

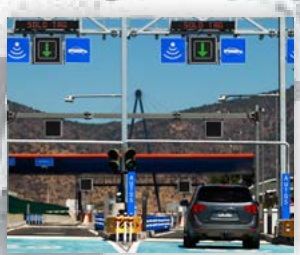


REGIONAL OBSERVATORY OF INTELLIGENT TRANSPORT SYSTEMS FOR LATIN AMERICA AND THE CARIBBEAN



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CONTENTS

1 EXECUTIVE SUMMARY

Executive summary

The main purpose of this report is to show the current state of Intelligent Transport Systems (ITS) implementation in Latin America and the Caribbean (LAC). The report provides an overview of the transport problems encountered in the LAC region, an analysis of the potential benefits gained when implementing ITS applications to the transport sector as well as a description of the ten most relevant applications to solve the current problems of Latin American cities.

Through the review of existing literature and the consultation to ITS and transport related stakeholders in administrations at all levels in the region, the report unveils the level of development of Intelligent Transport systems in 26 countries of Latin America and the Caribbean.

In spite of the particularities of each country, the region as a whole presents similar transport problems: increased congestion, pollution and environmental deterioration, lack of productivity and competitiveness, road safety and scarce infrastructure.

The region is highly urbanized, with very large cities where there is a growing reliance on private transport. This increase on the number of vehicles is causing traffic congestion and extended travel times. The higher rate of vehicle ownership and longer travel times have also contributed to aggravation of pollution levels. The overall worsening of air quality has a direct effect on public health. As

a result of the lack of road safety policies, the number of fatalities in Latin American roads has not been contained; on the contrary there is a tendency to rise by 2020. The deficient situation of transport infrastructure and urban mobility is an obstacle for economic development and production growth that could translate in social progress and increased competitiveness.

Intelligent Transport Systems have proved to have the significant potential to improve:

- Safety
- Efficiency in mobility
- Congestion reduction
- Productivity
- Energy and environment and
- Customer satisfaction

Aiming at finding solutions to amend the current situation, the Inter-American Development Bank (IDB) is promoting the creation of a **Regional Observatory of Intelligent Transport Systems in Latin America and the Caribbean**, with the objective of compiling and sharing the successful experiences and fostering best practices on ITS deployment. The focus has been put on the (33) main cities within the LAC region and the (28) emerging cities participating in the Emerging and Sustainable Cities Initiative (ESCI) promoted by the Inter-American Development Bank (IDB) since 2011.

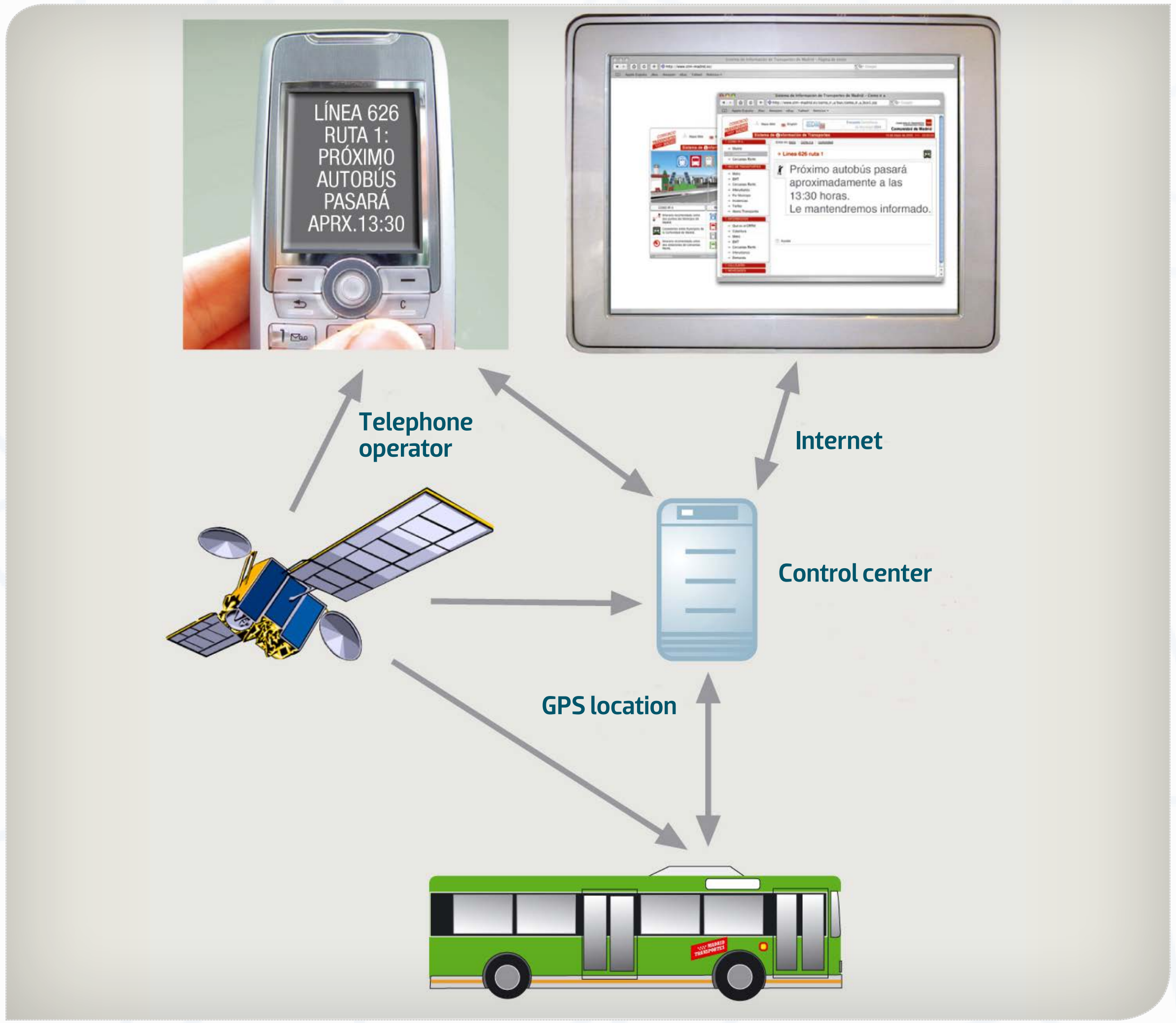
With a view on developing the ITS Observatory, a descriptive taxonomy of **10 key ITS applications** has been compiled (see Chapter 4) in response to the transport sector's needs and priorities in the selected cities:

- **Transit Fare Collection**: Automated ticketing system based on smart cards or magnetic stripes, which provide cost savings, increased efficiency, fleet management and control for administrative agencies. Other benefits that may be listed are enhanced safety and reliable services that translate into simplified traveler access, reduced travel times and user satisfaction. This type of application is justified given the need to fight against fraud, speed up boarding payments and obtain useful information for the public transport operators.

  The first choice for this kind of systems nowadays is smartcard technology, as contactless smartcards prove to be the most secure, the one with the lower maintenance costs and

the lowest transaction costs. From the operation point of view, the business models used in this ITS system are usually the **Public-Private-Partnership (PPP)** or concession model, more often used in Latin America, and the **European model**, in which the Public Transport Authority and/or the public transport operators tender the supply and maintenance of the Transit Fare Collection System.

The transit fare collection systems are currently in a mature level of development. In Latin America they have been successfully implemented in cities such as **Bogota (Colombia), Lima (Peru), Mexico D.F. (Mexico) and Santiago de Chile (Chile)**. In the latter, in 2013 the number of Tarjeta Bip!cards, used in the system and based on contactless technology was 4,966,650.



- **Automatic Vehicle Location and control systems (AVLC)**: Automatic vehicle location (AVL) and computer aided dispatch (CAD) systems facilitate transit operations management, providing up-to-date information on vehicle locations to assist transit dispatchers and inform travelers of bus status. The main benefits of these applications are improved fleet management, transit reliability, with reduced waiting times, added security and efficient fleet management through enhanced vehicle-to-dispatch communications, enabling faster responses to physical threats and attacks, accidents and vehicle breakdowns.

AVLC and CAD give response to the public transport problematic situation in LAC. These types of ITS applications support public transport priority at intersections, passenger information systems, and systems for frequency regulation according to the prevailing demand. Among their advantages are significant reductions in commuting time, a better use of the operating bus fleet and, from the environmental approach, savings in fuel and pollution emissions reduction. In this case, the business models used in this ITS system are usually the **Public-Private-Partnership (PPP)** or concession model and the **European model**.

In recent years cities like Milwaukee and Kansas City in the USA, and **Curitiba and Sao Paolo (Brazil) or Guadalajara (Mexico)** in LAC have already implemented AVLC systems, with an investment of around 5,000 - 8,000 USD per bus.

Source: commons.wikimedia.org/wiki/User: Mariordo

- **Traveler Information Systems in Transit Area:** Dissemination of transit information to users through in-vehicle, wayside, or in-terminal dynamic message signs, as well as the internet or wireless devices. Information systems provide substantial benefits in terms of time savings and user satisfaction, since they allow the traveler to plan their trips in advance, eliminating uncertainty and waiting times and contributing to a better user's perception of reliability and punctuality. The technologies available to provide real-time information (RTI) are electronic signs or Geographic Information Systems (GIS) via web.

However, the key challenge in the implementation of these technologies is to procure data collection from different sources and secure its integration with other applications in order to offer accurate information.The same business models used in the previous applications are being used in this case: **Public-Private-Partnership (PPP)** or concession model and the **European model**, in which the Public Transport Authority and/or the public transport operators tender the supply and maintenance of the Traveler Information System.

It is worth to mention the experiences implemented in cities like Seattle (USA), Ottawa-Carleton (Canada), London (UK) and Madrid (Spain), where the Public Transport Integrated Management Center (CITRAM) delivers real time multimodal information to support decision making and public transport coordination. Meanwhile, in Latin America these systems are already a reality in cities like **Curitiba (Brazil), Guadalajara (Mexico) and Santiago de Chile (Chile)**.

- **Shared Mobility Systems:** These shared used mobility systems are new technology-enabled services and tools that give instant access to new services and travel information while complementing traditional modes like fixed route transit. Examples include bike-sharing, car-sharing and taxi-sharing, new forms of ridesharing, technology-enabled shared ride services, new private forms of transit and travel itinerary services that ease the selection of travel options with a click of the mouse or a tap on your smartphone. This report focuses on shared bicycle systems.

Latin American cities have a clear need to improve sustainability and urban mobility through economic, efficient mobility options. Bike sharing systems have recently been implemented with fast growing demands in **Buenos Aires (Argentina), Quito (Ecuador) and Mexico City (Mexico)**, among others. In the case of **Mexico City, EcoBici** has an estimated capital cost per bike of approximately USD 3,400.

The technology used is oriented to offering information in websites or mobile apps, planning services to monitor the use of bikes and payment services including user registration and integration with other modes through smart-cards and bike keys.

The institutions involved in the implementation of these schemes are the government agencies in charge of the planning process and the operators responsible for the day-to-day operations of the systems. The key challenges for these bodies during the implementation process are the station density, bikes per residents, coverage area, quality of bikes and easy-to-use stations, and last privacy regulations and payment laws.

- **Urban Traffic Management:** Systems used in cities to improve the efficiency of urban roadways, using traffic detectors, traffic signals, and various means of disseminating information to travelers. These systems make use of information collected by traffic surveillance devices and others sensors to smooth the flow of traffic along city corridors.

  Among the main benefits of urban traffic management systems are:

  - Reduction of traffic congestion,
  - Reduction of fuel consumption and pollutant emissions,
  - Integration of traffic management in a region and,
  - Enhanced communication in transport management related issues between the implementing institutions, that is, traffic and mobility authorities and the traffic control centers assisted by technological companies.

  LAC countries may benefit from these applications given the growing numbers of road users and the limited resources offered by the current infrastructures in their cities. The centralization and management of signalized intersections, traffic control systems and traffic and road information contributes to appropriate management of urban traffic, reducing waiting times at traffic lights and relieving traffic congestion. The most used technologies in this field are the **Traffic Control Systems** (software for data collection, traffic strategies design, and dynamic traffic signs control), **Signalized Intersections and Traveler Information Systems** (Variable Message Signs (VMS), Dynamic Speed Control, Website and Social Networks).

  Some international examples worth to mention are the cases of London (UK), Beijing (China), New York (USA) and Toronto (Canada). In the LAC region, cities like **Medellin (Colombia)** and **Quito (Ecuador)** have also deployed Urban Traffic Management Systems. In **Quito**, for example, the Metropolitan authority invested around 27 Million USD for a 24 months implementation project. The key implementation challenges have proved to be multi-agency co-operation and coordination, interoperability, standardization and systems operation and maintenance of the equipment.

- **Enforcement in urban environment:** Automated enforcement systems are electronic devices that detect traffic violations and document, through photo or video evidence, the vehicle at fault. The most common types of automated enforcement systems in urban environments are associated with speed limit compliance, red-light running and other signal violation (dedicated lane, illegal turn, etc.).

The benefits of speed enforcement relate to:

- Safety improvement,
- Reduced driving aggressiveness and
- Speed enforcement assistance.

Road safety is one of the main challenges in Latin American urban centers. There is an urgent need to plan specific policies and automated enforcement systems have proved to reduce the number of casualties due to exceeded speed limits.

The traffic or transport department of the municipality is the public agency in charge of implementing the systems, although it may be done under various different models.

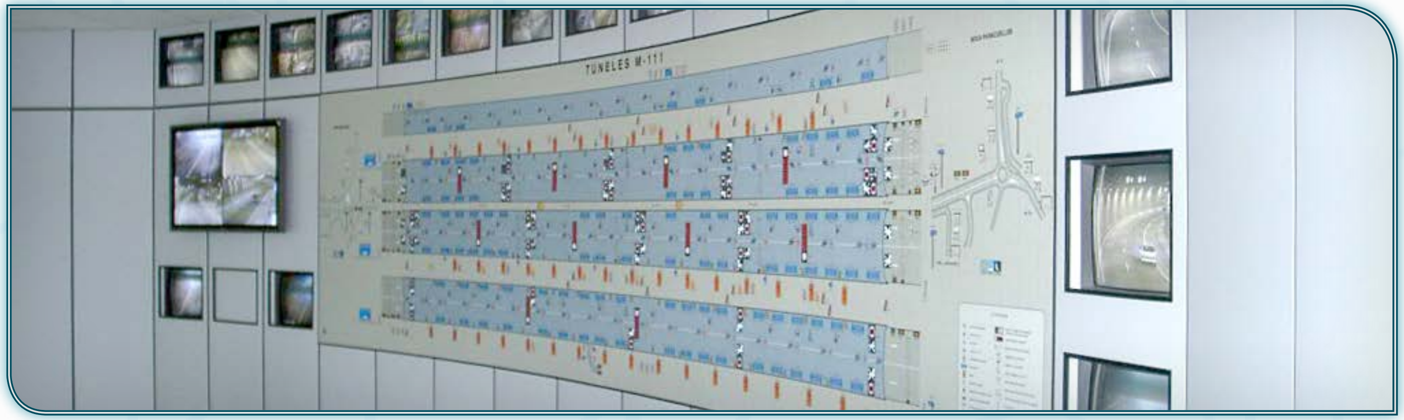
Countries like Australia, Canada, Singapore and the United States have successfully implemented Automated Traffic Enforcement (ATE). In Europe, the city of London (UK) is an international example worth to mention and in Latin America, cities such as **Lima (Peru), Medellin (Colombia) and Río de Janeiro (Brazil)** should also be highlighted. The key implementation challenges are the existence of a centralized register of vehicles and owners, the use of traffic safety criteria to determine where to use automated traffic enforcement systems and technical considerations related to features and limitations of each technology.

