supply, maintenance and operation of public parking within the city, to assist the public in their daily business. Kerbside parking within CBD’s is to facilitate short-term parking within short distances of places of business; medium term parking and long term parking will be accommodated at progressively further distances. People requiring all-day parking should be accommodated in parking areas at the fringes of the CBD. This differentiation is normally achieved by appropriate time limits and payment structures.

One of the most efficient ways to encourage more efficient use of existing parking facilities is to operate a parking management system, charging suitably high parking fees. This encourages most long term parkers to park in further away less expensive parking, leaving the nearby parking available for short term parkers. An effective parking management system must also address the problem of so-called “informal parking attendants” who generally provide an unpleasant experience for parkers and facilitate crime.

Car park utilisation counters linked to a TMC can monitor parking availability and record the location of parking spaces. This information could be displayed on electronic signs or relayed to the in-vehicle telematics systems, to reduce the time spent in traffic by motorists searching for parking as well as the resulting CO² emissions.

Roadside equipment and interfaces are required to support central parking management systems, including hardware to interface to existing parking lot management systems and special purpose electronic signage. The central management functions would be provided through the integrated control functions of the TMC or a dedicated back office facility. This back office would handle all customer related queries, overall system administration and reporting functions but depending on how the contract is structured, the responsibility for the daily operational management of the parking areas would be the responsibility the allocated service provider. As such the Fare Media Validators (FMV’s) and parking fee collection and validation equipment can be sourced from more than one supplier and therefore interoperability must be demonstrated to the satisfaction of transport authority during the testing phase.

2.1.6.1 Parking Management Back Office

The back office and associated equipment is the heart of a parking management system and provides the following critical components:

- Call centre: which handles all calls relating to parking management, faults and maintenance issues including such calls diverted to them via the TMC.
- Back Office staff (including administration)
- Reporting functionality (generating reports relating to parking)
2.1.6.2 Parking Payment
Cash payment is to be discouraged and electronic fee payment is preferred, using dual interface, contactless, bank issued fare payment media which can be integrated with fare payment on different modes of public transport. These cards must comply with the National EFC Regulations and function on the principle of pre-authorised debit.

Kerbside parking can be processed by means of EMV certified mobile handheld Fare Media Validators (FMVs) to accommodate the bank issued fare payment media described above. The FMVs are GPS equipped and will update the parking record on the smartcard with location (co-ordinates) and date/time stamp information. Use of the mobile FMV’s enables parking to be serviced by parking attendants in an orderly manner with reduced opportunity for fraud and corruption. The parking attendant will also be able to assist passengers with information.

Off-street parking will be processed by the necessary infrastructure and POS devices provided, which shall accommodate the same bank issued fare payment media used for on-street parking above. The necessary control measures (boom or attendants) must be in place.

The parking fee would vary according to location, and be time based. The kerbside parking payment process is more complicated than off-street and requires that the parking attendant records the vehicle registration on arrival and, when the driver returns, the vehicle registration is checked on the FMV to calculate the time parked and the parking fee due. The driver may then pay by means of cash or a fare media card.

2.1.7 Community satisfaction
Maximizing the efficiency and capacity of a transportation system through ITS initiatives keeps through traffic on the main streets and minimizes traffic intrusion into residential neighbourhoods. This presents social benefits to the community through improved quality of life and also supports its economic development as a result of improved mobility and accessibility

2.2 Improving road safety
South Africa currently has some of the highest road accident fatality rates in the world. New technology provides an opportunity to increase the safety of drivers, vehicle occupants and other road users, including the more physically vulnerable sectors of society.

ITS particularly supports the road safety agenda in three main ways:
1. Network management techniques that help to tackle congestion described in Section 4 also provide safety benefits and vice versa
2. Camera technology linked to back-office systems support enforcement of road traffic legislation, including through safety cameras and CCTV, and also help enable prompt remedial action in the event of an accident
3. In-vehicle ITS developments offer additional safety features to drivers, and there is potential for greater co-operation between vehicles and the road infrastructure to support safety and other
objectives. In-vehicle ITS technologies fall into three broad categories known as Telematics, deploying technologies that:

- support drivers by giving warnings and providing information. Dynamic route guidance systems that forewarn of real-time traffic conditions are reaching the mass market;
- assist the driver and allow them to hand over specific elements of vehicle control; and
- can actually-override the driver and take control, particularly in emergency situations.

Some of these technologies are already available through several top-of-the-range vehicles but ultimately some level of telematics will be a standard feature in all makes and models. It is clear that the more advanced and automated solutions are likely to contribute significantly to future targets for road safety. Insurance companies are exploring the potential of in-vehicle ITS devices to assess driver behaviour, aid risk assessment and inform annual premium rates more generally.

### 2.3 Convenient travel and reliable traveller information

Ideally one would envisage a transport system that enables people to make informed choices about when and how they travel. Using technology to keep people informed both before and during the journey should be a central feature in the overall transport strategy and provides an essential tool to deliver better network efficiency and improved safety.

#### 2.3.1 Reduced traveller delay

Travellers on a transportation network experience delays as a result of congestion, which is due either to traffic demand that exceeds capacity (recurring congestion) or due to the presence of incidents that reduce roadway capacity (non-recurring congestion). ITS improves the operational efficiency and capacity of the transportation network by improving traffic signal coordination, reducing the duration of incidents, providing transit priority, informing motorists of traffic problem areas, etc. The benefits can be manifested as an effective increase in capacity and reduced congestion, with the associated improvements in travel times, operating speeds and traveller delay.

Traffic signal systems and the provision of coordinated traffic signal operation generally improve traffic operation on arterial roads by in the order of 10 to 30%, with the added inherent benefit of reducing rear-end collisions on the arterial by up to 35% during peak traffic periods. However, research also indicates that the safety benefits of signal progression can vary significantly with corridor speed, level of congestion, signal spacing and the number of turning movements at access points. Vehicle actuated (VA) traffic signals reduce queues at isolated traffic signals where the arrival of vehicles is erratic and can be serviced on demand.

Also, transit priority systems can yield up to 40% reduction in bus travel times. Delays, however, typically increase for cross street under coordinated operation and one should be careful that increases in operational efficiency on the arterial roads are not outweighed by delays on the side streets.

Severe traffic congestion is most frequently caused by non-recurring congestion or congestion due to incidents such as collisions, vehicle breakdown, road maintenance, weather / road conditions or other irregular or unpredictable events.
ITS technologies are deployed to detect and respond to incidents as quickly as possible and provide real-time information to advise drivers of unusual traffic conditions or to divert vehicles to alternate routes.

ITS traveller information systems can cut travel times by 10 to 45% during congested periods and comprise in-vehicle, portable, internet as well as roadside based components, using analysed and consolidated input from:

- Floating vehicle data, that is a useful mechanism to judge the rate of traffic flow and provides an ITS basis for some businesses to provide real-time and targeted information to drivers via an in-vehicle Highway Radio Service
- Advanced systems that assess real-time traffic conditions to provide visual or audible in-vehicle route guidance to drivers
- Mobile telecommunications companies offer real-time services to subscribers providing benefits to the travelling public (although legislation is in place about mobile phone usage whilst driving to safeguard road safety)
- Information provided at the roadside through Variable Message Signs that gives network operators an essential tool for real-time, visual message which can be purely informative, advisory, or mandatory in nature
- Advanced signage that can provide real-time information on parking availability
- Websites that can provide information on current road traffic conditions such as traffic incidents, road works and congestion on the strategic network
- Improved accuracy of satellites enables data service providers to target individuals with focussed, location based and personalised information.

2.3.2 Travel Time Reliability
Reduced delay and the provision of traveller information, particularly with respect to capacity reducing incidents, can have a significant impact on the reliability of a trip. The provision of traveller information with respect to trip duration, expected delays or arrival times and reasons for the delay has a significant impact on the quality of a trip and level of frustration. This is particularly important with respect to public transportation where commuters typically require information on:

- current state of the network based on real-time information across all transport modes;
- real time public transport information, such as scheduled arrival and departure times
- travel options and available services

Pre-trip information has traditionally been available to the travelling public though radio and television services. An accurate, reliable and relevant flow of information to travellers during a journey is equally important. The advent of the Internet created opportunities for public and private sector web-based journey planning and information services that are now maturing into real-time information sources in a way that could provide broader information.
2.4 Improved public transport

More than 65% of South Africans use public transport for access to educational, commercial and economic activity. In general public transport services are poor but this image is transforming, through the implementation of Bus Rapid Transit (BRT), a high quality mass transit system using high capacity buses along dedicated bus lanes. Public transport travel time reliability can be improved through effective scheduling / timetable adherence using vehicle tracking systems and traffic signal pre-emption (to allow priority for BRT vehicles through traffic signals). Likewise, reduced passenger queues (& hence time delay) can be achieved through easier fare payment for passengers by using Electronic Fare Collection (EFC).

ITS technologies can provide better and more inclusive public transport services to commuters through improved reliability and accessibility; to operator through efficiency gains; and to both users and operators in terms of cost-effectiveness and affordability of service provision. International experience indicates that ITS initiatives can increase transit revenues by as much as 10 to 15%.

Several ITS measures are used to support reliability and efficiency of public transport services, including:

- The deployment of satellite tracking or Automated vehicle location (AVL) technologies to:
  - manage public transport vehicle fleets, leading to greater efficiency in bus utilization and the ability to reduce the vehicle operating fleet by 5 to 10% with equivalent savings in fleet operating costs.
  - to give buses priority at traffic signals
- Roadside and in-vehicle camera technology to enforce bus lanes and to help protect the safety of passengers
- Optically guided buses that use ITS to position vehicles properly at bus stops to allow disabled access.
- Integrated approach to electronic fare collection that provides the Integrated Fare Management (IFM) framework for seamless ticketing and payment services among public transport operators and across all modes. Benefits will include:
  - A more simple, user-friendly and cost effective payment mechanism for public transport users that will enable them to travel seamlessly between modes
  - Opportunities for operators to provide more efficient and seamless services that will be attractive to users and offer cost-effective benefits in terms of operating costs over time.
- Implementation of traffic signal coordination, public transport priority measures and incident management improves on-time performance and trip time reliability for public transport users. This improvement in level of service provided by the public transportation system results in increases in ridership and, consequently, revenue increases.