- **Interurban Traffic Management:** Systems used on a local and regional road network level to maximize the effectiveness and efficiency of a roadway and result in improved safety, trip reliability and throughput. These systems provide updated information from an operations center that receives and processes field information picked up continually by sensors on main roads. Telematic systems, such as Variable Message Signs, are designed to correct this situation, allowing the same panel to provide information continuously updated by remote control from a control center.

This allows users to re-route or chose the best route based on up-to-the-minute information with a positive effect on user's safety (decreased crash rate, improved road capacity and system performance), efficiency, traffic congestion, delays and pollution.This is especially relevant for trade transport moving in interurban highways, since improvements will lead to increase trade efficiency and productivity growth. The technology is in a mature level of development, largely implemented in highways internationally.

The entities responsible for the planning of these systems are generally the Ministry of Public Works and the Traffic Authorities from the public side and the concessionary companies on the private side, in charge of the building, operating and maintenance ofinterurban highways and their ITS systems. International examples may be reported, such as the case of The Netherlands and Germany. In LAC, we may find some examples of interurban ITS equipment in **highways of Mexico**. The key challenges reported after the implementations are the following:

- Multi-agency co-operation and coordination
- Interoperability
- Standardization
- Systems Operations and Maintenance



- **Road Safety in interurban environment:** It relates to speed enforcement to control speed limits; surveillance and weather and road conditions monitoring to mitigate the impacts of weather related risk and driver information systems based on Variable Message Signs (VMS) and Variable Speed Limit Signs (VMLS) to warn drivers. Among the benefits that these systems will accomplish are safety and traffic optimization. The overall payback is decreased average speeds, less fatal accidents, reduction of traffic noises and emissions.

These road safety systems are widely spread throughout the world. As in the previous cases, the entities responsible for the planning of these systems are the Ministry of Public Works and the Traffic Authorities (in charge of enforcement) from the public side and the concessionary companies on the private side, in charge of the building, operating and maintenance of interurban highways and their ITS systems. The participation of the Meteorological Agency, the Civil and Emergency Protection, the Police are also useful to provide weather information and forecasts, assist in case of emergency and enforce speed limits.

The speed management and enforcement applications have been applied in Australia, Canada, Europe and the United States for over a decade with very positive results. In Latin America, examples of tunnel safety applications may be found in the **Coviandes Tunnel in Colombia** and **Sinaloense Tunnel in Mexico.**

- **Electronic Toll Collection (ETC):** This technology allows drivers to pay tolls without cash and without having to stop at control points. The toll fee is automatically deducted from the user's bank account by identifying the vehicle's number plate on its way through the toll gate. Among the main benefits of implementing ETC systems are:

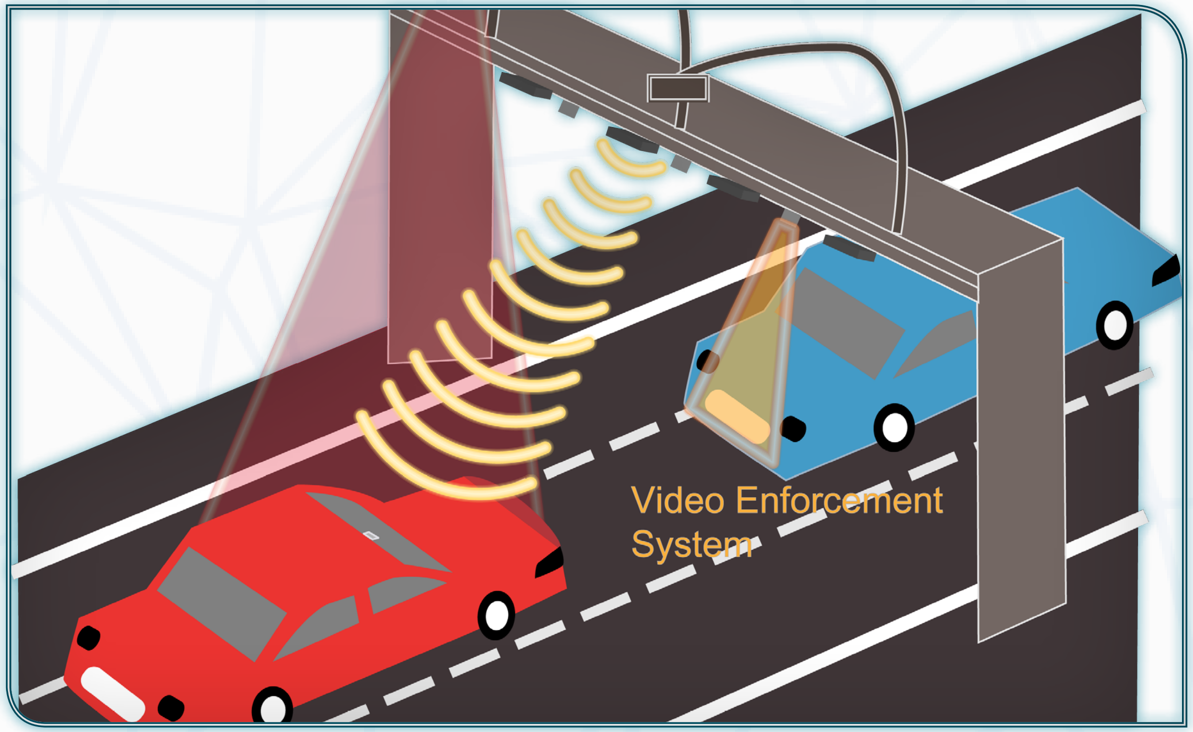
  - Safety during payment at toll plazas
  - Reduced fraud and money costs (cost effectiveness)
  - Increased flexibility in toll fees
  - Decreased emissions
  - Improved performance (faster collection).

(toll), taking into account road maintenance costs. The usual concession model is Build-Operate-Transfer (BOT) —tolls are deployed by the private sector, which operates the infrastructure on a concession regime and then is transferred to the government.

The ETC technology is widely used in toll roads over the world. Implementation of ETC applications may be done in 3 different ways:

- Electronic tolling added to conventional toll lanes
- Electronic toll only lanes
- Open road tolling – Multilane Free Flow Tolling

The challenges to overcome are the existence of a legal context, standardization of tags and equipment and interoperability of the payment systems. A couple of good examples are the implementation of the E-Zpass electronic toll collection systems in the New Jersey Turnpike (USA) and Oklahoma Turnpike, one of the first U.S Highways to use high speed electronic toll plazas. On the other hand, the Electronic Toll Collection system installed in **Santiago de Chile (Chile)** is a noteworthy example in Latin America.



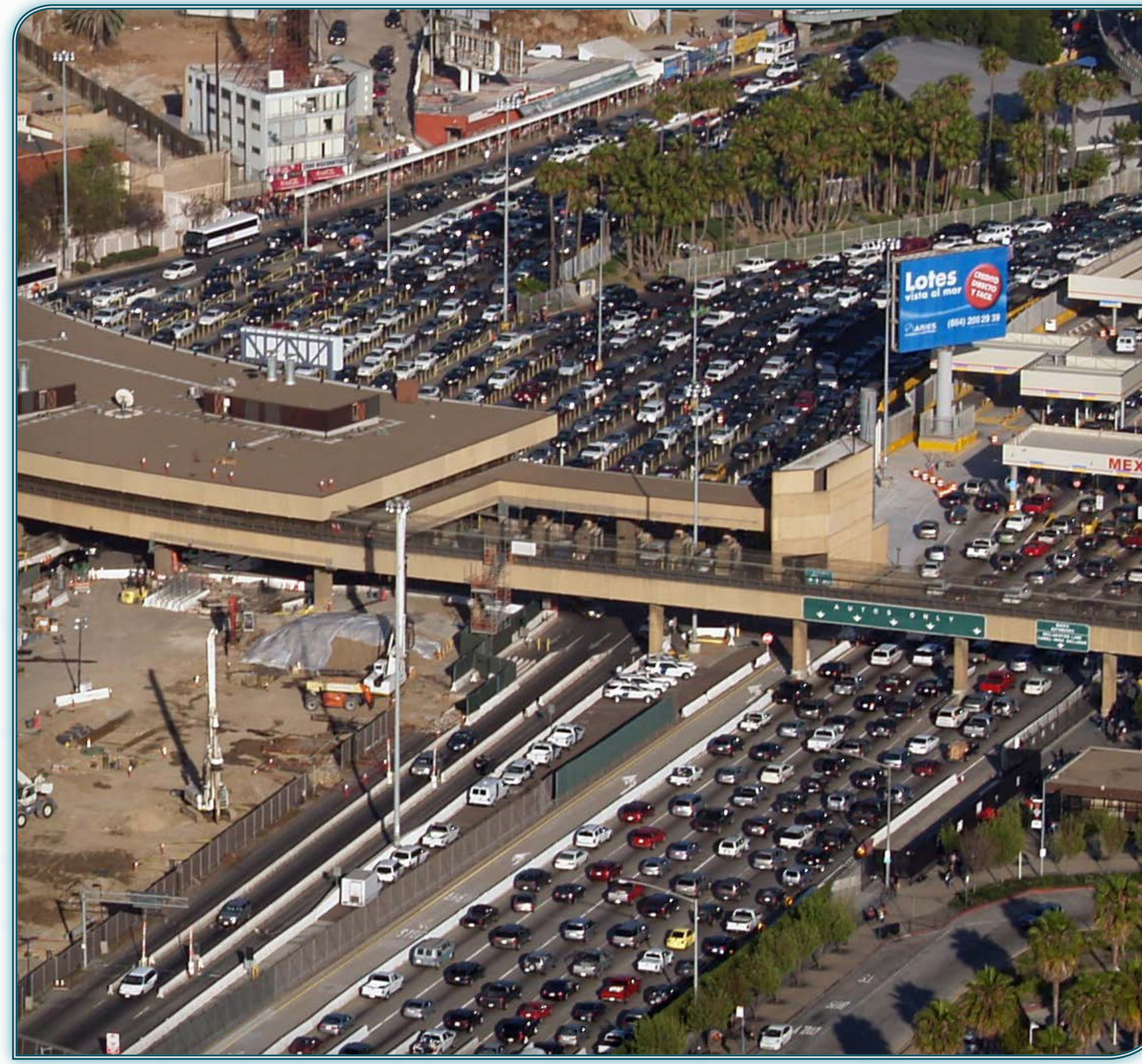
- **Automatic Vehicle Identification (Border Crossing):** ITS applications for commercial vehicle operations (ITS/CVO) are designed to improve the communication between motor carriers and regulatory agencies, concerning automatization and report of regulation, monitoring, inspection and enforcement processes by transport authorities. They achieve this through the use of Automated Vehicle and Weight-in-motion technologies.

  Border crossing processes in Latin American countries are inefficient, long and repetitive. E-Screening technologies contribute to expand commercial vehicle operations, reducing time and costs for the administrations in charge and the trade companies.

The main benefits that ITS/CVO may accomplish are:

- Improved effectiveness of commercial vehicle safety enforcement activities.
- Decreased congestion and improved efficiency in weight stations at international border crossings.
- Increased safety and productivity, reducing commercial vehicles accidents.
- Reduced administrative costs for supervisory agencies.
- Improved economic competitiveness by reducing transport companies costs.
- Reduced costs related to carrier operations and national regulatory requirements.

The most important experiences of Electronic Clearance at international borders are located in **USA/Mexico** and USA/Canada **(FAST-Free and Secure Trade)**. The key implementation challenges to be faced are the exchange of data, the cooperation of agencies involved, information protection measures and the use of interoperable transponders at cross borders.



Source: commons.wikimedia.org/wiki/UserPhilkon

The study concludes that the level of development of ITS applications in Latin American countries is to a certain degree, homogeneous. As shown in the picture below, countries like Mexico, Argentina, Brazil, Chile and Colombia have a very high level of development in terms of implementation of applications. This is because they have implemented at least 8 of the 10 types of applications previously described. Closely after follows Guatemala, Panama, Uruguay or Venezuela, all with a high level of development, having implemented 6-7 types of ITS systems. In general terms, it is observed that the Caribbean islands have a lower development level in the implementation of ITS applications. Previous action is required in those countries, where there is still an urgent need to regulate y reorganize public transport operations and moreover, to build or rehabilitate road and railway infrastructures.

Source: commons.wikimedia.org/wiki/Jaan-Cornelius K

Figure 1

Presence of the 10 ITS applications in Latin America and Caribbean countries

Two conclusions can be drawn from the comparison of the state-of-the-art of the 26 countries.

First, factors such as the size, geographic and demographic characteristics, socio-economic configuration, financial resources and the public transport system status determine the development level of Intelligent Transport Systems at a national level. Smaller countries have clear constraints given the nature of their configuration (i.e. reduced km of highways and therefore, the impossibility to install toll roads and e-tolls, reduced institutional support, etc.). The number of applications implemented clearly relates to the size, institutional capacity, political will, financial and organizational capabilities, and also depends on the number of cities selected for the study in each country.

Second, the analysis of the state-of-the-art at the city level, reflects that most Latin American capital cities have a high development level, taking into consideration that most of them have deployed or are in the middle of a planning or construction process of integrated transport systems, and thus have implemented or are implementing Transit Fare Collection Systems, Automatic Vehicle Location and Fleet Management systems, Traveler Information Systems, Urban Traffic Control and Management Centers, etc. This could be a result of a latent need for technological systems to solve mayor congestion problems, environmental issues, and mass transportation demand.

Figure2

Presence of the 10 ITS applications in Latin America and Caribbean countries

Level of development of the 6 ITS applications in LAC:

1. Transit Fare Collection
2. Automatic Vehicle Location and control systems.
3. Traveler Information Systems in Transit Area.
4. Shared Bicycles.
5. Urban Traffic Management.
6. Enforcement in urban environment.