2.5 Supporting efficiency of the road freight sector

Freight transportation is a very competitive business and, as such, efficiency and cost-effectiveness is a priority. One of the major problems freight operators are experiencing is to ensure effective asset utilisation with a full load for the complete round trip. Reducing inefficient empty trips has the effect of reducing fuel consumption / costs and hence CO² emissions.
Using ITS measures, freight supply chain management include multi-modal information services, electronic data interchange and smartcard pre-clearance (particularly at cross-border controls) based on the monitoring of electronic tags fitted to the containers at source. GPS and other location sensing technologies are supplemented by GSM / GPRS, satellite, and other vehicle to centre communication, providing reliable end-to-end tracking of freight vehicles to manage the exact location of a vehicle and its freight at any given time. By extending this system, it can help to control the traffic by routeing the freight to a less congested route.

Overloading is hugely detrimental to vehicle performance as well as to the road infrastructure and Weigh-in-motion (WIM) is an ITS technology for weighing heavy vehicles on route, without requiring them to stop at weigh stations. Trucks are sampled on the main route and overloaded vehicles are pulled aside to a nearby static weigh station for accurate measurement and prosecution if necessary.

2.6 Reducing negative environmental impacts

The transport sector is the most rapidly growing source of greenhouse gas emissions in South Africa, since congestion results in increased fuel consumption and, consequently, an increase in air pollution. Reductions in the environmental impact of motorized transportation are, therefore, usually measured in terms of reduction in CO² emission and fuel consumption and directly attributed to improvements in operational efficiency and reductions in travel delay that can be achieved through ITS initiatives.

A strategy for a developmental green economy for Gauteng (Preliminary Report for the Gauteng Province Department of Economic Development – January 2010) proposes to:

- Promote low carbon transportation systems
- Remove subsidies for fossil fuel and penalise inefficiency (high fuel consumption)
- Establish a long-term strategic shift away from private car use and support for mass transit, public transport, rail, etc. (through an increase in quality, affordability and availability of public transport and penalising private car use).

2.6.1 Reduced CO² Emissions

The Lancet (one of the world’s best known, oldest, and most respected general medical journals) has reported that air pollution is the second fastest growing causes of death in the world ... in 2010 3.2 million died prematurely due to air pollution, compared to 800,000 air pollution deaths reported in 2000. 2.1 Million deaths were in Asia where car markets have exploded in the past ten years and where the large car is seen as a status symbol. The study found that it was specifically the type of air pollution caused by car and truck exhaust that are doing the most damage.

Mandatory vehicle emission standards have been in place in many countries for a number of years but South Africa has only recently introduced emission specifications for new vehicles, which focus on a reduced carbon footprint. Green ITS deploys different measures that help reconcile economic growth with a sustainable transport system, by producing more energy efficient transportation systems, better use of existing road infrastructure and reduced CO² emissions. Internationally, Traffic and incident management systems have proven to be able to reduce fuel consumption by as much as 40 % and vehicle emissions by up to 50%.
There are 2 transport related approaches to reducing CO² emissions: technology and changed behaviour, which include such measures as:

2.6.1.1 Technology:
- traffic management tools, which improve flows and speed distribution to reduce the number of accidents. Traffic flows are to some extent controlled by network managers through traffic signals, ramp metering, variable speed limits, and prompt resolution of traffic incidents. Also, driving at a constant speed produces fewer emissions than driving patterns with large variations in speed.
- vehicles powered by other that fossil fuels, such as electric or hybrid cars, as long as the electricity is generated from renewable or nuclear sources.
- enabling integrated public transport, through electronic fare payment using a bank issued card, helps encourage a modal shift away from private cars and providing commuters with a safe and comfortable travel environment.
- ITS functionality will provide more information and allow travellers to make better informed decisions on when to travel, the mode to choose and the route to take. This increase in information will encourage the use of alternate travel modes and help reduce the environmental impact of transportation.
- parking information systems reduce the number of vehicles in the traffic stream, biding their time until a parking space is available.

2.6.1.2 Changed behaviour:
- demand management / congestion charging, where the intention is to reduce traffic volumes through charging a fee for vehicles entering a city cordon or traveling on a section of road. Energy efficient or electric vehicles are charged a reduced fee, which has the added effect of reducing CO² emissions.
- modal shift to public transport
- ecodriving: a technique to reduce fuel consumption and emissions by changing driver behaviour through real-time, in-vehicle driver feedback.

2.6.2 Reduced Carbon Footprint (Energy Efficiency & Efficient Operations)

A carbon footprint is a measure of the impact that human behaviour has on the environment and climate change.

Besides new vehicle technology and the use of alternative fuels, the following ITS measures help reducing the carbon footprint of transport systems:
- LED traffic signals introduce energy savings and also reduce the carbon footprint with a longer service life (life cycle uses less material) and low maintenance (fewer service trips).
- influencing driver behaviour, through in-vehicle telematics (which monitor emissions), in conjunction with energy efficient engines and effective fleet management
• information dissemination provides travellers with accurate, real-time information on transport alternatives available, in order to make better informed travel decisions.

2.6.3 Green Vehicles
Motor vehicle manufacturers are focussed on developing new technologies to reduce CO² emissions and improve fuel economy while scientists are striving for a clean, alternative fuel. Congestion charging schemes, which are primarily mobility driven, are introducing measures to reward “green” behaviour and penalise polluters.

There have been significant developments in the field of hybrid or electronic vehicles but until their use is supported by policy actions such as preferential access, green incentives, or travel pricing they are unlikely to be able to compete with the convenience of fossil fuels.

2.6.4 Green Information
There is a concerted move in the ITS industry to acquire environmentally relevant real-time transportation data and to use this data to create useable information to support trip decision making. This would facilitate “green” transportation choices, and assist system users and operators with green transportation alternatives or options.

2.7 Supporting security, crime reduction and emergency planning measures
Monitoring of the transportation system and parking facilities for incidents and unusual conditions through CCTV cameras provides significant benefits to the users of these facilities in terms of personal security. Incident management and traffic management systems monitoring the roadways for unusual traffic conditions, transit management systems monitoring their vehicles and bus stops, and parking management monitoring parking facilities are a few other examples of where CCTV cameras are recommended for deployment. The monitoring of these video images through manned centres can provide quick response to motorists, transit patrons, pedestrians and cyclists in need of assistance.

Advanced security camera systems and the availability of fast broadband wireless communication facilitates accurate automated site monitoring to the point where human intervention is only required in the form of armed response to a security incident.

The traffic conditions and planning associated with large events, such as sports matches, concerts or emergency incidents can be managed effectively with ITS technology through CCTV monitoring, electronic signage, traffic signal priority and liaison with police personnel on the street … all from a centralised control room. More sophisticated control rooms provide integrated facilities for all responsible authorities under one roof, with event management controlled from a Joint Operations Centre (JOC).
2.8 Data Management

Transportation related data has always existed in abundance but, until recently was collected and stored manually, making it impossible to access freely. Technology has provided the means to manage data storage effectively to the extent that we are now drowning in knowledge and information.

It is only when this information is converted into skills or action that we appreciate its true value. It is no longer just about knowledge, but rather what can be done with that knowledge that counts.

2.8.1 Data collection
New data collection techniques have been developed to replace the previous generation of time consuming on-site traffic surveys, primarily using a type of sensor. Sensors, and the information they deliver, are integral to traffic management and control systems and comprise inductive loops, piezoelectrics, acoustics, microwave radar, passive infrared, photo electrics or video imaging. Online data on traffic flows is also acquired through different sources such as traffic actuated signal detector loops and dedicated traffic monitoring devices. This online data can therefore be classified by type and level of aggregation (counts or speed records, vehicle based or interval based). Data collected includes vehicle counts, classification, speed, occupancy, flow density, queue length, headway, incident occurrence.

This traffic data is supplemented by spatial detectors (licence plate recognition, transponders, active & passive tags) which measure travel time and location, using Automatic Vehicle Location (AVL) or Global positioning systems (GPS) technologies. Probe data is another particularly useful form of data collection technology which uses vehicles with mobile phones as traffic probes, by anonymously tracking those switched on, but not necessarily in use. At the data collection end, technology is being developed to transform these phones into mobile traffic information sensors by gathering mobile phone GPS data, converting it to represent traffic speed and density, aggregating this information with other existing data sources and distributing the data via the Internet to provide the public with real-time traffic and congestion information. These later tools remain indispensable to journey planning, traffic forecasting, route guidance, dynamic asset allocation, safety augmentation and for streamlining the transportation infrastructure.

ITS systems can in effect motivate their own success by providing a multitude of data that is collected during normal operations, such as travel times, speeds, flows and volumes, for quick feedback as to which strategies are successful and under what circumstances. ITS data also has the potential to support improvements in travel demand forecasting, traffic simulation, air quality modelling and travel behaviour research.

The collection, storage and maintenance of data can be expensive so it is important to understand how it will be used in order to determine data structure, analysis criteria and what action will be taken based on the measured results. Other vitally important issues are:

- cost of data collection & accessibility of data
- data quality & completeness
- understanding extraneous influences in the data
- liability for appropriate action (or lack of)

In the first instance collecting and acting upon data relating to ITS equipment performance is becoming increasingly important in the traffic management arena. Software applications process data provided by
most ITS devices and automatically monitor equipment status and notify a technician, log service activity, manage inventories and schedule preventative maintenance. Authorised personnel, remotely accessing all the relevant graphical user interface screens and reports, can undertake performance measurement using statistical evidence to provide a qualitative basis to decide whether equipment has reached the end of its effective lifespan and requires replacement.