- Low
- Medium
- High

Source: Own preparation

Figure 3

Presence of the ITS applications in Latin America and Caribbean countries (ITS systems implemented at national level)

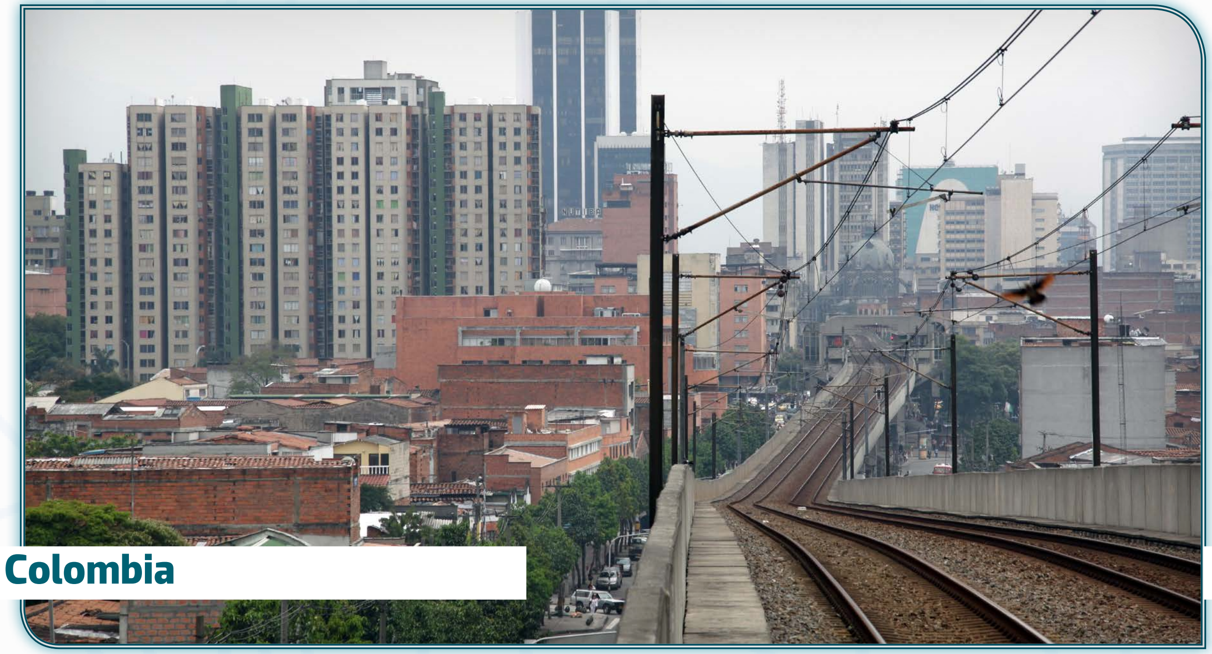
Level of development of ITS applications in LAC:

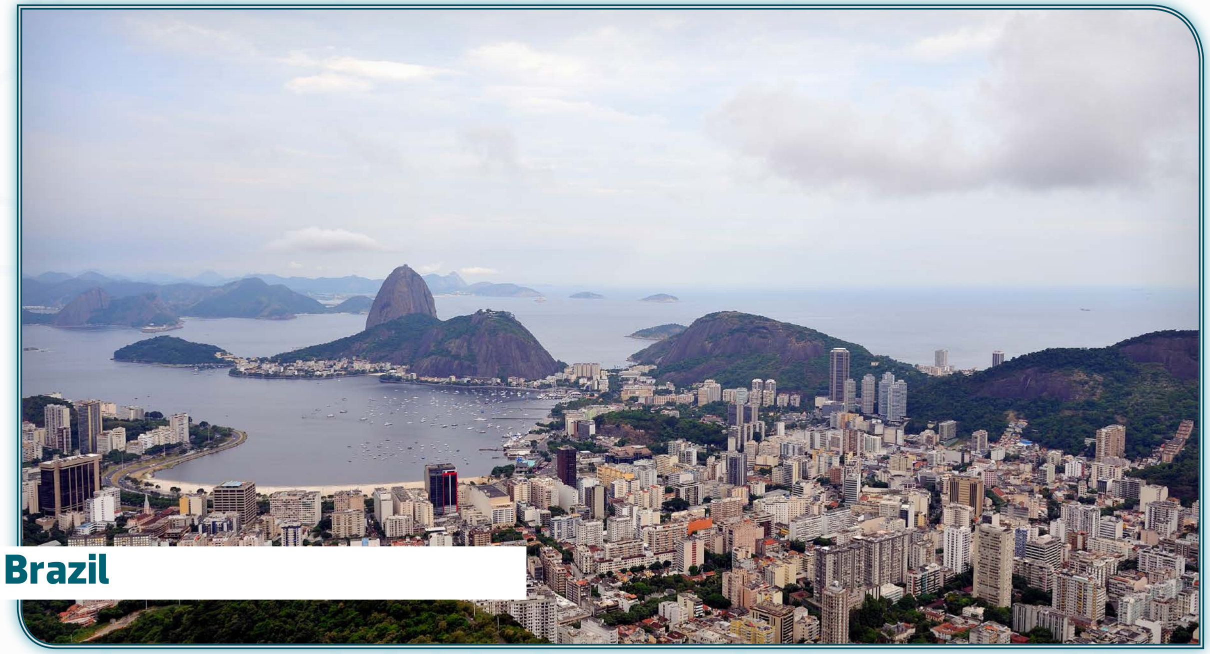
7. Interurban Traffic Management.
8. Road Safety in interurban environment.
9. Electronic Toll Collection.
10. Automatic Vehicle Indentification – Border Crossing.

- Very Low
- Low
- Medium
- High
- Very high


Mexico


Chile


Colombia


Brazil

Countries like Mexico, Chile, Colombia and Brazil are leading the transformation process in terms of ITS implementation in the LAC area. However, this report convenes that there are significant development perspectives in the field. One may observe the potential market for Intelligent Transport Systems and their capacity to bring along extremely valuable benefits for the States from the social, legal, economic, environmental and organizational points of view.

Although there is still a huge development potential, the implementation of ITS technologies has already delivered a sound and robust improvement of the transport sector in the region. A number of problematic areas are being handled by the local governments, and nowadays, it is possible to find the many of the ten ITS solutions previously described deployed over many cities in the region.

Figure 4

Presence of the ITS applications in Latin America and Caribbean countries (ITS systems implemented at city level)

The report concludes that based on the existing experiences in the Latin American and Caribbean countries, it is possible to materialize the potential benefits of implementing Intelligent Transport Systems in the region. It is important to mention that the study reflects the state-of-the-art of ITS application sat a concrete moment of time; the current status is rapidly evolving as most cities and national governments are considering or planning the inclusion of ITS applications in their transport systems and infrastructures.

2

INTRODUCTION TO ITS IN LATIN AMERICA AND THE CARIBBEAN

2.1 Latin America and Caribbean Transport Problems

Latin America and the Caribbean (LAC) is the most urbanized region in the developing world with 470 million of people in 2010 and 51 cities with population over 1 million. As shown in **Figure 5,** the region went from 40 percent of the population living in cities at 1950 to almost 80 percent sixty years later, and the forecast indicates that the proportion of urban population will approach 90 percent by 2050[1]. The cities may be diverse but there is one similarity: urbanization speeds and levels they are facing. Different from developed countries, where urbanization has historically occurred gradually, major cities in this region have experienced explosive growth in recent decades.

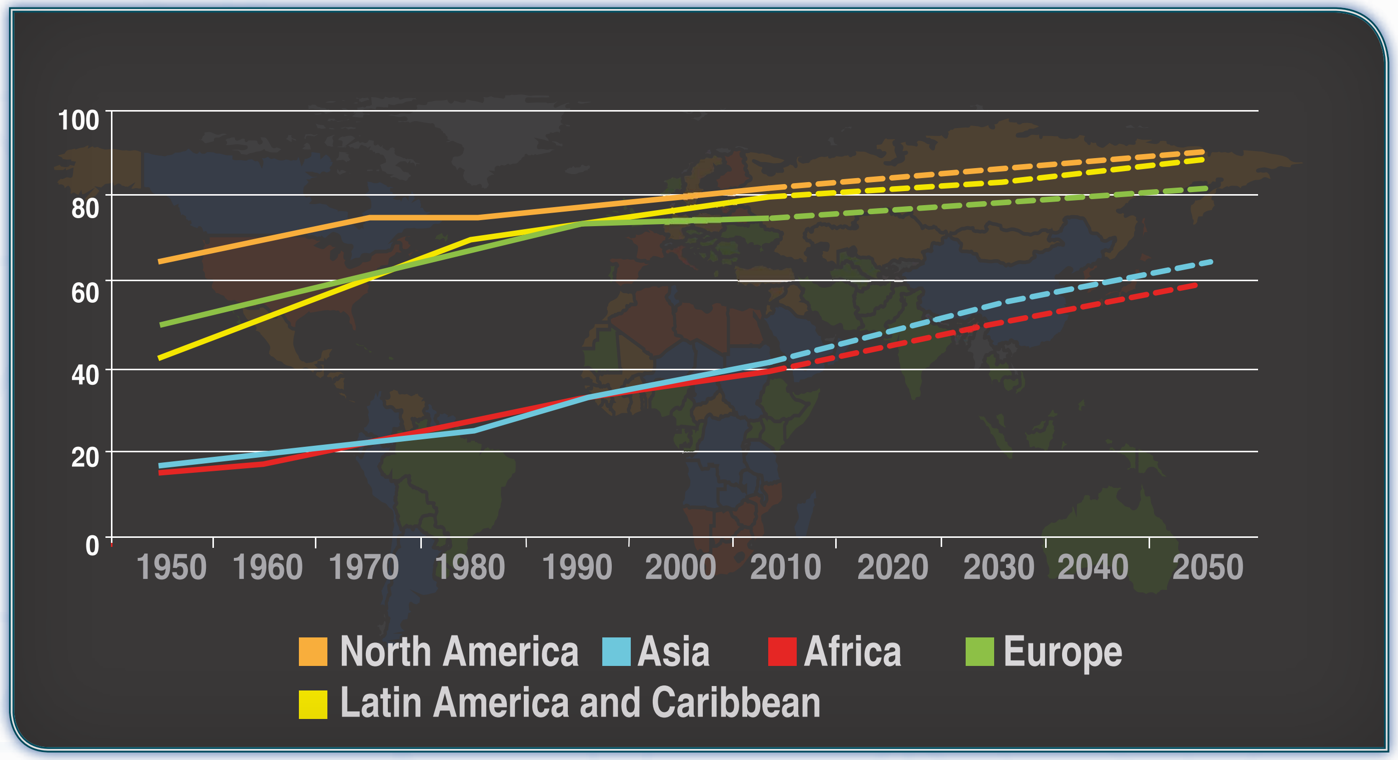


Figure 5. Urban Population by World Region

Source: Urban Population by World Region (Source: Urban Ages, Cities Programme of London School of Economics and Political Science)

At the same time, the motorization rate is increasing rapidly in major cities, such as Santiago de Chile or Mexico DF, although in the region is still clearly below the average of OECD countries. Then, in parallel, road congestion, accidents and air pollution are also increasing; problems that added to the lack of infrastructures represent the main transport problems in LAC region. Each of these ones is briefly analysed below.

2.1.1. Increased Congestion

The demand growth for transport and transportation infrastructure has increased congestion, delays, accidents and environmental problems, particularly in LAC's largest cities.

This explosive increase stems from greater access to cars and to credit, lower sales prices, larger supply of used cars, population growth, fewer people per household and the limited application of well-structured urban transport policies. These are the main observations of an article about "Urban Transport Congestion: Causes and Economic and Social Consequences", by the Transport Unit in the Economic Commission for Latin America and the Caribbean (ECLA)[2].

The same article indicates that Latin America's major cities invest around 3.5% of the regional GDP in transportation, and GDP itself is influenced by traffic congestion, which affects private and public transport users, bringing with it losses to economic efficiency and other negative effects for society.

The authors define 'congestion' as the prevailing condition if the introduction of a vehicle into traffic flows rises the circulation time of the rest; but the congestion problems not only impact in travel-time, there are other negative effects which affect to quality of life of all city inhabitants: more noise and air pollution, negative impact on mental health, stress, etc.

A recent study released by the Industry Federation of the State of Rio de Janeiro (FIRJAN)[3], confirms that traffic congestion has tremendous economic costs. The study found that congestion cost the cities of Rio de Janeiro and São Paulo R$ 98 billion (roughly 43 billion USD) in 2013 alone. The loss amounts to about 8% of each metropolitan area's Gross Domestic Product (GDP), and 2% of Brazil's entire GDP. This is greater than the estimated budget for transport capital investment in Brazil, Mexico, and Argentina combined. The situation is serious, as the survey only accounted for the economic cost of lost work hours and wasted fuel, but figures would be much greater if it included other costs, such as the increased spending on public health, vehicle maintenance, or road infrastructure, all of which create significant costs for city governments and individuals.

To face this 'congestion' reality, cities can turn to sustainable transport alternatives to fight the costs of traffic congestion while providing additional benefits for health, safety and quality of life.

Figure 6. Traffic congestion (São Paulo).
Source: TheCityFix. Photo by Paulo Fehlauer /Flickr

2.1.2 Pollution and Environment Deterioration

Pollution and environmental risk by greenhouse gas emissions (GHG) are other main problems related to transport of Latin America and Caribbean Region. Transportation is the second largest contributor to global carbon dioxide (CO2) emissions from fossil fuel combustion, see Figure 7. In comparison with the world as a whole, CO2 emissions in Latin America are heavily concentrated in transportation, which produces 35% of its total emissions, compared to a 24% of transport emissions throughout the world. Moreover, transport emissions are concentrated in road transport, which accounts for over 90% of these emissions, split equally between passengers and surface freight[4].

Furthermore, transport is the largest contributor to the urban air pollution in all cities in general, and largely in LAC megacities, which has important implications for public heath, as indicated by World Health Organization: "Air pollution is a major environmental risk to health. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma. Reducing outdoor air pollution also reduces emissions of CO2 and short-lived climate pollutants such as black carbon particles and methane, thus contributing to the near- and long-term mitigation of climate change"[5].

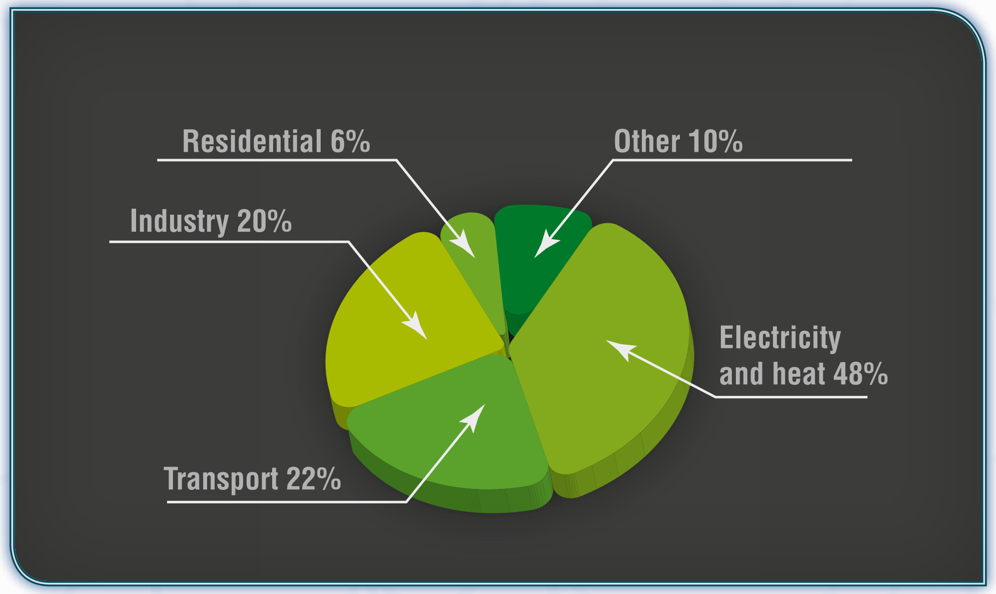


Figure 7. CO2 Emissions from Fuel Combustion
Source: International Energy Agency (IEA). 2012. CO_2 Emissions from Fuel Combustion: Highlights. IEA, Paris.

2.1.3 Road Safety

Concerning road safety in Latin America and the Caribbean, a publication by The Economic Commission for Latin America and the Caribbean (ECLA) –the Spanish acronym is CEPAL– indicates the importance of the road safety challenges for Latin America and the Caribbean, where despite national and multilateral efforts in the framework of the Decade of Action for Road Safety, the estimated road traffic death rate is 17.8 per 100,000 inhabitants). If current trends continue, deaths could rise to 31 per 100,000 by 2020. Most of these deaths occurred among vulnerable road users, with pedestrians accounting for up to 31% of total road traffic fatalities recorded in the region[i], while figures are 12% and 14% respectively in countries such as the United States and Canada. In 2010 alone, more than 23,500 pedestrians died on the streets and roads of Latin American and Caribbean countries, according to data from the Pan American Health Organization (PAHO, 2013). In addition, Latin American countries lose an average of 2% of their annual gross domestic product (GDP) due to motor vehicle deaths and, in some cases up to 4% or 5%.