2.8.2 Information dissemination (also see Section 2.3 Convenient travel and reliable traveller information above)

Currently the information requirements for travellers (ie. drivers in traffic) and passengers (public transport commuter) are fairly diverse, as are their means of dissemination, but rapidly changing technologies and possible future cross-modal applications will see an integration of these elements. Significant advances have already been made through in-vehicle telematics and the convergence of communication modes using smart phones, where any motorist can access traffic information for the highway stage of his trip as well as public transport schedule updates for his next mode of travel, (bus or air) all via the internet.

Accurate, real-time information based on improved collection and processing of real-time data, supplemented by improved communications between “Connected Vehicles” (transit, truck, cars and fleets with wireless / Internet connectivity) and infrastructure will also impact transportation mobility by providing travellers and transportation system operators with dynamic, cross-modal decision making capabilities.

2.8.2.1 Traffic information for motorists

Traffic information dissemination systems can distribute a wide range of information to help individual trip planning and re-routing. The information includes traffic and road conditions, closure and detour information, incident information, and emergency alerts and driver advisories. The major traffic information dissemination modes include:

- Dynamic Message Signs
- In-Vehicle (telematics) Systems
- Internet
- Mobile phone
- Highway Advisory Radio & other media

2.8.2.2 Public transport information for commuters

A key Bus Rapid Transit (BRT) ITS feature is data collection and information dissemination, both for the BRT system management as well as to transit operators and passengers. Traffic reports now feature regularly on radio during peak traffic hours, to help motorists avoid congestion, but buses and taxis are unable to change their routes due to waiting commuters at preordained stops. ITS monitors any incidents of abnormal traffic congestion on the BRT feeder arterials as well as satellite tracking of the BRT busses and, if delays are unavoidable, real-time passenger information systems can relay revised arrival times to electronic signage at the BRT stations or on the busses. Regular commuters could subscribe to receive this information by SMS on their cell phones or via the Internet.

Passengers essentially require information on bus routing / timetables and real-time schedule adherence to assist in their public transport trip planning. Passenger information systems collate and interpret all the passenger data from the related ITS systems to ensure this information is reliable, accurate and in real-time information.
4.1 Background

South Africa was a late starter in terms of Intelligent Transport Systems (ITS) deployment and only received the necessary impetus though projects related to the FIFA Soccer World Cup in 2010. This also holds true for Gauteng, where a number of key projects were launched leading up to the World Cup event. However, due to fast track deployment as well lack of structured policy, ITS architecture and strategic frameworks at National or regional level, the true benefits of ITS deployment are probably not fully exploited at this point. An important driver of ITS systems is the benefits that accrue due to integration of infrastructure, various ITS output as well coordinated activities on an institutional level.

Figure 1 depicts the current fragmented environment for ITS in Gauteng.

4.2 State of ITS Planning and deployment in Gauteng

The status quo of ITS in Gauteng is described both from a planning as well as deployment perspective.

4.2.1 Gauteng ITS Planning Initiatives

Some pertinent ITS planning projects were launched within Gauteng as shown in the Table below. Although the planning documents are in different stages of implementation, they do not necessarily represent a consolidated approach for ITS within the province.

<table>
<thead>
<tr>
<th>No.</th>
<th>ITS STRATEGIC PLAN</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Johannesburg Roads Agency (ITS Roadmap)</td>
<td>October 2006</td>
</tr>
<tr>
<td>2</td>
<td>SANRAL National ITS Strategy</td>
<td>January 2010</td>
</tr>
<tr>
<td>3</td>
<td>Gauteng ITS Strategic Plan</td>
<td>June 2010</td>
</tr>
<tr>
<td>4</td>
<td>Gauteng Integrated Fare Management Framework</td>
<td>2012</td>
</tr>
</tbody>
</table>

4.2.2 State of ITS Deployment in Gauteng
Various ITS flagship projects have seen the light in Gauteng during the last couple of years. Whereas these projects have created opportunities for a fledgling ITS industry in South Africa, challenges are now faced with regards to sustainable operations and maintenance as well as funding thereof. Specifically, the provisions of dependable power supply as well as communications connectivity via a redundant backbone are hampered by cable theft activity as well as roadside construction damage.

Some of the major projects in Gauteng with their typical application areas are listed below:

**Bus Rapid Transit Projects:**
- **Rea Vaya system, City of Johannesburg**: Full scale deployment of ITS systems, including automated face collection, CCTV surveillance, fleet management and control, traveller (passenger) information, operations centres and communications between devices and control;
- **City of Tshwane BRT**: Planning and Tender phase on ITS systems, encompassing most of the above functionality; and
- **City of Ekurhuleni**: Early stages of planning.

**SANRAL Freeway Management System (FMS)**: These systems have been deployed on large portions of the Gauteng freeway network, covering most of the National roads within Gauteng. The systems are currently being expanded and improved, all under a new performance based contract where the design, build, operations and maintenance (DBOM) activities are all sourced out to a single service provider. Typical application areas include CCTV surveillance, vehicle detection systems, traveller information, travel time prediction, communication systems and centralised operations.

**Gautrain**: Extensive ITS applications support the day-to-day operations of this high quality public transport mode. These include Automated Fare Collection, CCTV surveillance systems, traveller information, communication systems and centralised operations. The fare collection system does however not use bank-based contactless smartcards operating on the principle of pre-authorised debit.

**SANRAL Open Road Tolling**: The ORT system is supported by wide-ranging ITS applications along the Gauteng Freeway Network. These include various detection devices along the gantries, some CCTV surveillance, communication systems, supporting software systems and centralised operations (including violator processing and transaction clearing).

Whilst the above projects are at various stages of implementation and/or operations, few of these were planned and deployed giving much thought to an overall provincial ITS context. Opportunities are likely to have been missed to integrate, facilitate, coordinate the sharing and optimisation of resources, information and technology.
The benefit of ITS systems (by virtue of being systems that collect data, analyse it, and disseminate information) is often significantly improved by exchanging data between implementations (and not only within individual implementations).

Practical (hypothetical) examples in the case of Gauteng might be the sharing of real time (and static) service information of the Johannesburg BRT, Tshwane BRT, and Gautrain (rail and bus) with a central facility (i.e. data warehouse) which in turn disseminates such information to a live journey planner on the Gauteng Transport website, and mobile device applications (“apps”). In this manner travellers would be able to make informed choices about their trip based on the latest information.

Ultimately a successful ITS Plan will provide a platform to integrate all transport systems. However there are numerous barriers to be overcome. The following are the critical most components for integration:

### 5.1 Architecture

In order to ensure interoperability between systems it is necessary that a framework is followed which prescribes a set of “rules” to which ITS deployments should conform.

An ITS architecture typically describes ITS systems by means of:

- **Logic / Functional views.** These are described by means of data flow diagrams showing information flows and processes. These are location and technology independent and merely describes processes and information flows.
- **Physical views.** These are described through references to physical objects such as travellers, control centres, vehicles and roadside equipment. These views are often presented in different levels of detail. Refer to Figure 3 for the highest level of detail of the physical architecture from the American ITS Architecture.
- **Organisational/Institutional views.** These views present the roles and responsibilities of authorities in executing the abovementioned processes.
- **User Requirements.** These are typically mapped to the other architecture views.
- **Use Case Diagrams.**
- **Standards.** An architecture can contain a listing of standards to which ITS implementations should conform. If different systems use the same standards they are likely to be interoperable. Furthermore it means that equipment can be replaced with alternative brands or types of equipment preventing vendor lock-in.

The benefits that can be derived from following an ITS Architecture in the early stages of ITS deployments can be summarised as follows.

**Projects:**
- starting point for producing the Component Specifications for the elements needed for the ITS deployment
- basis for the necessary Communications Specifications, including standards for the communication links between components and also with external interfaces
Technical:
- facilitates component inter-operability
- facilitates successful integration with other systems
- facilitates consistency of information and hence sharing of data
- permits technology independence, leading to easy system upgrade / extension
- enables problem identification and solution at less cost

End Users:
- seamless working of integrated transport services, eg through trip planning and on-trip information.
- project satisfies the expectations of the users

Business:
- provides an open market for services and equipment
- permits economies of scale

Political:
- encourages investment because it provides a platform for stable product development and implementation.

All:
- provides a common understanding that is particularly useful for the broad spectrum of stakeholders.
- enables better planning of ITS deployments because problems can be highlighted at an early stage when they are not too expensive to resolve.

Figure 2: US Physical ITS Architecture highest level view
5.2 Gauteng Institutional Relationships

5.2.1 Key Role-players

Role players within the ITS environment encompasses both the public and private sector. The accomplishment of sustainable ITS deployment is often reliant on established government-to-government partnerships, or public-to-private sector partnerships. A plethora of possible key role players within the larger ITS industry has been identified, and shown in Figure 3 below. The respective roles of these entities typically need to be considered in developing the concepts for large ITS projects.

Proper coordination (institutional and technical) – and specifically between the three spheres of government – is critical to ensure that ITS is rolled out in an efficient way. This accentuates the importance of identifying all the relevant role players in order to:

- Integrate between key role players
- Establish and encourage institutional relationships
- Promote and enable public and private partnerships
- Encourage innovation in the public and private environment
- Inform and lead processes to develop ITS policies, standards, technical enhancement, accountability and financial sustainability.

Gauteng comprises (see Figure 3 below):

- 3 metropolitan areas (City of Tshwane; City of Johannesburg; Ekurhuleni Metropolitan Municipality)
- 2 district municipalities (West Rand District Municipality; Sedibeng District Municipality).
The West Rand District Municipality comprises the local authorities of Merafong City, Randfontein, Westonaria and Mogale City Local Municipality, while the Sedibeng District Municipality includes Emfuleni (Vereeniging / Vanderbijlpark), Midvaal, and Lesedi Local municipalities.

Transport Authority for Gauteng is an initiative being considered, to establish an appropriate institutional structure to coordinate, integrate and manage (public) transport for enhanced mobility and quality of service.

Consideration has to be given to institutional structures relevant to ITS deployment and the relevant policy environment for the local ITS industry. There are three spheres of government in South Africa and the Constitution of South Africa dictates how this government process works, i.e.:

- National government
- Provincial government
- Local government

The spheres of government should not be seen as hierarchical as they are in fact completely autonomous, all operating according to the Constitution and laws and policies made by national Parliament.