Figure 8. Lack of road safety in Latin American city
Source: The World Bank

For these reasons, it is necessary to implement effective road safety policies, which not only pursue a comprehensive and sustainable mobility policy, but also their effects on other public spheres, such as financial impacts on the national budget and on social welfare.

2.1.4 Lack of infrastructure

Like other infrastructure sectors in Latin America, transport infrastructure has significant shortcomings. According to the article "The economic infrastructure gap in Latin America and the Caribbean" published by ECLA[6], one of the reasons behind the gap with other emerging economies is that total transport investment in the region has dropped to half its levels over the past two decades and, in terms of gross domestic product (GDP), it is one third of what it was in the mid-1980s.

i Proportion varies by subregion: the rate is 25% in the Andean region, almost 27% in the Caribbean and 31% in Central America (PAHO, 2013).

In addition to lower public investment, the insufficient private-sector mobilization and the complex geography of the region have also contributed to this lag in transport infrastructure, see table below.

This remains one of the key challenges, increase availability and quality of infrastructure services help reduce production and distribution costs as well as increase the productivity of local companies.

Therefore, all systems that boost investment on infrastructure, such as electronic toll collection, will contribute to the economic growth in the region.

Indicator	LAC	OECD	Gap
Transport infrastructure	**3.30**	**4.96**	**1.66**
Quality of overall Infrastructure	**3.86**	**5.53**	**1.67**
Quality of roads	**3.58**	**5.19**	**1.61**
Quality of railroad Infrastructure	**1.90**	**4.47**	**2.57**
Quality of port Infrastructure	**3.93**	**5.21**	**1.27**
Quality of air transport Infrastructure	**4.44**	**5.58**	**1.14**
Available airline seat Km/week, millions	**397.33**	**3,373.87**	**1,976.53**

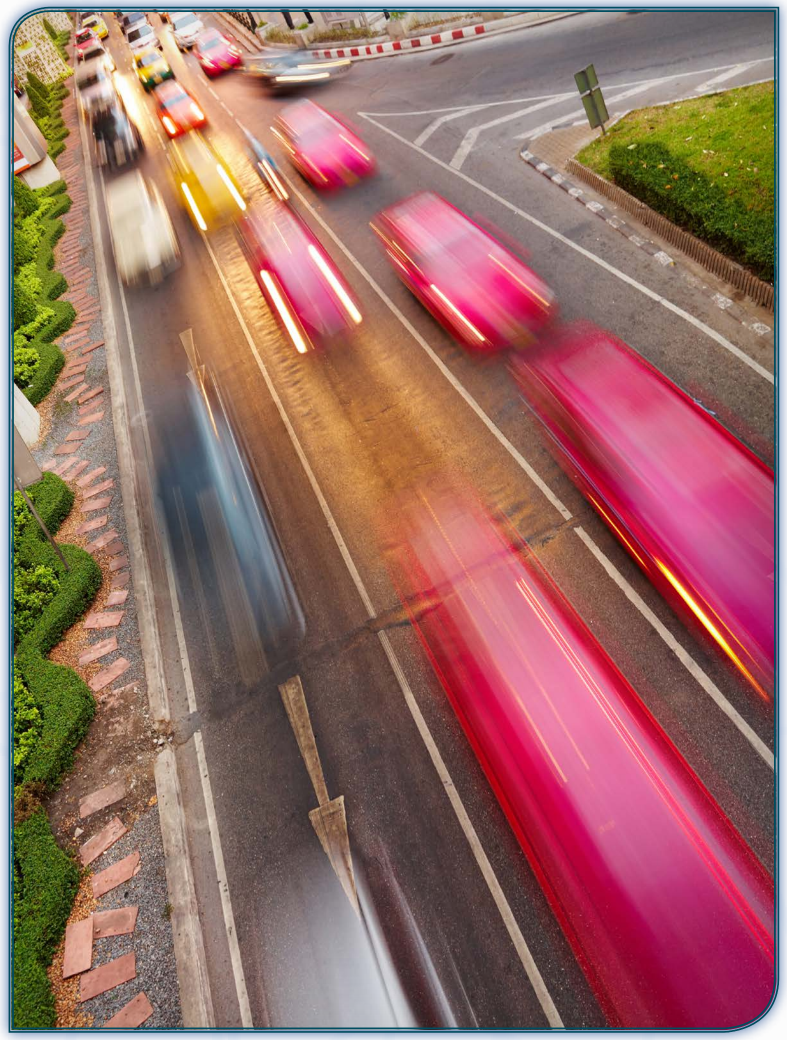


Figure 9. Transport infrastructure: LAC compared with OECD countries
Source: The Global Competitiveness Report 2012-2013

2.1.5 Competitiveness and Productivity

Despite the region's rapid economic growth of the past decade and a positive economic position, it continues suffering low levels of productivity and slow productivity growth rates. Overall, after a few years of general improvement, the results of the "Global Competitiveness Report"[7] show that most countries are stagnating in their competitiveness performance and, therefore, urgent actions should be taken to support the transition of Latin America towards higher productivity levels. There are four important areas of action:

- improve the functioning of the institutions;
- improve the quality of infrastructure;
- provision of production factors through enhanced competition;
- improve the skills, technology and innovation base.

2.2. Intelligent Transport Systems and its Potential Benefits

Intelligent Transport Systems are shown as an efficient solution to improve mobility, safety and environmental problems, with relatively low investment; therefore, they are a very interesting tool, particularly in large cities and metropolitan areas with increasing demand.

This section provides an overview and defines Intelligent Transport Systems (ITS) and its potential benefits.

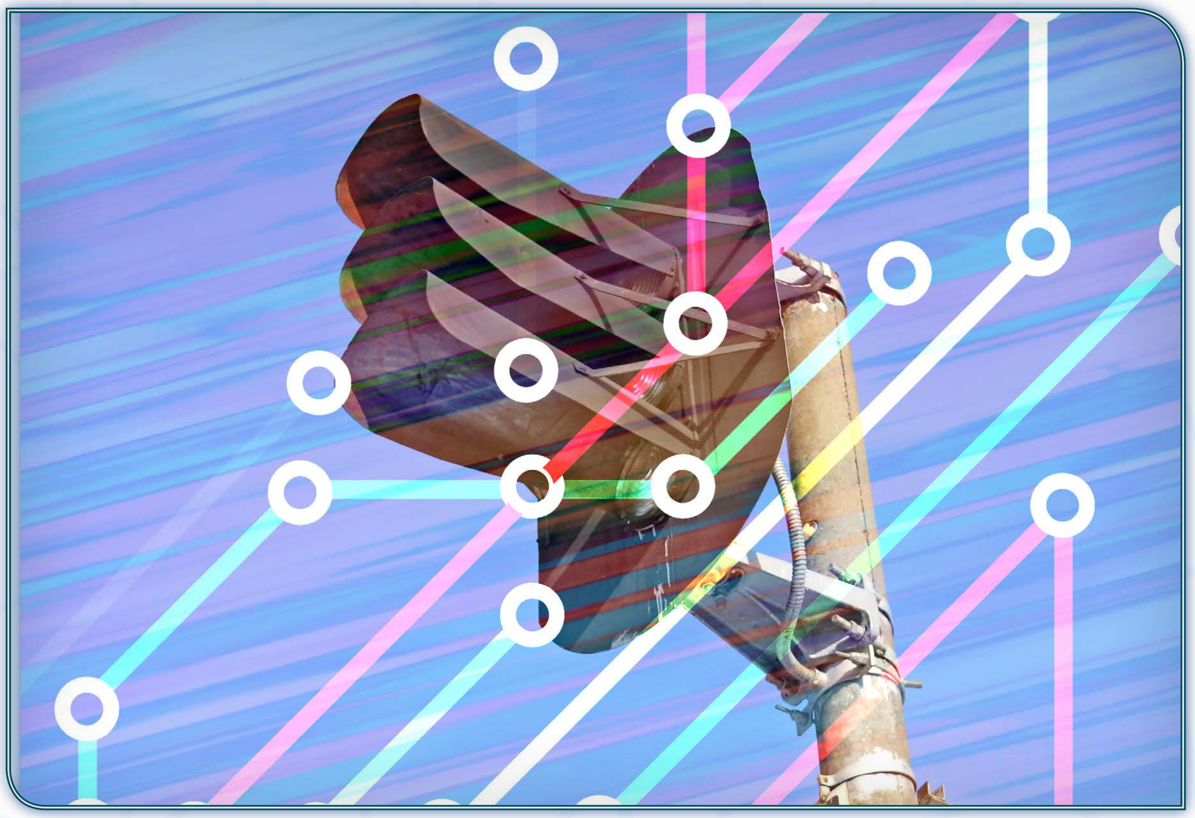
2.2.1. Definition of ITS

According to PIARC, ITS (Permanent International Association of Road Congresses), is a generic term for the integrated application of communications, control and information processing technologies to the transportation system. As a result, ITS systems save lives, time, money and energy and the environment. The term "ITS" is flexible and can be understood either in a broad

or in a narrow way. "Transport telematics" is a term used in Europe for the group of technologies that supports ITS.

ITS covers all modes of transport and considers all elements of the transportation system – the vehicle, the infrastructure, and the driver or user, interacting together dynamically. The overall function of ITS is to improve decision making, often in real time, by transport network controllers and other users, thus improving the operation of the entire transport system. The definition encompasses a broad array of techniques and approaches that may be achieved through stand-alone technological applications or as other transportation strategies enhancements.

Information is at the core of ITS systems, either static or real-time traffic data or a digital map. Many ITS tools are based on the collection, processing, integration and supply of information. Data generated by ITS systems may provide real-time information on network current conditions, or on-line information for journey planning, enabling highway authorities and agencies, road operators, public and commercial transport providers and individual travelers to make a more efficient use of the network.



2.2.2 ITS Benefits

ITS systems help to achieve many of today's transportation goals: safety, mobility, productivity, energy and environment, and customer satisfaction.

2.2.2.1 Safety

ITS services can improve the whole transportation system by making it safer. Among others, they can help reduce the number and severity of accidents, warn drivers about hazardous conditions, enforce safety rules, make risks more visible to road users, make safer intersections for pedestrian and cyclists thanks to visual-audio warnings and providing automatic speed reduction when they approach crossings. Some of the ITS applications that contribute to this purpose are Traffic Signal systems, enforcement devices (red light cameras, speed enforcement devices, etc.), Dynamic Message Signs, Road Weather Information and Management, Incident Detection Systems, Work Zone Management and Collision Avoidance Systems.

2.2.2.2 Efficient mobility, congestion reduction

ITS systems improve the performance of a country's transportation system by maximizing the capacity of existing infrastructure, reducing the need to expand the road infrastructure and its environmental impact.

The ITS applications that contribute to enhancing the operational performance of transportation networks impacting on travel time or delay savings, as well as travel time budget savings, and on-time performance. For example, traffic signal light optimization can improve traffic flow significantly, reduce stops, decrease gas consumption, cut emissions, and reduce travel time, the same benefits of electronic toll collection deployment in highways. ITS services for this purpose, for example, can monitor current traffic conditions and disseminate traffic information to road users, or implement video surveillance of congestion hot spots, or centralize traffic signals to minimize delays and queues in real-time, among others.

2.2.2.3 Improvements in productivity

Traffic congestion affects productivity, causing delays in supply chains and increasing business costs. ITS can increase productivity by finding innovative ways to increase the capacity of the infrastructure.

Some ITS applications have a proven economic impact, for example:

- Automatic Vehicle Location improves fleet time performance thanks to a better management of the public transport vehicles in real time and prioritizing public transport at traffic lights, thus resulting in a reduction of commercial vehicle speeds and vehicles/hour.
- Automated vehicle location systems allow transit agencies to reduce their operational costs.

- The implementation of an automatic incident detection system allows great savings due to a reduction in delays and congestion caused by incidents.
- The inter-connection of traffic control centers and public transport real-time operation monitoring centers allows a fast detection of relevant incidents affecting the traffic flow and a more efficient response.
- Centralization of signalized intersections reduces travelling times, the number of stops and general delays.

Other technologies associated with productivity benefits are:

- Road Weather Information & Management.
- Traveler Information Systems (Dynamic Message Signs, etc.).

2.2.2.4 Energy and environment

Fuel savings and reduced pollutant emissions are benefits in the area of Energy and Environment. Among the helping measures are the following:

- Minimizing the use of private vehicles, favoring and making public transport more attractive or ensuring the use of dedicated lanes (public transport lanes, high occupancy lanes, etc.)
- Monitoring and managing air quality (pollution detection and prediction) and implementation of strategies to ease air quality problems.
- Favoring smoother flows, reducing times to stop at tolls, at customs or traffic lights through Electronic Toll Collection, Electronic Screening or Centralization of Signalized Intersections, respectively.
- Helping to plan a more efficient route using Traveler Information Systems.
- Implementation of eco-driving systems in public transport vehicles.

2.2.2.5 Customer satisfaction

ITS systems have also helped to increase the quality of services, for example:

- Reducing travel uncertainty providing real-time information at stops and stations.
- Giving priority to public transport vehicles in order to reduce journey times, improving
- reliability and punctuality, and making public transport more attractive.
- Increasing security for freight movement and individual travels.
- Increasing efficiency for operators and users.
- Allowing passengers to save time through electronic payment systems, which include 'smart cards' and flexible ticketing.

3

RELEVANT ITS APPLICATIONS FOR LAC

3.1 Introduction

In this chapter, a set of ITS applications relevant for LAC countries is proposed, according to the previously identified problems. This classification does not intend to be a standardized or scientific classification for ITS systems, it should be understood just as a practical way to include the ten most commonly demanded/ needed ITS applications, grouped in different areas that directly correspond to potential "investors" or "decision-makers".

The following table shows the proposed classification:

In the following section, there is a detailed description of each one, including their benefits, international examples and cost/benefits benchmarks.