Table 1 below shows these three spheres of government with their associated responsibilities:

<table>
<thead>
<tr>
<th>SPHERE</th>
<th>LEGISLATURE</th>
<th>EXECUTIVE</th>
<th>ADMINISTRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>Parliament</td>
<td>President and Cabinet</td>
<td>Directors General and departments</td>
</tr>
<tr>
<td>Provincial</td>
<td>Legislature</td>
<td>Premier and Executive Council</td>
<td>Heads of Department and staff</td>
</tr>
</tbody>
</table>

Figure 3: Gauteng Province Institutional Structure
It is the lack of coordination (institutional & technical) at all 3 levels of government which ultimately inhibits systems integration. An example is the poor coordination of Freeway Management across National / Provincial / Metro boundaries, such as on the M1.

The operation of ITS systems includes the cooperation and input from many agencies, including IT departments, Emergency Responders, Traffic Engineering, Law Enforcement and others. Communication between all the parties involved can be quite complex, and needs to be planned in in terms of Standard Operating Procedures. Likewise, all the different jurisdictional issues need to be resolved especially where there is an overlap in responsibilities between the different responders and other agencies.

5.2.2 National Department of Transport (DoT)
The underdevelopment of ITS is largely due to a lack of national co-ordination, as the main ITS deployment efforts have been at the metropolitan level but these have been hindered by institutional inconsistencies. These Municipal Authorities (and SANRAL) are deploying ITS technology in an institutional vacuum, since the roles and responsibilities of the DoT have not been clarified to regulate and consolidate all institutional ITS technological requirements.

The DoT acknowledged this deficiency in the Draft ITS Policy for South Africa which was drafted in 2008. This document proposed that the DoT would establish an ITS capacity which will play an advocacy, coordination and promotion role of ITS in the country. This capacity will ideally be a line function, and be placed within a Branch that shall be decided by the Director-General. In the interim, the Director-General must identify a group of people, or a line department, that will play this co-ordinating role until a line function has been established.

As such, the Department of Transport would be key to motivating the allocation and provision of funding for implementation of ITS systems at a Metropolitan level. At a Regional level, the Department of Transport would be instrumental in setting up regional ITS Steering Committees, providing synergies between the various implementing authorities and ensuring a co-ordinated approach to ITS deployment. Unfortunately this Draft ITS Policy was never officially adopted.

While the National Land Transport Act (2009) promotes and provides for a much better aligned institutional dispensation for the planning, implementation and management of transport functions in the country, the implementation of the ITS institutional structures and arrangements will, however, not be achieved in the short-term. The NLTA also requires that the Minister of Transport must develop, establish and maintain a national information system with regard to land transport, based on sound business processes, and in collaboration with the provinces integrate that system with the information system kept by provinces.

5.2.3 Major institutional gaps
In terms of the Gauteng ITS Plan, the following major institutional gaps have been identified:
- Lack of a political champion (support) for ITS
- Lack of (institutional & technical) coordination which prevents systems integration
- Lack of spending on ITS projects as a result of poor management of the contractual process
- General lack of awareness of ITS technology

*It is therefore critical that an ITS Directorate be established within GDRT*
The purpose of establishing the ITS Directorate within GDRT would be to:

- Motivate budget for ITS funding
- Employ qualified Engineers to:
  - arrange & manage ITS contracts
  - be available and receptive for knowledge transfer from experienced contractors
- develop and maintain Provincial Public Transport Data Warehouse to provide:
  - public transport travel information
  - bus subsidy information
- Create ITS awareness at Provincial level to:
  - motivate for prioritising ITS funding
  - establish Provincial ITS Integration Committee

5.3 User requirements

User requirements emanate from a user needs analysis and are therefore entirely user oriented. On the other hand, system requirements are a series of formal statements that describe the features of the system that will be necessary to satisfy the user requirements.

5.3.1 Needs Assessment

The purpose of this task would be to develop an understanding of the current state of the Gauteng transportation system from a multi-modal perspective, including current issues, concerns and problem areas as well as projects, proposals, strategic plans and inter-governmental agreements pertinent to transportation within the Province. The focus is therefore on identifying:

- Current transportation issues, concerns and problem areas, and quantification of the extent and severity of the problems
- Future transportation issues, concerns and problem areas, and identification of the extent, anticipated timing and severity of the problems
- Current policies and initiatives or strategic plans regarding transportation within the Province and their respective funding mechanism
- Existing and planned transportation infrastructure
- Existing legacy systems and planned ITS applications
- Existing and developing organizational structures and institutional arrangements relative to the planning, operation and maintenance of the transportation system, including roles and mandates of the respective agencies
- Provincial characteristics of infrastructure

Comparing the needs assessment with the existing ITS inventory a gap analysis can be provided based on transport needs.

5.3.2 Mapping User Requirements to Toolbox of ITS Solutions

5.3.2.1 ITS Toolbox

An ITS Toolbox presents potential ITS technologies, which can be deployed to address the gaps between the existing ITS inventory and the identified User Needs. Being able to operate and manage a roadway requires, as a minimum, the ability to view the roadway, control field devices, and measure the traffic on the roadway. Other items, such as VMS for travel information, incident detection, CCTV surveillance
cameras and a communications network may not be a necessity but greatly enhance the management of the roadway.

5.3.2.2 Typical ITS User Requirements
The following is a list of relevant (but not all-inclusive) ITS User Requirements, with their appropriate ITS solution:

- **Effective policing / enforcing of Traffic Regulations**
  - Electronic / automatic enforcement

- **Emergency response to traffic incidents**
  - Emergency Notification and Personal Security
  - Emergency Vehicle Management
  - Hazardous Materials & Incident Notification

- **Accurate, accessible, timely Travel Information**
  - Pre-trip Information (Internet)
  - On-trip Driver Information (in-vehicle or VMS)
  - Personal Information Services (sms)
  - Route Guidance and Navigation (GPS)

- **Effective Traffic Management**
  - Traffic Control
  - Incident Management
  - Traffic Demand Management
  - Safety Enhancement for Vulnerable Road Users
  - Transport Planning Support
  - Policing/Enforcing Traffic Regulations
  - Infrastructure Maintenance Management

- **Useful In-Vehicle Systems (to improve driver safety & driving experience)**
  - Vision Enhancement
  - Automated Vehicle Operation
  - Longitudinal Collision Avoidance
  - Lateral Collision Avoidance
  - Safety Readiness
  - Pre-crash Restraint Deployment

- **Efficient Freight and Fleet Operations**
  - Satellite tracking / AVL
  - Commercial Vehicle Pre-clearance
  - Commercial Vehicle Administrative Processes
  - Automated Roadside Safety Inspection
  - Commercial Vehicle On-board Safety Monitoring
  - Commercial Fleet Management

- **Safe, comfortable and reliable Public Transport**
  - Public Transport Management
  - Demand Responsive Public Transport
  - Shared Transport Management
  - On-trip Public Transport Information
  - Public Travel Security
  - Electronic Fare Payment
The following are some cutting edge ITS services which are being considered for use in Gauteng, but not yet fully implemented:

- Highway advisory radio (HAR) – by tuning in to an allocated radio station, travellers can learn of localised travel conditions
- Probe data – vehicles collect and transmit real-time data via technologies such as GPS or others
- Advance Traveller Information System (ATIS) technologies, using smart phones and the internet
- Incident management technologies such as freeway incident detection & response coordination, and automated vehicle location (AVL) for emergency response vehicles
- High Occupancy Vehicle (HOV) lane technologies such as license plate / tag verification and lane control at gantries

For many of these services to operate effectively they must be supported by Traffic Management Centre (TMC) roadside equipment and software, including:

- Centre-to-centre interfaces
- Regional and national data archives and advanced traffic information system (ATIS) portals
- Maintenance tracking
- Automatic Vehicle Location (AVL) or satellite tracking of vehicles
- Tolling (electronic and open road tolling) support (database, software)
- HOV enforcement / bus rapid transit integration and monitoring

Likewise, there are certain performance or quality requirements that must be considered, in order for any ITS service to be effective:

- Data Exchange - compatibility of information format, equipment and infrastructure
- Adaptability - the capability to conform to the changing patterns of User Needs
- Constraints - the rules and regulations to which the systems will have to conform
- Continuity - the capability to maintain a service in time and space
- Cost / Benefit - the avoidance of unnecessary or fruitless expenditure
- Expandability - the capability to add equipment and functions
- Maintainability - the capability to be maintained, repaired, modified or enhanced with minimum disruption to the service
- Quality of Data Content - the information should be fit for its purpose
- Robustness - the capability to operate satisfactorily under all expected conditions
- Safety - the capability to not cause harm to persons or the environment
- Security (data) - the capability to protect the system and data from external attack or interference
- User Friendliness - be simple and efficient to use.
5.4 Overcoming barriers to ITS deployment

There are distinct barriers to ITS deployment that have to be overcome and, while they are particularly relevant to this ITS Plan, these barriers are experienced across the entire country.

5.4.1 Resources
Given that resources will always be scarce, they need to be carefully coordinated to maximise their value and realise their full potential. The efficient and effective use of resources can only be achieved if they are directed towards the common vision and purpose provided by the ITS Plan, that focusses on the big picture and avoids the risk of using resources in an ad-hoc manner that meets narrow objectives with limited benefit.

5.4.1.1 Funding
Funding priorities dictate the diversion of funds towards social services, such as housing, education and health. Consequently roads authorities have to look at methods of improving the efficiency and effectiveness of service delivery in order to achieve the highest value for money.

There are conceptual and empirical difficulties involved in answering these questions because most impacts of ITS are indirect, enabling other activities that improve the livelihood and well-being of the poor.

5.4.1.2 System Engineering approach and the “ITS Life Cycle”
However, even in cases where funding is available, there is an even more serious obstacle to spending on ITS projects. This is as a result of poor management of the contractual process (from tender advertising / procurement & contracts / systems approach / to deployment & testing), due mainly to a lack of ITS competence or skills and a focus on managing the "Civil Engineering" style procurement contracts. The latter stems from a poor understanding of the System Engineering Approach to system development and implementation that needs to consider the entire lifecycle of a system and emphasise up-front planning and system definition (see V-diagram below).
The Systems Engineering Approach is a tool to assist with:

- Appropriate documentation of the system
- Effective stakeholder participation
  - with a clear indication of proposed deliverables
  - ensuring system development reflects the user needs
- Addressing risks early, when system costs are lowest
  - Evolving systems with minimal redesign and additional costs
  - Ensuring predictable outcomes
    - Minimizing or reducing cost overruns
    - Keeping the project on schedule
- Increasing system reliability and stability
- Ensuring a strategic approach to system implementation

The above describes a specific process for systems development that considers the entire lifecycle of a system and illustrates the influence of the early phases of the project on the end of the project. It emphasises the up-front planning (including needs analysis) and system definition that is required to ensure an effective solution, as well as the planning for operations and maintenance and the eventual system replacement.

Similarly, this approach can be applied to the full lifecycle of an ITS Project ... from performing a needs analysis through design and construction, to implementation, operations, and performance monitoring.

**The lifecycle of an ITS project is a multi-step and iterative process, comprised of various phases, each building on the previous.**

This lifecycle is described in Figure 5 below and the process is repeated as expansion is required or the needs of the ITS system change.
As can be seen from Figure 4 above, there are 6 important phases involved in the ITS Project Lifecycle:

**Planning and Needs Analysis**
During this phase stakeholder input will be sought, at key points in the process, which is critical to understanding where the system is now and what the vision is for the future. Examples of planning activities include preparation of a Concept of Operations, Systems Engineering Analysis, or Implementation/Deployment Plans.

**Plans, Specifications, and Estimates (PS&E)**
This phase includes multiple steps, including the design (eg. devices to be installed), specifications and obtaining the necessary clearances (environmental, utility, and right-of-way). Projects always have budget constraints and it is in this phase where we monitor the available funding and ensure the design is consistent with that funding.

**Implementation**
This phase includes activities during the time that the project is being advertised, such as responding to contractors’ queries, but mainly involves activities during deployment, such as addressing unusual field conditions, field integration, device testing, system testing, and preparing records.

**System Integration**
The next step in the lifecycle is System Integration, which incorporates a wide range of tasks including network configuration, centre-to-centre communications with other agencies, system testing, and software integration. This is when we ensure all equipment and devices operate and communicate correctly with each other.

**Operations and Maintenance**
Activities in this phase relate to the use of the system for its intended purpose, as well as the maintenance thereof. It includes following operational strategies such as standard operating procedures and incident management plans. These operational strategies may apply to Traffic Management Centre (TMC) operations, field maintenance, or dissemination of traveller information. Managing the inventory of devices is also included.

Performance Monitoring and Evaluation
During this phase, data is collected to evaluate the performance of the ITS functions or devices (eg. before and after studies) in order to determine the benefit of the system. This phase may also include evaluating what features are available that are not being utilized and what additional benefit could be realized by implementing them. Results from the performance monitoring and evaluation phase can be incorporated into the planning and needs analysis step of the next iteration of the lifecycle. By following this process the program is continually rationalised and evaluated for on-going improvement or updated to include new technologies.

5.4.1.2 Expertise
Specific qualities are required in terms of expertise and experience in order to manage the effective design and deployment of ITS technology, however, South Africa has a lack of ITS skills and an inability to retain existing expertise or experienced Engineers. It is therefore imperative that an ITS Strategy actively promotes the development of knowledge transfer through the appointment of specialised and appropriately experienced contractors or consultants. This entails a clear focus on the following activities:

a. Education
   Intelligent Transport Systems is an interdisciplinary area of expertise with ITS practitioners coming from their original “mother disciplines” such as Civil (Traffic and Transportation), Electrical, IT and Communications Engineering. Until recently there has been no formal tertiary education for ITS, but this industry has subsequently grown into an area of specialisation which led ITS South Africa to establish a ITS Centre of Excellence as a delivery mechanism. It is a virtual centre that encourages cooperation with local and international universities and technical universities to explore synergies around educational programmes. As a result several major South African universities are now offering post graduate courses in Intelligent Transport Systems and under graduate courses are being planned for the near future.

b. Training
   - General training
     It is necessary to identify training needs for staff involved at different levels in ITS projects, to inform a process of knowledge transfer and training. This will ensure the training services provided, and technology transfer program developed, will strengthen the capacity of the personnel, relating to the operation, maintenance and best practice for the entire ITS technical platform.

     An understanding of these systems, gained by ITS personnel through the training and knowledge transfer, will assist in developing this resource.

   - Training in specialist areas
     ITS systems incorporate cutting edge technologies, which require the provision of training in specialist technical areas. A program of institutional strengthening would provide specialist, on-going training for operations personnel, but management and executives would also benefit from exchanges with international ITS experts and managers.
Consideration must be given to knowledge transfer being entrenched in technology deployment contracts, such as through a formal exchange programme, for Engineers and technicians, with International companies.

5.4.2 Sustainability

5.4.2.1 Operations and Maintenance
The most obvious sign of the lack of priority given to the maintenance of the transportation infrastructure is the poor state of the road network and this will be addressed by both the 5 and 25 year plans.

However the actions that have been highlighted to receive attention include creating more roads engineering capacity, conducting annual infrastructure assessments and producing an annual report on maintenance projects and their finances.

On a technical level, a typical ITS system can include complicated technology which will require significant skill and organizational infrastructure to maintain, to ensure system availability is kept at an acceptable level. In the South African Environment the use of an outsourced infrastructure maintenance service appears to be the most practical way in which to addresses the following minimum requirements:

- **ICT (Information & Communications Technology):**
  This covers the administration and maintenance of the communications and computer network as well as the data that is accumulated through all the operational systems. Resources are also necessary to assess the cause of any system incompatibility and manage the process of rectifying the matter timeously.

- **Field Equipment**
  Competent technicians are required to maintain the electronic equipment deployed in the field, provide adequate planning of preventive maintenance and maintain the power and communications infrastructure to the field devices.

- **ITS System Integration**
  Competent System Engineers and software developers are critical to managing integration issues as well as ensuring smooth incorporation of new sub-systems and components.

It is therefore suggested that ITS Operations & Maintenance is outsourced, as it would pose a significant challenge for the Gauteng transport authority to manage this aspect. It is therefore important to ensure that adequate budget provision is made for the full contract period as the ultimate success of the entire ITS system will hinge on continued availability of operations expenditure.

5.4.2.2 Lack of political awareness and support for ITS projects
This effectively results in a lack of ownership and accountability for the ITS function, which impacts on the priority assigned to the allocation of ITS funding and resources. This matter can only be addressed through an appreciation of technology and inspired political leadership.

5.4.2.3 Integration
For an effective Public Transportation service there has to be integration at both the systems and operational levels. Despite the decline in the national rail system this mode still has the potential to be the backbone of Gauteng’s Public Transport system, especially with the Passenger Rail Agency’s (PRASA) roll-out of its multi-billion Rand modernisation programme over the next three years. It is therefore suggested that this modernisation be supported and integrated with other public transport initiatives planned in the province.
To this end, it has proposed that a joint planning and monitoring forum be established to co-ordinate all transport and integration activities, while also developing a joint corridor vision to ensure alignment of services and priorities. The Integrated Fare Management (IFM) Framework also proposes the establishment of a Gauteng Transportation Integration Committee and the ITMP25, with its similar focus on Strategic and Operational Integration, could prove the ideal medium to facilitate establishing such a Committee.

There is a dire need for a forum to manage transportation integration across Gauteng and GDRT should take ownership of this function. Proof of this is the Gautrain Integration Committee which was formed to specifically attend to Gautrain related integration issues but, since it is the only integration forum of this type, proceedings often digress to cover more general integration concerns.

### 6. IMMINENT NEW TECHNOLOGY

> Any sufficiently advanced technology is indistinguishable from magic ...
> Arthur C. Clarke (1962)

The development of new technologies that can be used in ITS can have a significant impact on the nature of future ITS systems.

#### 6.1 Communication Technology

Communication infrastructure is required to transmit data between the field devices and the TMC and also between the TMC and other transport authorities. Advances in wireless technology, coupled with falling costs of communications and improved internet access, have made very sophisticated ITS applications easily accessible to the transport industry.

Dissemination of information to travellers and transport authorities is readily available through VMS, web and mobile technologies and security monitoring of transport operations by relaying real-time CCTV footage is also commonplace. Likewise in-vehicle telematics provide drivers with information on their vehicle performance as well as real-time traffic conditions, with estimated time to a destination, work zones ahead, incidents, weather, tolls and (in the case of freight vehicles) updated delivery information from the fleet control centre. DSRC communications are deployed where there is a need for a localised exchange of data (for example, in electronic tolling) or where occasional, rather than continuous, communication with the roadside infrastructure is required.

#### 6.2 Probe data

The cost of collecting traffic data (typically done by deploying roadside traffic detection devices) appears set for significant reduction with the recent commercialisation of probe vehicle technology. Traffic probe technology is essentially different from conventional vehicle detection (loops, radar etc.) in that measurements are taken over a section of road rather than at a particular point. Conventional detectors measure traffic volume, point speed and occupancy (% time that a vehicle occupies a detection zone). On
the other hand, vehicle probe technology measures travel time between consecutive points along a vehicle’s route (and thereby its speed).

Probe data usually involves the tracking of cell phones or GPS devices (or even toll tags), but the following limitations and advantages apply:

**Cellular floating car data**
- This is tracked through a network of GSM masts
- Measurements are not accurate in congested conditions
- Low cost, wide-area coverage

**GPS probe data**
- Commercial, location based services require respective vehicles to be fitted with GPS devices
- Very accurate in high volume traffic
- Less coverage (less probe units compared to cellular phones)

Data fusion is the collation of data from different sources (including road surface loop detectors) into a unified data stream and can classify traffic flow in such a way as to distinguish an isolated event and emerging congestion or predict the effect of accident / incident.