AREA		ITS APPLICATION
TRANSIT	1	Transit Fare Collection
	2	Automatic Vehicle Location and Control systems- AVLC
	3	Traveler Information Systems in Transit Area
	4	Shared Mobility Systems
URBAN TRAFFIC	5	Urban Traffic Management (traffic signal, detectors, VMS, ...)
	6	Enforcement in urban environment (speed control, red-light cameras, left turn cameras, ...)
INTERURBAN ROADS	7	Interurban Traffic Management (traffic signal, detectors, VMS, ...)
	8	Road Safety in interurban environment (speed control, weather information, tunnel safety, ...)
ROAD PRICING	9	Electronic Toll Collection
COMMERCIAL VEHICLES	10	Automatic Vehicle Identification (Border Crossing)

Figure 10. ITS Applications

3.2 Transport problems in LAC region vs ITS applications

The selection of these ten applications takes into account the correspondence between the most relevant needs and solutions in LAC countries. The table below shows the interrelation between the problems of Transport LAC region highlighted in the chapter 2.1 and the selected ITS applications:

	TRANSPORT PROBLEMS IN LAC REGION ITS APPLICATION	Increased Congestion	Pollution & Environment Deterioration	Road Safety	Lack of infrastructure	Competitiveness and Logistic Productivity
1	**Transit Fare Collection**	Relevant Impact	Relevant Impact	Relevant Impact	Slight Impact	High Impact
2	**AVLC**	Relevant Impact	Relevant Impact	Slight Impact	Relevant Impact	High Impact
3	**Traveler Information Systems in Transit Area**	Relevant Impact	Slight Impact	Slight Impact	High Impact	Relevant Impact
4	**Shared Bicycles**	Relevant Impact	Relevant Impact	Slight Impact	Slight Impact	Slight Impact
5	**Urban Traffic Management**	High Impact	Relevant Impact	Relevant Impact	High Impact	Relevant Impact
6	**Enforcement in urban environment**	Slight Impact	Slight Impact	High Impact	Slight Impact	Slight Impact
7	**Interurban Traffic Management**	High Impact	Relevant Impact	Relevant Impact	High Impact	Relevant Impact
8	**Road Safety in interurban environment**	Slight Impact	Slight Impact	High Impact	Slight Impact	Relevant Impact
9	**Electronic Toll Collection**	High Impact	Relevant Impact	Slight Impact	High Impact	Relevant Impact
10	**Automatic Vehicle Identification (Border Crossing)**	High Impact	Relevant Impact	Slight Impact	Relevant Impact	Relevant Impact

Slight Impact | *Relevant Impact* | *High Impact*

Figure 11.Transport Problems in LAC Region vs ITS Applications

Source: Own elaboration

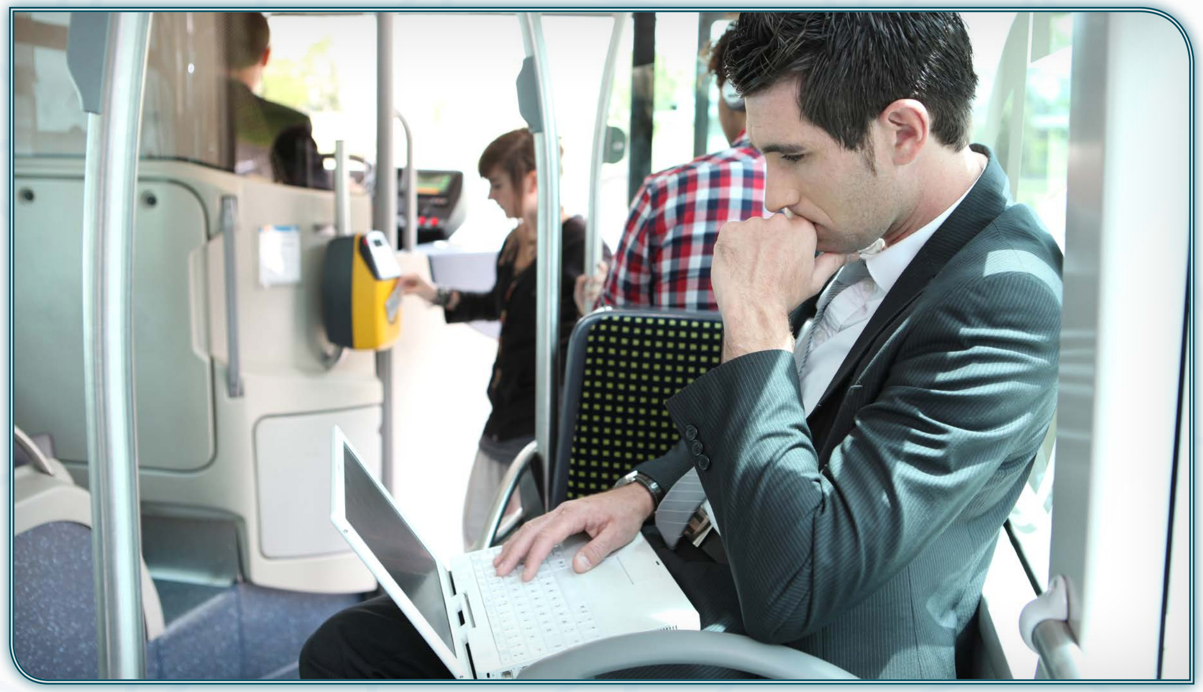
ITS applications can be very wide, ranging from intelligent on-board navigation functions to national security issues. We focus our attention in those applications that best suit the needs in LAC countries, grouped in five areas,in correspondence with potential decision-makers in both urban and non-urban environments. Each one is described and justified below.

ITS applications in TRANSIT for LAC cities

Traffic congestion, air pollution and increased noise pollution are daily city problems that hit hardest in Latin American megacities. Therefore, urban authorities make significant efforts to encourage the use of public transport against private vehicles.

Ensuring mobility through a high-quality public transport system, attractive, comfortable simple and safe is necessary. Economically attractive fare policies, with all public transport modes using the same payment system, are usual trends nowadays. All these can be achieved through ITS (Intelligent Transport System) applications such as:

- **Transit Fare Collection**
  Simplifying or speeding up on board fare payments, reducing fraud and improving on board safety are relevant concerns for public transport companies and authorities in general, also in LAC cities. Current technologies like smart cards can solve these matters, as well as other important issues like using the same payment means in several operators/transport modes or discriminating incomes among them. The key to improve their fleet management is a good use of the information contained in the cards.



- **Automatic Vehicle Location and Control systems-AVLC**
  Among AVLC advantages is a significant reduction in commuting time, a better use of the operating bus fleet and, from the environmental approach, savings in fuel and pollution emissions reduction.
  All these advantages are especially interesting in LAC region, both for improving public transport system and making it more attractive to the user.
- **Traveler Information Systems in Transit Area**
  Traveler Information Systems play a significant role in the aim of achieving a more attractive public transport to users. This technology provides passengers with information on travel time, continuously updated expected bus arrival times at every stop, and traffic conditions, through interactive kiosks where commuters can enquire about routes and buy tickets, as well as at bus stops and the Internet. This way, users can plan better their travels, eliminating the uncertainty and reducing waiting times at stations and, in consequence, enjoy safer journeys.

- **Shared Mobility Systems**

Shared mobility is already transforming globally the mobility scenario, but it could go further increasing the sustainability of urban mobility systems, which is a clear need in the LAC region megacities. That is why for example bike-share systems in cities like Buenos Aires, or taxi innovations such as taxi apps in Mexico City or Bogota are enhancing the quality of existing options already reducing traffic congestion, parking places unavailability, and air pollution.

This report will give a greater focus on Shared Bikes System which are helping to create a more sustainable transportation system in the LAC region: they provide a new mobility option for urban trips, more economic, more efficient, more sustainable and often faster and more pleasant that private vehicles in the Latin America mega-cities.

ITS applications in Urban Traffic for LAC cities

- **Urban Traffic Management**

Growing numbers of road users in LAC countries and the limited resources provided by current infrastructures lead to a continuous increase in traveling times, which is affected by traffic light controllers in urban areas. An incorrect traffic light management increases time waste for drivers and fuel consumption, aggravating congestion. Hence, centralization and management of signalized intersections, to reduce waiting times at traffic lights, can save important amounts of time and money annually, at the same time that helps relieve traffic congestion and create a cleaner environment in LAC cities.

Equally, the deployment of Traffic Control Systems together with Traffic and Road Information in urban areas of LAC region helps managing urban traffic and make a better use of the current infrastructure, particularly in cities where increasing the road/street capacity is complicated. The data collected by this equipment make possible to know current traffic conditions and act in real time on urban traffic signs: providing updated information to the user, directing vehicles to areas with less congestions and warning drivers immediately about incidents, road works, occupied lanes, etc.

- **Enforcement in Urban Environment**

As exposed in the report "Moving Forward: Progress Made In Latin America For Road Safety 2010-2012", urban environment is one of the great challenges of road safety in Latin America and the Caribbean in the coming years. In almost all countries, an important part of accidents and deaths take place in that environment. Then, appropriate and specific policies are required in the urban environment area, to ensure the protection of vulnerable road users. In this context, implementing automated enforcement systems is important, such as speed and red-light camera enforcement, in order to reduce the number of vehicles that do not stop at a red light or exceed speed limits. The experience in the cities where these systems have been deployed showed a significant decrease in the number of accidents and their severity.

ITS applications in Interurban Roads for LAC cities

- **Interurban Traffic Management**

Latin American trade comprises only a small portion of total traffic within urban areas. Hence, the improvements that will lead to increase efficiency of Latin American trade have an impact in all traffic traveling on the highway network. ITS applications on interurban traffic management area help to this target with the enhancement of road safety, the prevention of flow breakdown and improving road capacity network, which in turn have effects on productivity growth and less impact environment.

- **Road Safety in interurban environment**

According to World Health Organization, in Latin America and the Caribbean, despite national and multilateral efforts in the framework of the Decade of Action for Road Safety, the estimated road traffic death rate is 17.8 per 100,000 inhabitants (PAHO, 2013). If we add that speeding-traveling is a safety concern on all roads, especially in freeways where the speed limit is higher and the unforeseen situations are more hazardous, it becomes evident that road safety applications, as speed enforcement, weather and roadway conditions monitoring or driver information system, should be one of the measures to implement in LAC region and then one of the applications selected for this study.

ITS applications in Road Pricing for LAC countries

Source: commons.wikimedia.org/wiki/File:Storebaelt_toll_area.jpg

Electronic Toll Collection

In theLAC region demographic and territorial growth context, it is essential the investment in new infrastructures and/or extension of the current ones. They may be supported either with public or with private investment with a return over investment by a pay per use (toll), taking into account road maintenance costs. Therefore, the last option is very interesting for countries with less economical capacity in the region.

ETC systems can address some notable needs in the LAC Region, such as decreasing traffic congestion problems, reducing fraud options and increasing security and safety during the payment.

ITS applications in Commercial Vehicle for LAC countries

Automatic Vehicle Identification (Border Crossing)

Commercial vehicles crossing countries borders are subject to laws and regulations relating to the vehicle, operator and cargo. The process involves several sequential steps, each requiring a vehicle to stop. The stopping points often become congested with long queues. Each stopping point adds time to the total journey. The current process also includes a large number of parties, each requiring an exchange of data, some of which is exchanged multiple times. This redundant process is inefficient since data could be shared among the stakeholders at the many stopping points.

Examples include electronic registration and authorizing programs, electronic exchange of inspection data between regulating agencies for better inspection targeting, electronic screening systems, and several applications to assist operators with fleet operations and security. These and other technologies such as weigh-in-motion (WIM) scales improve efficiency and reduce congestion at check stations by allowing safe and legal carriers to bypass inspections and return to the mainline without stopping.

E-Screening has the greatest potential to improve truck operations in general, and in border crossings operation in particular. With Electronic Screening Programs the enforcement resources are targeted at high-risk operators, as they provide an alert-based system that expedites the safe and legal truck crossings while targeting unsafe operations. Wirelessly obtains commercial vehicle information and verifies compliance during the border crossing process, using an interface with border administration and border inspection related functions. While all motor carriers are subject to roadside inspections, the deployment of these ITS solutions reduces the number of roadside inspections to which motor carriers safe and legally registered are bound by. Therefore, this ITS technology allows commercial vehicles to be identified, checked and weighed as they drive along a highway, reducing time and costs of carriers and agencies.

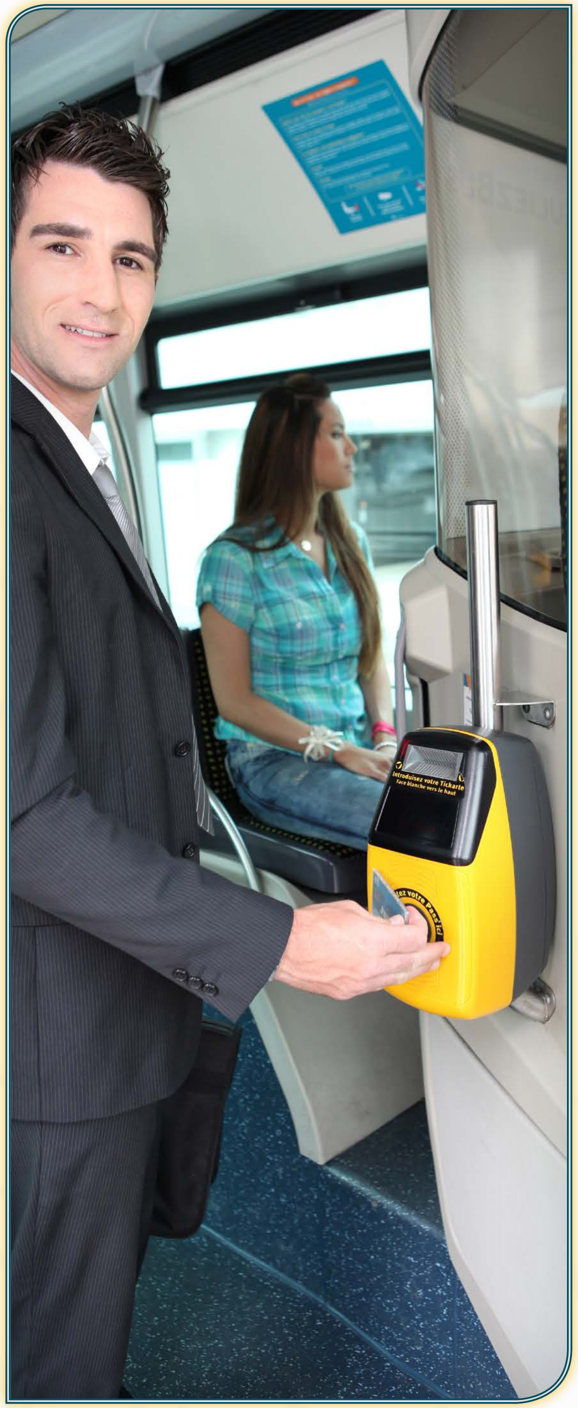
E-Screening has the ability to reduce congestion at inspection stations, reduce travel time and reduce enforcement costs by regulatory agencies, favouring international trade and better trade flows by road. For this reason, it has been selected as a relevant application for this Regional LAC Observatory of Intelligent Transport System.