Positioning technology allows carriers to provide additional location based services so motorists could opt to receive customised information based on their location, route and traffic conditions. To allay fears regarding privacy issues, traffic data would be anonymised, making it impossible to identify individual phones.

### 6.3 In-vehicle telematics

The desire for motorists to be always connected has resulted in remarkable innovations in the realms of telecommunication and informatics, leading to the field of vehicle telematics, which can be loosely defined as the convergence of wireless communications, advanced vehicle tracking and in-vehicle Internet technologies to provide motorists with communication, information, safety and security services.

However, no matter how accurate and information rich these maps might be, they cannot independently provide the real-time detail required to avoid a collision. Likewise, in-vehicle sensors alone are not the solution as they rely on line of sight. Cooperative Intelligent Vehicle Systems will fully integrate information from the roadway as well other vehicles in the vicinity to provide advanced warning of any potential dangers ahead. Such systems also require a degree of co-operation by road authorities and vehicle manufacturers, particularly in the standardisation of the information content.

Traffic detectors, motorist’s mobile devices and spatial detectors (license plate recognition, transponders, active & passive tags) are being integrated with GPS and radar capabilities to create so-called smart corridors, for enhanced roadside enforcement operations through improved screening and automated inspection / compliance checks at highway speeds.
Vehicle detection and communication tools remain indispensable to journey planning, traffic forecasting, route guidance, dynamic asset allocation and for streamlining the transportation infrastructure, but they are particularly critical to the following safety interventions:

- **Collision warning & avoidance**
  With Cooperative Intelligent Vehicle Systems, warnings of potential collision, immediate hazards ahead, undetectable by the vehicle (in poor visibility or on blind curves) and road geometry information to inform vehicle speed adjustments (for adaptive speed control) etc. can be communicated directly between vehicles. Major vehicle manufacturers have targeted 2015 for the release of vehicles with the capability of co-operative communication, which will see car-to-car safety devices providing reliable driver assistance. Transport Authorities will however need to provide the necessary communications infrastructure to support this vehicle technology. An ITS Strategic Framework should flag this for the necessary attention when the timing is appropriate for South Africa.

- **Warning of speeding**
  Provision of speed limit information appropriate to current geometric & weather conditions (situation-specific-speed limits) or an audible alarm to alert the drowsy driver. The system is designed to take ultimately appropriate action to protect the driver and other road users (in the extreme case, like break-steering the vehicle to the side of the road before stopping).

- **Lane departure avoidance**
  Systems are designed to guide a vehicle in its lane on the freeway, either by processing images of the vehicles proximity to lane markings (from an external camera) or the kerb line (by radar detection).

Ultimately the human element has to also be considered in order to eliminate distractions relating to ITS devices, to ensure that the “Connected Vehicle” does not actually introduce unforeseen safety problems contributing to crashes.

Vehicle telematics will use information relayed via UTC systems, from intelligent infrastructure on the street or from the vehicles themselves, which will provide an alternative form of traffic control to traffic signals, road signage and speed enforcement. However, before traffic control infrastructure and signage can be removed from the streets altogether consideration must be given to the safety of pedestrians and also motorists without in-vehicle telematics technology – possibly by tracking their mobile phones.

Machine vision is the latest development that uses high performance camera and radar detection technology that is being developed as the next generation of in-vehicle telematics. Many of the characteristics associated with machine vision, such as cutting edge analytics and image processing, are essential for the applications associated with (for example) autonomous driving.
6.4 Road User Charging / Congestion Pricing

Road User Charging offers the perfect market control system with which to manage excessive demand for a scarce commodity (road space), whether it be a lack of capacity or shortage of parking spaces.

ANPR, satellite tracking and wireless / radar detection offer a practical “user pays” parking system which monitors vehicles, detects where spaces are available and measures the time a vehicle is parked. Payments can be handled by credit or debit, such as with cell-phone calls where use of the service is recorded and the account is paid at the end of the month.

Likewise access can be restricted to certain zones at certain times and to authorised vehicles, or a surcharge can be levied for travel in peak periods and payment deducted from an electronic tag. The electronic vehicle ID will also indicate the carbon tax category of a vehicle to restrict access or impose a penalty for travel within environmentally sensitive zones.

It will be thus be possible to apply congestion pricing through an intelligent parking management system, by:
- charging a parking premium to a motorist who commenced or ended a parking event during peak hours as that implies travel during peak hours
- providing a parking or road-use credit to any motorist not travelling during peak hours, whether its owner drove before or after peak hour or took the bus or stayed home
- charging delivery vehicles per minute to stop on busy streets in peak periods

7. PROCUREMENT MODELS FOR ITS SYSTEMS

7.1 Design, Build, Operate, Maintain (DBOM)

DBOM is a project delivery method (or system) used by an agency for procuring the design, construction, operations, and maintenance services for a project in a single contract. This takes the Design Build concept (where the agency develops a conceptual plan for a project, then contracts the design and build out) one step further, by including the operations and maintenance of the completed project in the same contract.

7.2 Build, Operate, Transfer (BOT) with Service Contract

Build, Operate & Transfer (BOT) is a variation on DBOM which represents complete integration of the project delivery. The same contract governs the design, construction, operations, maintenance and financing of the project. This relates to projects such as Freeway Tolling, which are able to generate revenue, and where the facility is transferred back to the owner after a concessionary period.

7.3 Full Service Contract

A full service contract is one where the Contractor operates the contracted service and pays a monthly fixed fee to the project authority.
The Contractor will own and maintain his equipment and it will be his responsibility to ensure all necessary controls are in place to avoid instances of vandalism, fare avoidance etc, as may be relevant to the project. The project authority would reserve the right to award contracts to several service providers, provided that the contracts awarded shall be at the best price per function tendered. The Contractor must indicate how future upgrading or expansion of the system (including the use of new technology) would be managed.

The MFMA requires Municipal Authorities to obtain special authority to award a service contract for a period exceeding 3 years. In the interest of effective ITS systems integration and smooth operation it is strongly advised that such prior authorities are obtained, to extend the contract period to between 5 & 10 years.
The overarching objective of an ITS Strategy is to improve the operations of transport systems and enable seamless integration of transport subsystems which in turn will support the general objectives of mobility, safety, reliability, effectiveness, efficiency and environmental quality. [ITS Strategic Plan for Gauteng; 2010]

8.1 ITS Mission

Deployment of appropriate ITS technology to improve the effectiveness of transportation systems.

8.2 ITS Vision

“The ultimate vision for the future is the transformation of surface transportation into an effectively managed, well-integrated, universally available, affordable, and sustainable system”
Dr. CM Walton (University of Texas).

In line with the above quote from Dr. Walton, an appropriate ITS vision for the ITMP25 would be to support the principles of a Smart Province for deploying ITS systems to support transportation in Gauteng.

8.3 Supporting Objectives

The following objectives have been identified as focus areas in this ITS strategy:

- Provide cost effective ITS solutions to resolve transportation challenges
- Improve accessibility for the community
- Improve transport safety & security
- Improve effectiveness of transportation infrastructure
- Support protection of the environment
- Effective management of the road network (including incident management)
- Reduce traffic congestion
- Facilitate reliable and consistent journey times

8.4 Guiding Principles

Further to the above objectives, the more generic principles (linked to Batho Pele) should be considered (and taken forward to motivate some of the ITS interventions), such as:

- Innovation (transport solutions should be cognisant hereof)
- User focused (i.e. the solutions we propose should focus on what the users want, show sensitivity towards users)
- Facilitate the sharing of information/making available (ITS solutions will consider this aspect, e.g. ensuring traveller information is available)
- Technology solutions to assist in automatically measuring performance & service standards
• Integrated solutions (especially w.r.t. technology deployment, integrated solutions is of the essence. If not planned this way, it will result in unnecessary/abortive expenditure)

Some of these principles will be used to motivate ITS interventions, going forward.

Higher level priority areas are:
• public transport priority,
• road safety aspects,
• mobility & accessibility issues (related to safety)

8.5 Policies

In assessing policy and legal matters, various acts and guideline documents must be considered. These include the National Land Transport Act (NLTA), the Gauteng White Paper on Transport Policy, the Provincial Land Transport Framework and various other Gauteng legislation.

The existing organisational framework within implementing agencies needs to be considered. Gauteng Department of Roads and Transport (GDRT) plays a co-ordination role at provincial level, and its key focus areas are:
• Transportation Infrastructure,
• Traffic Management,
• Public Transport and
• Freight Transport.

The following policies and legal framework will provide the appropriate mandate to implement ITS and achieve the above objectives in the Gauteng Province:
• NLTA (National Land Transport Act, Act No 5 of 2009)
• Gauteng Public Passenger Road Transport Act (Act no. 7 of 2001)
• National Road Traffic Act, No. 93 of 1996 – as amended;
• Gauteng Transport Infrastructure Act
• Gauteng Freeway Improvement Scheme
• Public Finance Management Act (PFMA)
• Municipal Finance Management Act

The Local Government: Municipal Systems Act, 2000 established the requirement that local governments should prepare Integrated Development Plans (IDP). It is a requirement that the various functional integrated plans, including the Integrated Transport Plan (ITP), be included in the IDP. The Municipal Finance Management Act, 2003 determines that the municipal budget must be based on the projects included in the IDP, which covers the planning of all service delivery to the community. So the approved budget is the main mechanism by which the ITP is implemented. An ITP, as described in the NLTA, is a statutory plan which is prepared to guide the development of the transport system in a municipal area. As a statutory plan, it is important that the contents of the ITP be treated as one of the sectorial plans which are input into the IDP. Thus, the ITP budget should form a sectorial component of the overall IDP budget. Due to the individual project prioritisation mechanisms, integration between the various IDP projects is seldom achieved, hence a programme based budgeting process is very necessary.
The transport inputs for the IDP highlight the needs of local communities. The ITP, however, goes further by analysing problems associated with the transport status quo, and meeting national and provincial policy obligations in respect of the management of transport and rendering transport services in the municipalities. It is essential, therefore, in responding to national and provincial policies, that the transport planning process (the ITP) forms an essential component of the IDP.