4

APPLICATIONS, CHALLENGES AND INTERNATIONAL BENCHMARKS

APPLICATION

TRANSIT FARE COLLECTION



General Description

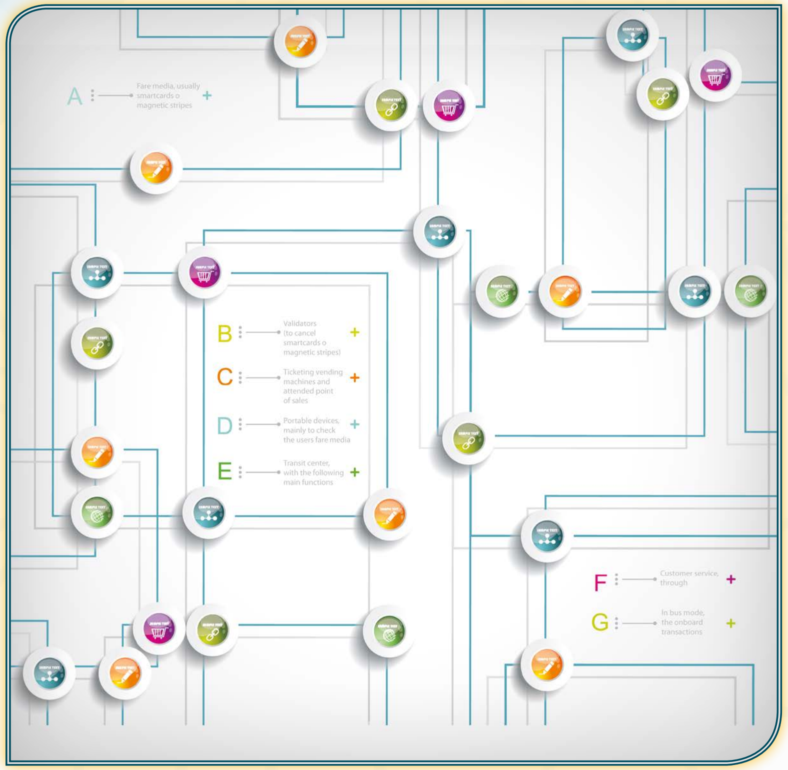
Definition

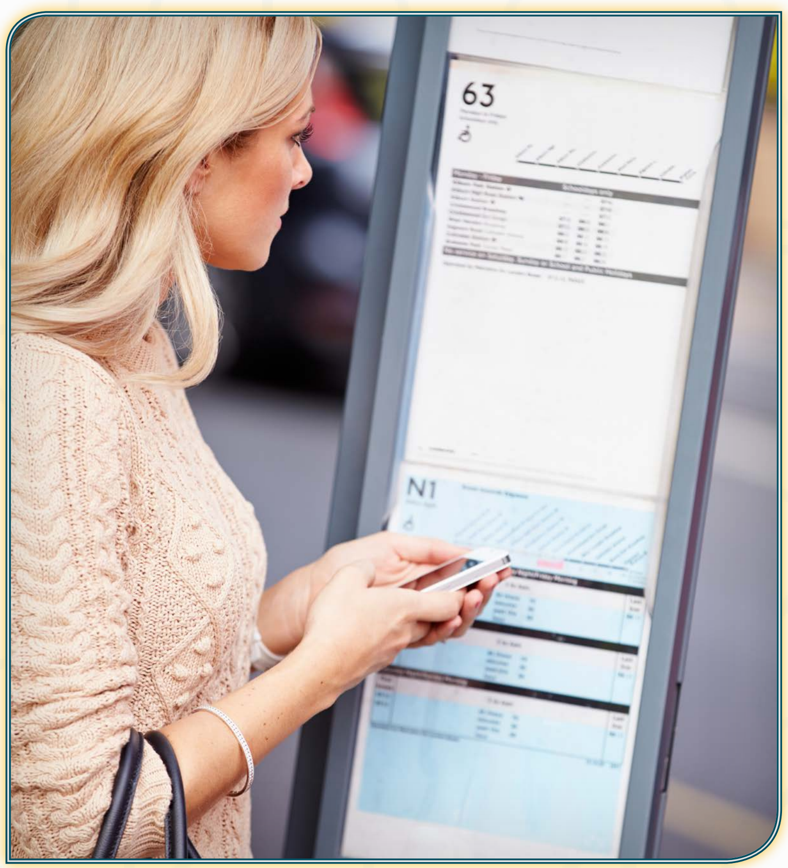
Automatic Transit Fare Collection (or automated ticketing for public transport), either by smart card or by magnetic stripe technologies, can provide great convenience to customers and significant cost savings to transportation agencies by increasing the efficiency of money handling processes and improving administrative controls.

Benefits

Transit ITS Applications are mature and constitute a good solution to meet the increasing passenger demand in a cost effective way, providing safer and more reliable services.

Electronic fare payment systems offer significant potential for transit agencies to streamline cash-handling processes and the potential for simplifying traveler access to multiple transit systems in a region, thus reducing transit vehicles average commercial speeds.





TECHNICAL DESCRIPTION

Stage of development

Operation as a mature solution.

Components

The components of a Transit Fare Collection System depend on the public transportation mode: rail or bus. However, both rail and bus environments present the following common elements:

- Fare media, usually smartcards or magnetic stripes.
- Validators (to cancel smartcards or magnetic stripes) and/or fareboxes (to pay the journey with coins).
- Ticketing vending machines and attended point of sales.
- Portable devices, mainly to check the users fare media, and to validate or charging journeys and money in the fare media.
- Transit center, with the following main functions: (1) Generate and distribute to field devices relevant configuration data: fares, action list, etc. (2) Receive and store all the transactions in the Transit Fare Collection System: validations, fare media sales, journeys sales and value/money charges in fare media, inspection transactions. (3) Clearing, settlement and financial management functions in order to process smart card transactions and move funds to the appropriate participants in the regional smart card program.
- Customer service, through: customer service center, to assist user incidences by phone and website and attended points.

The Transit Fare Collection System architecture present the following differences between rail and buses public transportation modes:

- In bus mode, the on-board transactions (generated in validators and fareboxes) can be sent to the transit center directly, by wireless means (like GPRS or 3G, typically), or through hardware and equipment installed in garages. It is unusual to install more than two validators by vehicle. In fare schemes based on traveled distance, an exit validator can be installed together with the entrance validator, to also register the user's exit bus stop. Transit Fare Collection Systems are usually deployed together with an Automatic Vehicle Location and Control System; as a recommendation, these two systems should be integrated and share information.
- In rail mode, the validators are installed in fare gates, in variable number depending on the size station. The transactions generated at level stations (validations and sales from ticket vending machines) are sent to the transit center through the station hardware.
  The rail architecture can be used in other transport service different from rail mode, like BRT (Bus Rapid Transit).

Technology

1

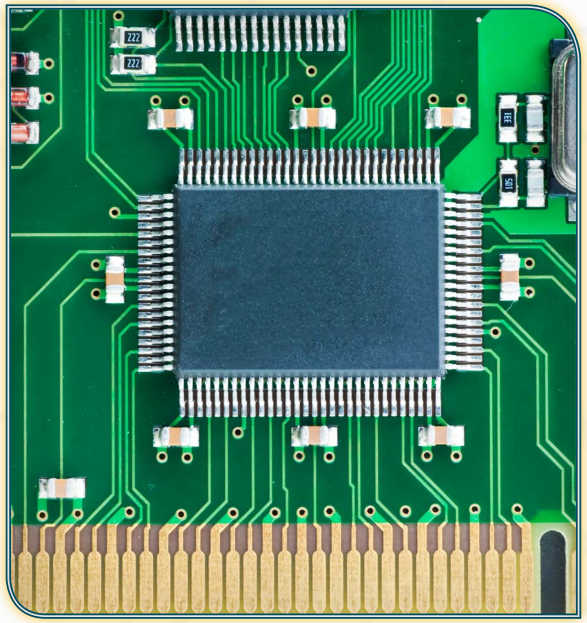
TRANSIT FARE COLLECTION

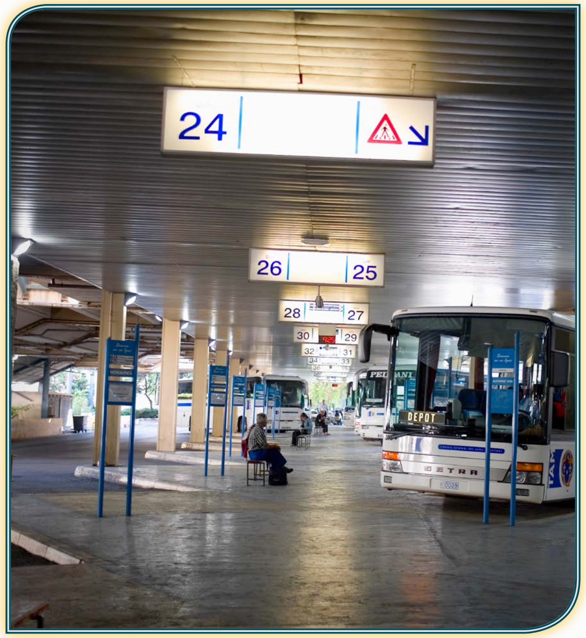
Transit Fare Collection Systems can use several types of **technologies,** depending on the fare media: paper, magnetic stripes and smartcards.

There are two types of smartcards technologies: contact and contactless. Contactless technology is most used in public transport environment, because of their lower transaction times and maintenance costs. NFC (Near Field Communications) in mobile phones and EMV financial smartcards, another two contactless fare media, can also be used combined with contactless smartcards.

Nowadays, in a new Transit Fare Collection System the choice is clear: contactless smartcards. This type of technology presents the following benefits and features:

- It is the most secure fare media, more than paper and magnetic stripes.
- It presents the lowest maintenance costs, because of the absence of electromechanical elements in validators.
- It presents the lowest transaction time, key point in the access to the transport service.
- A fare media can be reused many times over the years; therefore, it is considerably cheaper in the long term than paper or magnetic stripe, for users and for the whole system.





Communications:

- Between the media and the field devices (validators, ticketing vending machines, etc):
  - For contactless technology, the most used standard interface is ISO-14443.
  - For magnetic stripes, ISO or Edmonson format are commonly used.
- Between the bus and transit center:
  On-board transactions can be sent to the transit center in two possible ways:
  - Mobile telephone communications (GPRS or 3G, typically), or
  - Through the hardware installed in garages using a WiFi interface.

  When the on-board equipment include Transit Fare Collection Systems and Automatic Vehicle Location and Control Systems, two types of on-board architectures can be considered:
  (1) A central processing unit with an integrated validator, and
  (2) The validator and the central processing unit are two different physical devices. This architecture is more robust and modular than the first one.
- Between field devices and transit center in railway mode: a fixed communication between the hardware station (usually a host) and the transit center, typically Ethernet

Institutions

From a global point of view, two types of business models can be considered:

- PPP (Public Private Partnership) or concession model, typical in Latin America and other places in the world. In this business model, Public Transport Authority tenders the supply, operation and maintenance of the Transit Fare Collection System; in the case of bus transport services, the whole on-board equipment (Automatic Vehicle Location and Control System, Video Surveillance System, Traveler Information System, etc.) is usually included. After the concession period, the system administration is transferred to the Public Transport Authority. Fares are usually calculated in terms of being self-financing, without public subsidies.
- The European model. In this model, Public Transport Authority and/or the public transport operators tender the supply and maintenance of the Transit Fare Collection System. Public Transport Authority and the public transport operators would carry out the operation. In the same way, the Public Transport Authority and/or the public transport operators usually tender the supply, maintenance and operation of the sales network in a separated and different process. The European scheme is usually supported with public subsidies. For this reason, the European fare schemes offer a more diversified collection of tickets and fare products, cheaper and more attractive for the users.

INTERNATIONAL EXAMPLES

CITY	COUNTRY	CITY	COUNTRY	CITY	COUNTRY
Hong Kong	China	Barcelona	Spain	Bogotá (Transmilenio)	Colombia
Tokyo	Japan	Madrid	Spain	Guadalajara (Macrobús)	Mexico
Singapore	Singapore	Belo Horizonte	Brazil	León	Mexico
Seoul	South Korea	Curitiba	Brazil	México DF (Metrobús)	Mexico
Melbourne	Australia	Rio de Janeiro	Brazil	Lima (Metropolitano)	Peru
Paris	France	Sao Paulo	Brazil	Toronto	Canada
London	UK	Santiago de Chile (Transantiago)	Chile	Chicago	USA
				New York	USA

KEY CHALLENGES DURING IMPLEMENTATION

As many cities in Latin America are reorganizing their public transport network with modern companies and defining new transport services, new fleets are being equipped specifically with Transit Fare Collection Systems. In this context, a gradual implementation is strongly recommended.

To ensure success in a Transit Fare Collection System deployment, some key aspects should be taken into account:

- The cost of smartcards is relatively high. For this reason, cards are usually paid by users, wholly or partially, and users are allowed to register the card with the Transport Authority and receive balance protection in case of card loss.
- Transit Fare Collection Systems interoperability among all transport modes and operators: (1) a unique fare media or smartcard is accepted in all transport operators; (2) a clearing center receives all transactions from all sales networks and transport operators; (3) all actors and entities must follow a common set of technical and functional rules and specifications.

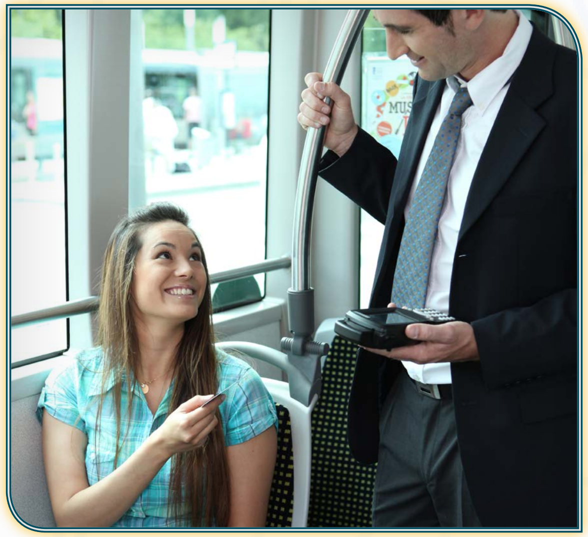
- Integration with other systems. The main public transport systems (Transit Fare Collection System, Automatic Vehicle Location and control systems and Traveler Information Systems in Transit Area) should be integrated, sharing the same data model. This would make the information managed more efficient for the three systems.
- Inspection. A staff of inspectors should be created, to force users to pay fares, together with a legal framework for their activities.
- Sales network. To ease users access to the transport service, deployment of a wide and well distributed sales network is essential.
- Compatibility with existing equipment.

COST/BENEFIT BENCHMARKS

TRANSIT FARE COLLECTION

General estimated costs:

General estimated costs: The following table shows a range of estimated bus- and rail-related costs while introducing magnetic farecard or smart card capabilities; variable system and fare media costs are also included in the table. This table has been extracted from "TCRP Report 94 – Fare Policies, Structures and Technologies: Update", from Transportation Research Board, entity within the National Academy of Sciences of USA[8].



COST ELEMENT	COST (DOLLARS)*		NATURE OF COST	
	Low	High	One-Time	Ongoing
Bus-Related Costs per Unit				
Mechanical farebox	2,000	3,000	X	
Electronic registering farebox (with smart card reader)	5,000	8,000	X	
Validating farebox (with magnetic & smart card reader)	13,000	17,500	X	
Stand-alone smart card processing unit	1,000	7,000	X	
Magnetic farecard processing unit (upgrade)	4,000	6,000	X	
Application software (smart card units)	0	100,000	X	
Garage hardware/software	10,000	20,000	X	
Central hardware/software	25,000	75,000	X	
Rail-Related Costs per Unit				
Ticket vending machine (TVM)	30,000	60,000	X	
Add-Fare machine (cash only)	5,000	25,000	X	
Fare Gate (magnetic/contactless card)	20,000	35,000	X	
Stand-Alone smart card validator	5,000	8,000	X	
Stand-Alone magnetic farecard validator	8,000	11,000	X	
Portable (hand-held) smart card validator	2,000	4,000	X	
Attended smart card revaluing device	2,500	6,000	X	
Attended magnetic farecard issuing device	5,000	10,000	X	
Station hardware/software (heavy rail)	50,000	100,000	X	
Station hardware/software (light rail)	7,000	10,000	X	
Central hardware/software	100,000	200,000	X	
Variable System Costs				
Spare Parts (% of equipment cost)	10	15	X	
Installation (% of equipment cost)	3	10	X	
Equipment maintenance costs (% of equipment cost)	5	7		X
Clearinghouse (e.g., card distribution, revenue allocation) ** (%of annual Automatic Fare Collection revenue) % of annual AFC revenue)	3	6		X
Fare Media Costs per Unit				
Magnetic or capacitive cards	0.01	0.30		X
Contactless cards (plastic)	2.00	5.00		X
Contactless cards (paper)	0.30	1.00		X
Contact cards	1.50	4.00		X
Dual interface cards	5.00	10.00		X

** 2002 $; the actual cost depends on functionality/specifications, quantity purchased and specific manufacturer.*
*** This depends on the nature of the regional program, if any.*

Figure 12. Fare collection. General estimated cost

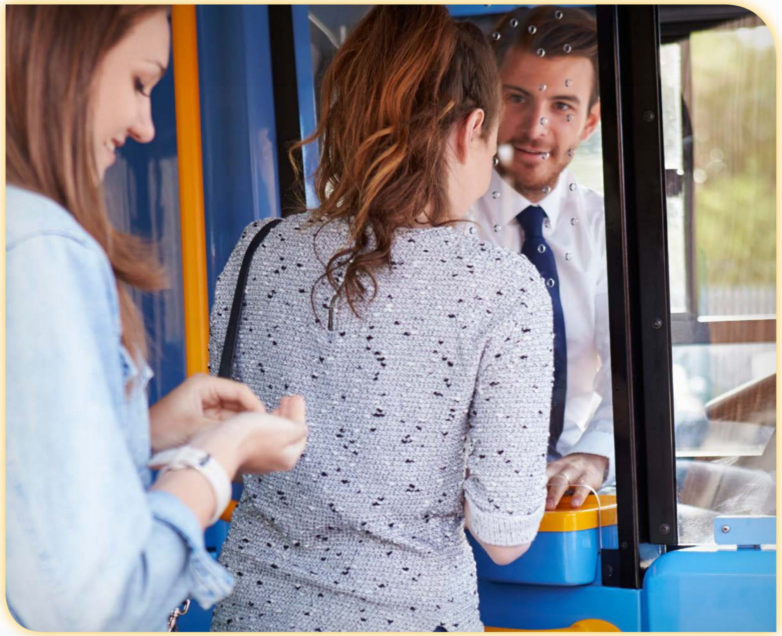
General benefits

Customer benefits:

- Innovative fare structure options, such as a frequency based discount or even a guaranteed lowest fare strategy.
- Popularity and customer satisfaction.
- Relevant features: registration/balance protection, auto-load and negative balance.
- Ability to use the same card with multiple agencies, if possible.
- Improved convenience of the contactless interface (i.e., the card does not have to be removed from the wallet or purse).
- Multi-application capabilities.