The local Municipalities are essentially the implementation authorities of a regional level strategy and there will be activities that do not require national deployment. Due especially to the uniqueness of the local environment, road network and objectives the Gauteng ITS Strategy takes into consideration that these activities might require some local customization.

8.6 ITS Implementation Plan

8.6.1 Purpose of ITS Implementation Plan
The purpose of the ITS Implementation Plan is to identify various strategic thrusts, that align with current transport priorities, and focus on appropriate actions (or projects) for each thrust. This plan will support the various initiatives contained in the Provincial 25-year implementation plan (ITMP25) and will also contain a vision for sustainable deployment over a longer period of time.

Specific considerations in developing an effective ITS Implementation Plan are to:
- ensure a systemic approach
- ensure practical implementation
- provide cost effective solutions based on the available systems and resources
- allow a modular approach
- focus on quick wins (1-2 years), medium term (3-5 years) and longer term (beyond 5 years)
- identify possible partnerships with other institutions or even possibly private partners
- consider funding models.
9. PROPOSED ITS IMPLEMENTATIONS

9.1 Review of typical user needs, and discussion of local user needs

This section reviews the typical ITS user services (adapted from the US Architecture) and considers where (and whether) opportunities for practical implementations exist in the Gauteng context.

Note that the term user service bundle refers to a collection of related user services.

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<tr>
<th>User Service Bundle</th>
<th>User Services</th>
<th>Comments</th>
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| Traffic Management  | • Pre-trip Travel Information  
• En-route Driver Information  
• Route Guidance  
• Ride Matching And Reservation  
• Traveler Services Information  
• Traffic Control  
• Incident Management  
• Travel Demand Management  
• Emissions Testing And Mitigation  
• Highway Rail Intersection | In this user service bundle the most prominent existing systems are SANRAL’s freeway management system (that covers most of the National freeways in Gauteng) with its Management Centre in Rooihuiskraal, and City of Johannesburg’s traffic management system with its management centre in the JRA building. These systems provide pre-trip and en-route information, traffic control, and may in future include travel demand management aspects (such as High Occupancy Vehicle Lanes). Integration between the two abovementioned systems is already being considered by the authorities. The information from these systems could however be integrated into a provincial travel information service. This is discussed under the information management user service bundle. Expansion of the Freeway Management Systems are encouraged. Such expansions could include: Provincial Roads:  
• The R80 from Eskia Mphahlele Drive to Soshanguve: 24km  
• The N14 from Brakfontein I/C to Eeufees Road: 11km  
• The M1 from Buccleugh to Corlett Dr: 10km  
• The R24 from the ORTIA to the R21 before Gillooley’s I/C: 8km (although currently managed by SANRAL) |
- The N12 from the Misgund Interchange with the N1 to Abubaker Asvat Dr (at Lenasia/Soweto): 10km
- The R59 from South Rand Road to Randvaal Road: 28km

Other freeway and arterial management system expansions could include for example the Golden Highway from N1 I/C to M1 interchange (appr. 10 km)

In general the management of important arterials by the metropolitan councils should be encouraged.

The unreliability of traffic signals must be addressed. In this regard one or more projects that address the following should be undertaken:
  a) fault reporting system,
  b) root cause analysis and rectification,
  c) enhancing the maintenance teams.

While this should be undertaken by the appropriate metropolitan councils and their respective departments/agencies the GDRT could partner and jointly fund such activities.

Public Transportation Management
- Public Transportation Management
- En-route Transit Information
- Personalized Public Transport
- Public Travel Security

The recent and planned public transportation systems such as Gautrain, and the BRT systems of Johannesburg, Tshwane and Ekurhuleni are (and will be) equipped with state-of-the-art control systems. These systems are understood to have en-route information provided, and facilities are typically equipped with CCTV cameras and other security features.

The PRASA modernisation programme is may also allow for improved service information to be available.

The above presents an opportune time to integrate with, and consolidate information from, these systems. This could be done in the form of a provincial travel information service. This concept is discussed in more detail in the Information management user service bundle.
| Electronic Payment | • Public Transport Fare Collection  
| | • Toll Collection  
| | • Parking fee collection  
| | W.r.t. public transport fare collection: New systems should comply with the AFC regulations published by the National Department of Transport. This will ensure fare media integration (use of same smartcard on all modes). The GDRT should encourage all operators to adopt this standard in order to achieve the goal of being able to use one bank-based smartcard across the province for all public transport systems. While new systems are expected to conform to the regulations, the implementation of compliant systems for existing bus operators will be challenging. In this regard the GDRT have a major role to play in facilitating and/or providing compliant fare collection systems to such operators. 
| | The SANRAL toll collection system is relevant in this user service. The toll collection does however not employ bank issued cards (i.e. acquiring of transactions, or issuing of payment media is not bank based). It would therefore not appear that there would be synergy in integrating it with the systems for public transport fare collection. 
| | The use of bank-based transaction acquiring systems in the use of parking fee collection is possible, and could be explored further, although no projects are currently proposed.  
| Commercial Vehicle Operations | • Commercial Vehicle Electronic Clearance  
| | • Automated Roadside Safety Inspection  
| | • On-board Safety Monitoring  
| | • Commercial Vehicle Administrative Processes  
| | • Hazardous Material Incident Response  
| | • Commercial Fleet Management  
| | Most of the user services in this bundle would be served by systems procured by freight operators themselves, therefore not requiring intervention by government. 
| | SANRAL has however in recent years implemented a number of overload control facilities that include safety inspection (vehicle testing) equipment. While these currently issue only road traffic offence/infringement notices (traffic fines) to incentivise against overloading and encourage vehicle maintenance, the systems involved are increasingly storing data of offenders which could be aggregated on a provincial or national basis and used to
engage with the freight industry and repeat offenders to create programmes to increase law abidance.

No projects are currently proposed for the GDRT.

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<td>There are a number of emergency management centres (for call taking and emergency service dispatching) in Gauteng. This includes that of the City of Tshwane, Ekurhuleni and Johannesburg. There is also the provincial EMS Call Centre in Midrand, and a separate Disaster Management Centre. No intervention / projects are currently proposed in this regard.</td>
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<td></td>
<td>These fulfilment of these user services are typically restricted to vehicle manufacturers, and currently restricted to the high-end vehicles in the market.</td>
<td>No projects are proposed in this user service bundle, apart from the statement that the design of a provincial information service should be receptive to inputs from vehicle manufacturers if there are opportunities for the creation of interfaces between vehicle guidance systems and the information system. This means that the information system could provide notice of road incidents to vehicle guidance systems.</td>
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<th>Information Management</th>
<th>Archived Data Function</th>
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<td>It is recommended that the GDRT fulfil the role of transport data consolidation for the province. In this regard the provision of a transport information service is proposed. This entails the creation of a facility with data processing and storage capabilities that are able to communicate with the various transportation management systems in the province and to disseminate it to various parties. While the opportunities for data exchange are large, one concept entails the provision of a province-wide journey planner (that could be accessed via the internet, accessed via a mobile device app, or by means of a telephone call). A user could therefore specify his/her departure point,</td>
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destination, and time/date of trip and the service would respond by providing a number of travel options and their cost. In order to perform this function the information service would need to have information on all transportation networks and modes in the province, including real time delays.

Such a facility could vary in physical size from a relatively small facility at which servers and data storage equipment are housed, to a large transportation management centre that could contain a call centre and could be used as a backup (during disaster recovery) for other management centres’ operation (as a strategic partnership with other authorities).

The functionality and possibilities for data exchange of such a service is discussed in more detail later in this chapter.

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<th>Maintenance And Construction Management</th>
<th>Maintenance And Construction Operations</th>
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It is suggested that the Freeway and Arterial Management Systems Contemplated in the above user service bundle be used to communicate maintenance and construction activities to road users and the Gauteng Information Service.

No further projects are proposed.

### 9.2 GTIP 5 Year Plan Action Items

Actions: Implement Gauteng vision of “One Province - One Ticket”

1. Deployment of the Gauteng IFM Framework to promote compliance with National EFC Regulations and initiate the 1st level of Public Transport Integration, ie. Fare Media Integration
2. Create an ITS Directorate within the GDRT that will be mandated to:
   - motivate budget for ITS funding
   - direct ITS investment and oversee the implementation of approved projects
   - develop and maintain the Provincial Transport Management Centre, including the management of travel information and bus subsidy information (see 25-year plan activities).
   - appoint skilled resources within the new department
   - arrange ITS training & skills development
   - represent the Gauteng Province in a Provincial Public Transport Integration Committee
3. Establish a Provincial Public Transportation Integration Committee. This committee will be tasked with taking the process of integrating Public Transport within the province forward. The mandate for which will remain to be defined clearly.

4. Undertake a project to improve the reliability of traffic signals in the province. This should be jointly undertaken with the metropolitan councils and should consider the following
   a) the implementation of a fault reporting system,
   b) root cause analysis and rectification,
   c) enhancing the maintenance teams (increased training and resourcing).

9.3 GITMP 25 Year Plan Immediate Action Items

9.2.1 Medium Term Actions

1. Establish a Provincial Transportation Management Centre
   1. Provide communication and other linkages with National & Metro TMCs
      • Establish the following facilities within the centre:
        o Provincial Transportation Information Centre
        o Provincial Transportation Data Warehouse
        o Freeway / Arterial Management Capability (this is associated with the implementation of freeway and arterial management on the corridors described below.)

2. Establish a communications backbone for the new TMC. The establishment of the above Transportation Management Centre will require reliable communications with other management centres in the province.

3. Establish Freeway / Arterial Management System
   • management of freeway traffic incident by providing adequate warning to motorists by utilising:
     • road based vehicles (travel) information
     • AVL data from BRT and subsidised busses (APTMS)
   • Potential Corridors for this system include:
     o The R80 from Eskia Mpahele Drive to Soshanguve: 24km
     o The N14 from Brakfontein I/C to Eeufees Road: 11km
     o The M1 from Buccleugh to Corlett Dr: 10km
     o The R24 from the ORTIA to the R21 before Gillooley’s I/C: 8km (although currently managed by SANRAL)
     o The N12 from the Misgund Interchange with the N1 to Abubaker Asvat Dr (at Lenasia/Soweto): 10km
     o The R59 from South Rand Road to Randvaal Road: 28km
     o The Golden Highway from Soweto towards the Johannesburg CBD

9.2.2 Long Term Actions

4. Action: Achieve Full Public Transport Integration. The achievement of fare media integration (i.e. the ability to use the same smartcard) and traveller information integration (discussed as part of the provincial transport information service) was discussed earlier in this section. The following two types of integration should be pursued in the medium to long term:
   a) Fare Structure Integration
• This refers to a fee structure that is common across all modes in the province. This would mean, for example, that if a zone-based fare system is applied in Gauteng, that all (or most) modes use that same structure in charging fees or defining transit products. Although this step does not imply integration between different fare collection systems, it is a necessary precursor for the following step in integration (fare integration).
  o Fare structures may include flat fares, distance-based, zonal, or time-based fares
• This means commuters are presented with potentially simple and consistent fare schemes across all modes

b) Fare Integration
• This type of integration means that a commuter can purchase a single product (for example a day-pass) and use it to access all modes. It would also allow one journey, that uses multiple modes / service providers, to incur a single fare.
• This is particularly useful to allow transit products such as period passes (day, week, or month passes) that would enable a traveller to make seamless use of any mode for that period and could be sold with reference to specific geographical fare zones.
• This type of integration however requires operators to reach agreements between each other relating to the apportionment of income from sold transit products and apportionment of fares from multi-operator journeys.

9.4 Additional discussion on the concept of a Gauteng transport information service

The proposal for a Gauteng transport information service stems from the vision that residents and visitors in Gauteng should have access to a service that will tell them how to get from one point to another in the province in the least time, or the least expense. The service should have knowledge of all possible transportation systems and schedules, and know whether there are delays at that point in time (or expected sometime in the future).

With the number of management systems being deployed currently this vision is becoming increasingly feasible.

For the purposes of this discussion the system should be considered in three parts: the inputs, the processing, and the outputs.

The Inputs to the system should contain the following:
  o Static travel information: This includes the routes and schedules for all services in Gauteng and should be available from the various operators.
  o Live travel information: This includes notices about current delays and future delays (in case of expected outages, construction works or industrial action). This will require an agreement with the various operators to interface with their systems so that delays are reported to the information service
  o Static Road traffic information: This includes the road network layout and is readily available
  o Live Road conditions information: This will require an interface with a potentially large amount of sources. Some of the sources might include
    • The SANRAL Freeway Management System
    • The provincial freeway and arterial system itself (proposed earlier in this chapter)
    • Metropolitan traffic management centres
    • Private traffic information services (for example Google Traffic ™ TomTom ™ and other fleet management service providers).
- It may be challenging to reach agreements with the latter in the constraints of the procurement regulations, but incentives such as sharing the consolidated output information (which will be more accurate by virtue of the number of sources) may prove to be enticing to such service providers.

**The processing and storage of data** may include (among other things) the validation and fusion of data into a single dataset. This is especially relevant for live road traffic condition information which may have multiple sources of data.

**The outputs of the system** could include:
- web-based journey planners,
- mobile device apps
- call centres could answer calls from the public
- SMS-based enquiries
- Interfaces with vehicle guidance systems
- Interfaces with fleet management systems

The above listing is not exhaustive and there may well be other means of dissemination in the future. If the data is retained in an open-standard based structure then the creation of additional interfaces in future should be possible, and even encouraged. In this regard the first phase of a deployment is proposed to contain only a small number of output interfaces, such as a journey planner. For an international example please refer to Annexure A.

While it would be expected that standard outputs would be provided freely to the public as the tax-paying public, private ventures could be charged a fee for obtaining specific data if such venture aimed to add value to the information in order to profit from it.

### 9.5 First Order Cost Estimates

The following table provides a high level cost estimate for the projects discussed above.

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Virtual TMC (building alterations plus equipment)</td>
<td>R 100 000 000.00</td>
</tr>
<tr>
<td>2. FMS network - provincial freeway system</td>
<td>R 215 000 000.00</td>
</tr>
<tr>
<td>3. Communications backbone &amp; linking of TMC's</td>
<td>R 45 000 000.00</td>
</tr>
<tr>
<td>4. Arterial management &amp; Surveillance</td>
<td>R 150 000 000.00</td>
</tr>
<tr>
<td>5. Traffic control fault reporting &amp; maintenance systems</td>
<td>R 100 000 000.00</td>
</tr>
<tr>
<td>6. IFM integration - bus equipment (validators etc)</td>
<td>R 75 000 000.00</td>
</tr>
<tr>
<td>7. Miscellaneous</td>
<td>R 25 000 000.00</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>R 710 000 000.00</strong></td>
</tr>
</tbody>
</table>
APPENDIX A: INTERNATIONAL EXAMPLE OF JOURNEY PLANNER

The following figures have been taken from the Transport for London (TfL) Journey Planner webpage which serves as an example of traveller information that can be offered to commuters if a well-managed transportation information service is available.

The first image shows the result of a person that submitted a journey plan request to travel from his/her residence (in this case using his/her postal address SW20 8QA which translates to an approximate address in Wimbledon, London), to the Houses of Parliament and Big Ben at a specific time of the day.

The Journey Planner responded (see the first screen-capture below) with 9 potential route options, showing the order and type of modes that would need to be taken. The modes, indicated in the small figure immediately below are (respectively): walk, mainline train, bus, and underground train.

The journey planner uses the route and schedule information to put together a number of possible routes, and based upon the user’s preferred time of departure calculates the time that it would take to reach his/her destination.

The green text below each option cautions the user of potential delays based on real-time service information received from each of the modes’ operators.

The second screen-capture shows the details of one of the route options. It sets out in detail how a user should proceed to take this route, where he/she must change from one mode to another, and for walking-segments it provides directions.

The bottom of the page then provides further links to real-time service information as well as fares and ticketing options.
Journey Planner

Choose your route/s from the options below

Journey Summary
Departing: Friday 12 August 2011 at: 09:22
From: SW208QA
To: Houses Of Parliament And Big Ben
Restrictions:

<table>
<thead>
<tr>
<th>Route</th>
<th>Depart</th>
<th>Arrive</th>
<th>Duration</th>
<th>Interchanges</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>09:19</td>
<td>10:21</td>
<td>01:02</td>
<td></td>
<td>View</td>
</tr>
</tbody>
</table>
Planned engineering works are taking place

<table>
<thead>
<tr>
<th>Route</th>
<th>Depart</th>
<th>Arrive</th>
<th>Duration</th>
<th>Interchanges</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>09:21</td>
<td>10:21</td>
<td>01:00</td>
<td></td>
<td>View</td>
</tr>
</tbody>
</table>
Planned engineering works are taking place

<table>
<thead>
<tr>
<th>Route</th>
<th>Depart</th>
<th>Arrive</th>
<th>Duration</th>
<th>Interchanges</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>09:23</td>
<td>10:23</td>
<td>01:00</td>
<td></td>
<td>View</td>
</tr>
<tr>
<td>4</td>
<td>09:23</td>
<td>10:24</td>
<td>01:01</td>
<td></td>
<td>View</td>
</tr>
<tr>
<td>5</td>
<td>09:25</td>
<td>10:26</td>
<td>01:00</td>
<td></td>
<td>View</td>
</tr>
<tr>
<td>6</td>
<td>09:25</td>
<td>10:27</td>
<td>01:01</td>
<td></td>
<td>View</td>
</tr>
<tr>
<td>7</td>
<td>09:27</td>
<td>10:29</td>
<td>01:02</td>
<td></td>
<td>View</td>
</tr>
<tr>
<td>8</td>
<td>09:29</td>
<td>10:29</td>
<td>01:00</td>
<td></td>
<td>View</td>
</tr>
</tbody>
</table>
Planned engineering works are taking place

<table>
<thead>
<tr>
<th>Route</th>
<th>Depart</th>
<th>Arrive</th>
<th>Duration</th>
<th>Interchanges</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>09:29</td>
<td>10:30</td>
<td>01:01</td>
<td></td>
<td>View</td>
</tr>
</tbody>
</table>
Planned engineering works are taking place

earliest earlier later latest View selected
# Journey Summary

**Departing:** Friday 12 August 2011 at 09:22  
**From:** SW208QA  
**To:** Houses Of Parliament And Big Ben  
**Restrictions:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Details</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:26</td>
<td><strong>Start</strong> SW208QA</td>
<td>Transfer time: 17 mins</td>
</tr>
<tr>
<td></td>
<td>Walk to Raynes Park</td>
<td>Average journey time: 18 mins</td>
</tr>
<tr>
<td>09:43</td>
<td>Raynes Park Rail Station</td>
<td>Zone(s): 4, 3, 2</td>
</tr>
<tr>
<td></td>
<td>Take <em>South West Trains</em> towards London Waterloo Rail Station</td>
<td></td>
</tr>
<tr>
<td>09:59</td>
<td><strong>Vauxhall Station</strong></td>
<td>Buses every: 4 mins</td>
</tr>
<tr>
<td></td>
<td>Take the Route Bus 87 from Stop: B</td>
<td>Max journey time: 15 mins</td>
</tr>
<tr>
<td></td>
<td>towards Aldwych / Drury Lane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parliament Square Stop: A</td>
<td>Average journey time: 5 mins</td>
</tr>
<tr>
<td></td>
<td>Walk to Houses Of Parliament And Big Ben</td>
<td></td>
</tr>
<tr>
<td>10:26</td>
<td><strong>End</strong> Houses Of Parliament And Big Ben</td>
<td></td>
</tr>
</tbody>
</table>

**Maximum journey time:** 01:00  
**Interchanges:** 1  

Not what you expected? Click here for information on planned service disruptions.  