Agency benefits:

- Ability to exploit relevant data, such as travel analysis or revenues forecasting for different pricing policies.
- Substantially reduced use of cash, as well as fare collection costs associated with producing, selling and distributing fixed-calendar period passes.
- Reduced fare abuse and evasion through automatic verification or validation of fare media.
- Service improvements due to faster boarding and better average commercial speeds.
- Reduced equipment and maintenance costs (contactless card readers).



Specific benchmarks

Chicago: The Chicago Transit Authority (CTA) operates bus and rail rapid transit service in the City of Chicago and 38 surrounding suburbs. CTA has approximately 2,000 buses over 200 routes, and several train services (11 suburban commuter train lines from several downtown Chicago terminals).

The total cost of implementing the AFC (Automatic Fare Collection) system in the nineties was 106 million USD. Of this total, 74% was for equipment, 14% for station construction, 5% for field forces, 4% for consultants, 2%for CTA engineering and administration, and 1% for marketing and start-up.

CTA saved in personnel costs from rail ticket agents, but these costs were increased at the same time, because of customer service attending enquiries related with the new technology. Implementation of Transit Fare Collection System has proven to be very popular with CTA's customers. Within the 3 months of initial implementation, one-third of all boardings were made with farecards. At present, 95% of rail riders pay with farecards, as 68% of bus riders do. In this success, fare restructuring was a key issue.

Later, CTA began the introduction of contactless technology without the need to invest in card readers (the initial AFC deployment included card readers, as eventual use of smartcards was planned in advance by CTA).

Seoul: The Greater Seoul Metropolitan Area, with 22 million residents, has a public transport network composed by 765 bus routes, 9 metro lines and 391 stations. T-Money is the commercial name of the Transit Fare Collection System. KSCC (Korea Smart Card Co., Ltd) is the company responsible for the development and operation of the Transit Fare Collection System. Below are some representative figures of the T-Money system:

Source: commons.wikimedia.org/Edmond Audran

ITEM	CONTENT
T-money smart card issuance	**100 Million Prepaid card issued 71 Million affiliated cards in use**
Card Validator	**Bus: 24,000 Subway: 10,000 Taxi: 12,000 E-money (CVS stores, Barkey, Parking etc.): 50,000**
Recharge Machine	**Recharge Machine: 58,000**
N° of transaction per day	**50 Million**

Figure 13. T-Money system from Seoul

Source: http://eng.koreasmartcard.com/ (Korea Smart Card Co. Ltd)

Santiago de Chile (Transantiago): Transantiago is the public transport company of Santiago de Chile, covers a population about 6.2 million inhabitants and has 7 bus operators and Metro de Santiago (subway operator). The bus fleet has approximately 6,000 vehicles, and Metro de Santiago has 5 lines and 108 stations. There are 6 modal interchange stations. There is fare integration between the above mentioned transport services, achieved through the common fare media "Tarjeta Bip!", based on contactless technology. In 2013, the number of cards used in the system was 4,966,650 and the average transaction number per working day was 5,595,675. The smartcard recharge network is composed of 1,500 points. The sale of smartcards is carried out in some load points and Metro stations[9/10/11].

APPLICATION

AUTOMATIC VEHICLE LOCATION AND CONTROL SYSTEMS-AVLC

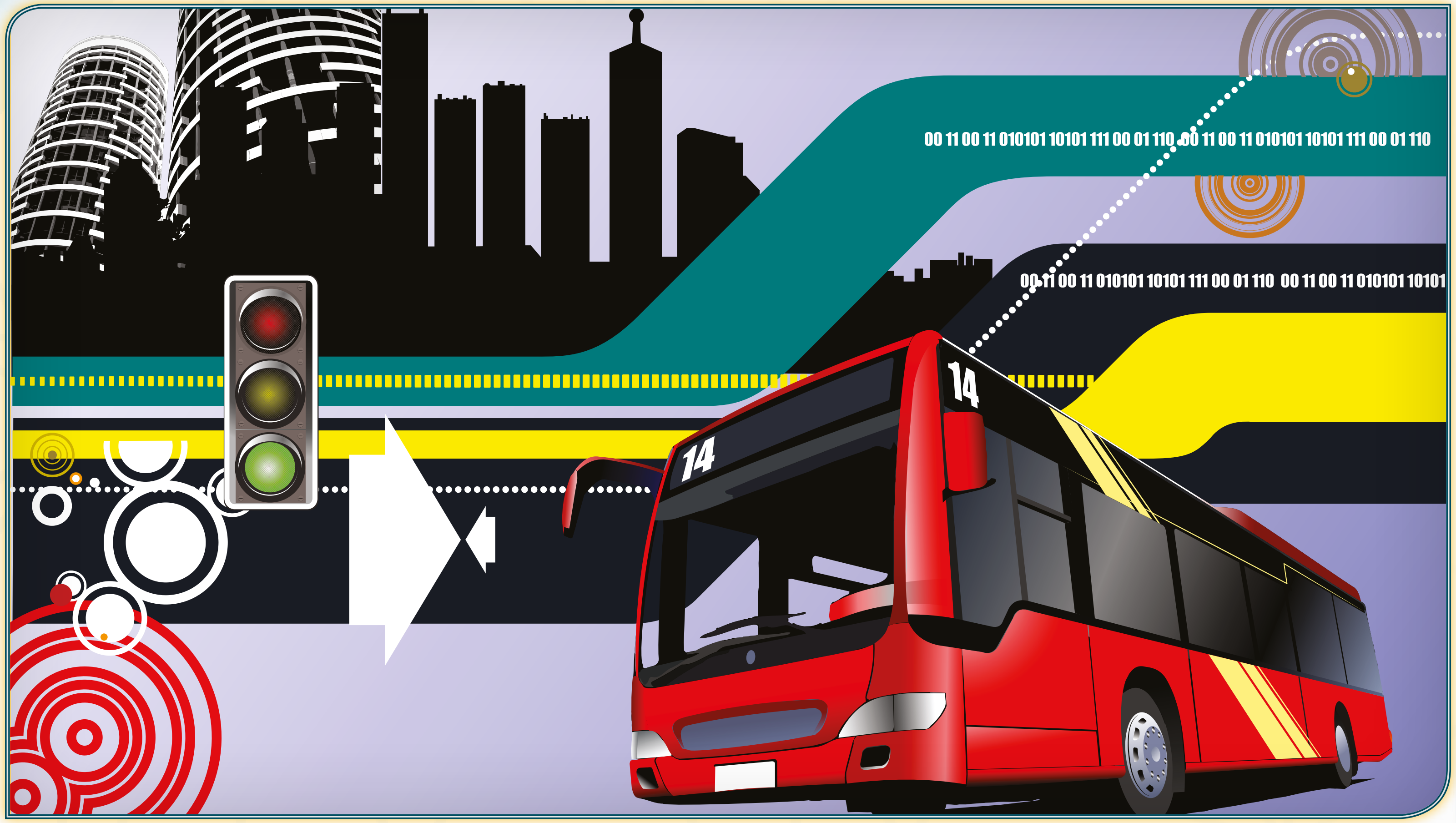
GENERAL DESCRIPTION

DEFINITION

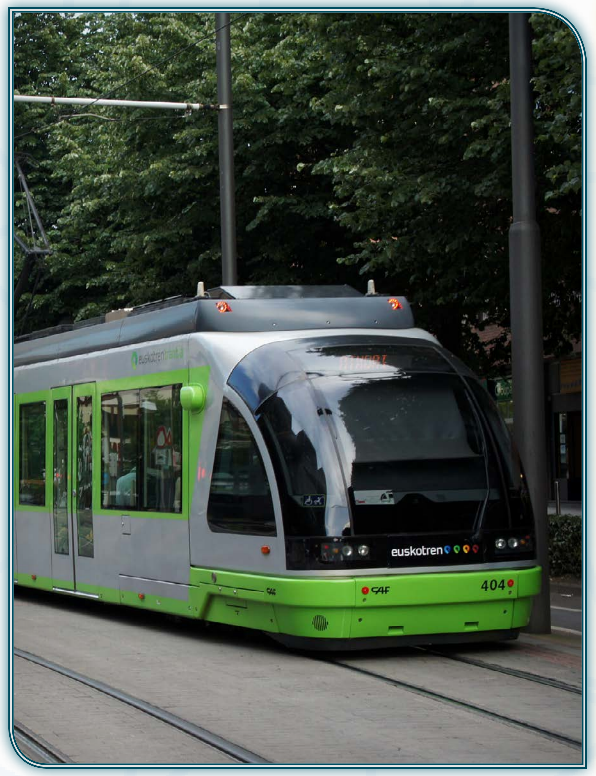
Automatic vehicle location (AVL) and computer aided dispatch (CAD) systems facilitate transit operations management, providing up-to-date information on vehicle locations to assist transit dispatchers and inform travelers of bus status.

BENEFITS

Transit operations and fleet management ITS applications improve transit reliability through the implementation of AVL and CAD systems, which can reduce passengers waiting times. These systems add security and improve incident management through enhanced vehicle-to-dispatch communications, enabling faster responses to physical threats and attacks, accidents and vehicle breakdowns.



Source: commons.wikimedia.org/wiki/User:Mariordo



TECHNICAL DESCRIPTION

Stage of development

Operation as a mature solution, now over 50 years since the first demonstration of AVL in Hamburg, Germany.

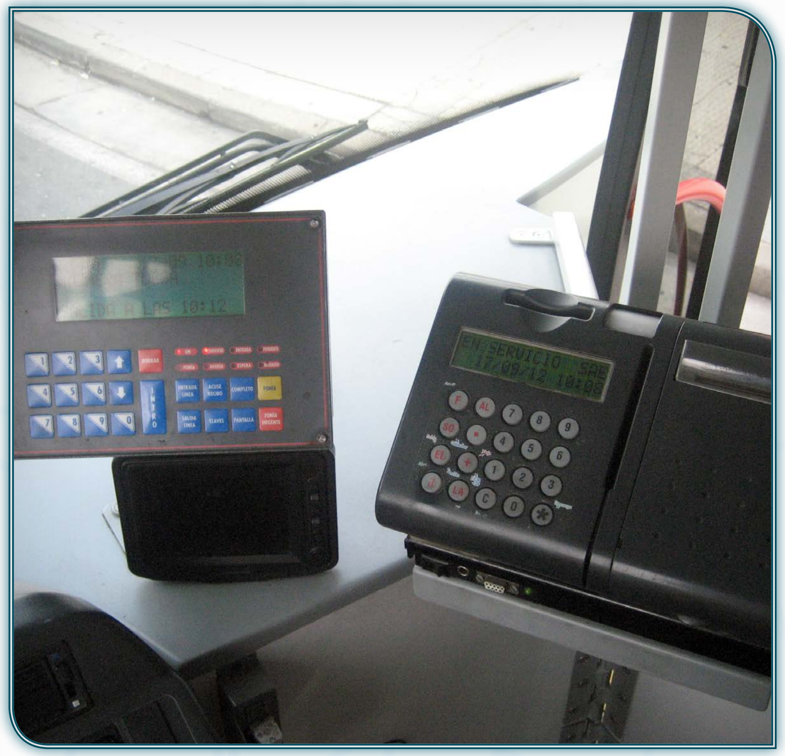
Components

The typical components of an AVLC system in transit bus fleets are the following:

On board equipment: processing unit, driver console, communication antennas (GPS/GPRS/3G/4G) and other alternative on-board equipment usually associated with AVLC systems, such as video surveillance, announcer speakers, announcer panels, traveler counting or ecodriving systems.

Transit center, with the following functions: (1) real time fleet control (synoptic diagrams with all relevant information for each line, geographical location of buses, services allocating to vehicles, table vehicles, notifications, calls, etc.), (2) traveler information monitoring (on board, in stations) and (3) operation historical reports (travel time per trip, planned / carried miles and offer performance).

Other systems: AVLC systems can be integrated with fare collection systems, technical supervision by the Authority, emergency Centers, all operating data can be exported to external systems; numerous implemented web services can exchange data in real time, data planning and multimodal information.



Technology

The key on-board device in an AVLC system is the processing unit. This element is an on-board computer connected to the other on-board subsystems such as a driver console, video cameras, user information panels, etc. The processing unit locates vehicles via GPS, centralizes buses communications with the transit center, stores all the information generated on board and manages/interacts with other on-board subsystems.

The processing unit must be designed to work in a hostile mobile environment, with variable temperatures, dust, vibrations, power surges when starting the vehicle, signal peaks, stabilization, etc.

The other typical on-board device is the drive console. This device acts like an interface among the

driver and the different on-board devices and the transit center. Several technologies can be used in this device, but the most used are touch screens with multifunction graphical interface. For voice communications, a button to request the establishment of connection from the transit center is usual.

To communicate with the transit center, wireless communications (GPRS, 3G or 4G) are commonly used.

Institutions

From a global point of view, two types of business models can be considered:

- PPP (Public Private Partnership) or concession model, typical in Latin America and other places in the world. In this business model, Public Transport Authority tenders the supply, operation and maintenance of the whole bus on-board equipment, including the AVLC System and other subsystems like Transit Fare Collection System, video surveillance system, Traveler Information System, etc. After the concession period, the system administration is transferred to the Public Transport Authority. Fares are usually calculated in terms of being self-financing, without public subsidies. The Public Transport Authority usually carries out the AVLC operation.

- The European model. In this model, the Public Transport Authority and/or the public transport operators tender the supply and maintenance of the AVLC System. The Public Transport Authority and the public transport operators would carry out the operation. In the most complex cases, a multi-enterprise AVLC integration can be under the same Public Transport Authority.

INTERNATIONAL EXAMPLES

CITY	COUNTRY	CITY	COUNTRY	CITY	COUNTRY
Tokyo	Japan	London	UK	Santiago de Chile	Chile
Singapore	Singapore	Barcelona	Spain	Bogotá	Colombia
Seoul	South Korea	Madrid	Spain	Guadalajara	Mexico
Sidney	Australia	Curitiba	Brazil	Chicago	USA
Paris	France	Sao Paulo	Brazil	New York	USA

KEY CHALLENGES DURING IMPLEMENTATION

As many cities in Latin America are reorganizing their public transport with modern companies and defining new transport services, the new fleets are being equipped specifically with AVLC Systems. In this context, it is strongly recommended a gradual implementation. This recommendation applies to whole bus on-board equipment, not only for the AVLC System.

To ensure success in a AVLC System deployment, some key aspects should be taken into account:

- Integration with other systems. The main public transport systems (Transit Fare Collection System, Automatic Vehicle Location and control systems and Traveler Information Systems in Transit Area) should be integrated, sharing the same data model. This would make the information managed more efficient for the three systems.
- Compatibility with existing equipment.
- To update on time and correctly all the necessary data for the AVLC System.

COST/BENEFIT BENCHMARKS

The cost to provide and install the on-board AVLC equipment ranges between 5,000 and 8,000 USD per bus, including the following typical components: on board processing unit, driver console, video surveillance, announcer panel. The approximated maintenance cost ranges from 5% to 7%.

The general **benefits** of this application are:

- Improvement of service perceived by users: (1) informing users about arrivals in real time traffic conditions, (2) reporting on board on the following stops, correspondence with other lines and incidents, (3) greater accessibility to information anywhere through the website, stop panels, panel board, mobile phone SMS, Bluetooth mobile phone near stops and on board, and other means, (5) reducing waiting times and more regularity in the passage of buses and, (6) safer night or conflicting lines.
- Improvement of the working conditions for drivers: (1) Increased driving safety thanks to the ability of immediate notification to an emergency center of situations that may threaten their safety. (2) Better planned lines thanks to automatically exploitation of the relevant data, such as travel and waiting times. (3) Permanent display of delays and advancements, as drivers should only worry about driving in time. (4) Detection of fast vehicle drivers who disturb bus regulations. (5) Continued support through communication with the center to receive precise instructions in case of incidents. (6) Travelers permanently informed.
- Improved management of the bus company: (1) Automation of company operating processes. (2) Savings through better planning that will enable optimization of the work times of vehicles and drivers and the reduction of the street based staff. (3) Much better understanding of the operations relevant parameters, through data and indicators generated automatically and in a thoroughly way. (4) Real-time control of the operation, by managing incidents and restoring the ideal conditions of service in the shortest time. (5) Improved planning of services through the precise knowledge of travel and waiting times. (6) Availability of accurate data for customer complaints. (7) Improved exchange of information with the administration head, showing objective data improvements in service quality, the impact of external circumstances, or needs for improvement.
- Major knowledge and capacity of action on the process, saving of costs, better image.
- Other possible benefits:
  - Possibility of establishing a quality control system of driving that will allow fuel economy, reduced maintenance costs and improved ride comfort.
  - Ability to establish services on demand, km reduction routes and increasing the commercial speed.
  - Possibility of establishing a system of preemption at traffic lights.
  - Ability to manage connections with other modes of transport, increasing demand and service quality.
  - Possibility of establishing a preventive maintenance system that reduces the impact on service and management costs and repairs.

Here are some **specific benchmarks** that vidence the above, collected by Research and Innovative Technology Administration US Department of Transportation[12]:

- AVL improved on-time performance in some cities of USA, by 80 to 90% in Kansas City, by 23% in Baltimore and by 90 to 94% in Milwaukee.
- After an extended analysis of travel times, Kansas City, Missouri, was able to reduce up to 10% of the equipment required for some bus routes using and AVL/CAD system. The system allows fewer buses to serve those routes with no reduction in customer service. The results are savings in both operating and capital expenses by actually removing these buses from service and not replacing them. The productivity gain of eliminating 7 buses out of a 200 bus system allowed Kansas City to recover their investment in AVL in two years. Other transit systems have reported reductions in fleet size of 4 percent to 9 percent due to efficiencies of bus utilization.
- Automatic Vehicle Location (AVL) on Reno (USA) buses leads to nearly four percent increase in on-time performance for paratransit services and more comprehensive schedule adherence data to create more accurate schedules.
- Implementation of ITS with AVL, real-time passenger information, and electronic fare media in a mid-sized transit system resulted in a minimum 3.9:1 benefit/cost ratio.

APPLICATION

TRAVELER INFORMATION SYSTEMS IN TRANSIT AREA

GENERAL DESCRIPTION

DEFINITION

Dissemination of transit information to travelers through diverse media, in-vehicle, wayside, or in-terminal dynamic messages signs, as well as the internet or wireless devices.

BENEFITS

Public access to bus location data and schedule status information in a web site, information panels, interactive information kiosks, mobile applications or another type of platform is interesting for users. Passengers can confirm scheduling information, improve transfer coordination, and reduce waiting times. In addition, electronic signs on transit status information at bus stops help passengers manage their time, and on-board systems such as next-stop audio annunciators help passengers reach their destinations in unfamiliar areas.

TECHNICAL DESCRIPTION

Stage of development

Nowadays there are different technologies for providing real-time information to public transport users. Electronic signs can offer both static and real-time information to passengers at stops and stations, or Geographic Information Systems (GIS) via the Internet. AVL technology now can be seen as a new one, although it is relatively recent the use of data from an AVL system to disseminate real-time predictions of bus arrivals, and not only to increase operational efficiency. Others, however, such as mobile devices for real time information (RTI) are experiencing a rapid development and growth in the last years.

Components

Underlying Automatic Vehicle Location System (AVL)

AVL systems provide information on the location of each public transport vehicle and in many times other critical information, such as vehicle speed and direction, and schedule adherence. Therefore, it is a key system for determining raw real-time information that will be disseminated to users after being processed.

Dissemination elements

Pre-trip: web site, mobile apps with static or real time transit information. This information can be complemented with a map and online tools to guide trip planners in the best choice of modes combination for their travels.

On-street: devices to provide real time information (RTI) at public transport stops and stations, for example the following ones:

- Phones, users call a phone number specifying the station ID and receive arrivals information.
- Electronic Signs, which display information through Dynamic Message Sign (DMS) or Interactive Screens using several types of technologies. Interactive Screens remind a sort of giant tablet that offers a wide range of transit information; in DMS, the most prevalent information is next vehicle arrival/departure prediction time. DMS can also include audio messages when a button is pressed, for handicapped users.
- Mobile Apps, which help users to track their services in real-time, estimated arrival times, real position of the next bus/train, services updates such as cancellations and delays, routes and schedule changes...

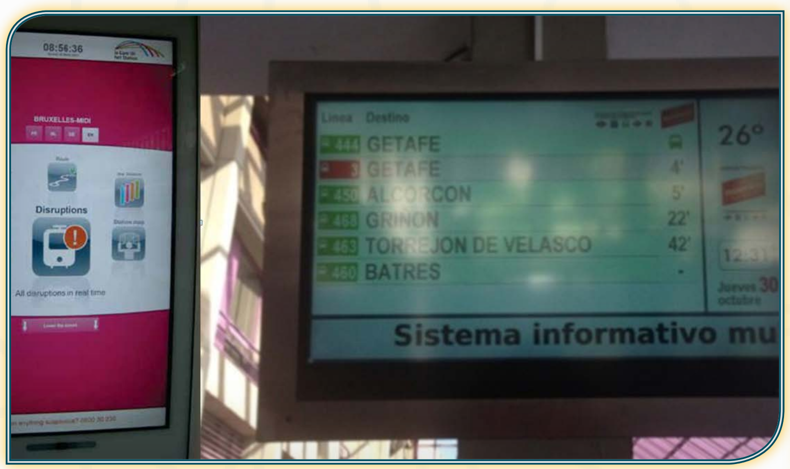
In-transit: devices to disseminate information in the vehicles. Through on-board displays or audio devices, passengers can be informed of the vehicle direction, next upcoming stops, time remaining until arrival at the most important stops, disturbances, connections with other modes (bus, trains, metro, shared bikes system, etc.) and in some cases other information such as key public places on the line (city halls, hospitals, cultural and sports places or economic activity zones and commercial centers)

Figure 14. Photos[13]: on street information through (1)phones, (2)electronic signs and (3) mobile apps

Technology

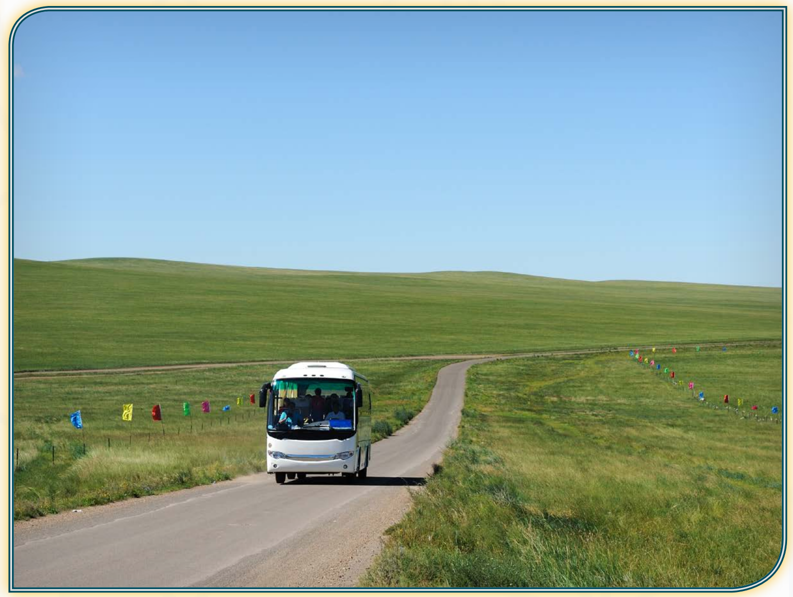
Underlying Technology: AVL software, computer-aided dispatch (CAD) software, software that calculates the real time information from data generated by CAD/AVL systems. Also Global positioning system (GPS) is used for vehicle tracking.

Dissemination Information Technologies: the technologies used to display information are: Light Emitting Diodes (LED), Liquid Crystal Display (LCD) also called Plasma Display and Thin Film Transistor (TFT) technology (a type of LCD display that improves image quality). This technology is applied in screens of diverse sizes and designs in function of their localization, following are show some examples[57]:



Institutions

The same two types of business models, Fare Collection Systems and Automatic Vehicle Location Systems, can be considered for Transit Traveler Information systems:



- PPP (Public Private Partnership) or concession model in which the Public Transport Authority tenders the supply, operation and maintenance of the bus equipment, including the AVLC System and other related subsystems, among others, Traveler Information System. After the concession period, the system administration is transferred to the Public Transport Authority. This model is typical in Latin America and other places in the world.
- The European model. In this model, Public Transport Authority and/or the public transport operators tender the supply and maintenance of the Traveler Information System. Public Transport Authorities and public transport operators would carry out the operation.

INTERNATIONAL EXAMPLES

Transit Traveler Information systems are usually implemented together with AVL systems, here are some international examples:

In **Madrid,** Public Transport Integrated Management Centre (CITRAM) responds to the increasing demand in real time multimodal information detected by the Madrid Public Transport Authority (CRTM)[14]. CITRAM receives, consolidates and converts data from the public transport system into information to support decision making and public transport coordination. Among the targets are coordination of all public transport modes in major events, particularly during incidents, intermodal information in real time to public transport users, technological integration and information management to support decision-making and continuous public transport system monitoring. More than 20,000 cameras are used, 5,000 bus vehicles are tracked and 6,000 information panels are connected[15]. Web sites are also used to disseminate information to public transport users, and even mobile apps are available in some cases (as EMT, Municipal Transport Company operator) thanks to an open data strategy.

In the **United Kingdom**, according to UK's 2012 Public Transport Technology Survey conducted by RTIG and published in April 2013 [16], "Stops covered by virtual dissemination far outnumber physical signs, and are continuing to expand strongly. SMS continues to be the most widely available dissemination method now covering 139,325 stops (up from 108,000 last year). However, Mobile Web, Mobile Apps and Local Authorities Websites are also now widely available too: Mobile Web is available for 122,140 stops this year and expected to overtake Mobile Apps and Websites by 2014."

Agencies across the **United States** use DMS and LED/ LCD monitors to disseminate on route information, on board or at-stations. The use of DMS is more likely at heavy and light rail stations or bus depots than at bus stops; although dynamic signs are being introduced at major bus stops as real-time vehicle location information is commonly used.

In LAC region this ITS application is also a reality in cities like Santiago in Chile, Guadalajara in Mexico or Curitiba in Brazil.

KEY CHALLENGES DURING IMPLEMENTATION

Integration.- Data should be integrated with other ITS applications data such as Urban Traffic Management or Shared Bicycles Systems, in order to offer accurate and useful information to users.

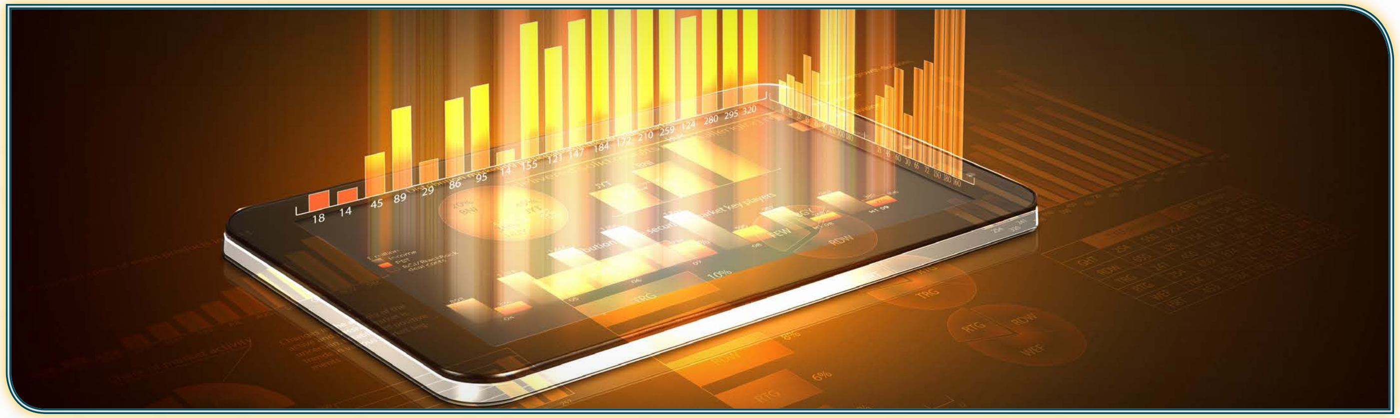
An **open data approach should** be considered or sharing data with external public parties, in order to allow new applications development and integration withexternal information systems.

In fact, providinggood information to travelers,in the appropriate place andtimefor taking better choices,means collecting and integrating information from different sources, public or private entities and operators. Therefore, it should be an **efficient coordination between all parts involved**, with a clear criterion to generate, send and show the information.

Travel Information systems should be deployed when **timeliness, accuracy, and reliability of data** are guaranteed, to avoid users' complaints.

COST/BENEFIT BENCHMARKS

Costs will vary depending upon the systems/technologies used, for example an indoor LED may cost from 200 to 12,500 USD, an outdoor LED from 1,500 USD to 17,500 USD, an indoor LCD from 500 USD to 5,500 USD and an outdoor LCD from 1,500 USD to 10,000 USD. Following, some benchmarks of Capital Costs for providing Real-Time Information, additional to the underlying AVL systems, according with the study of "Transit Cooperative Research Program"[17]:



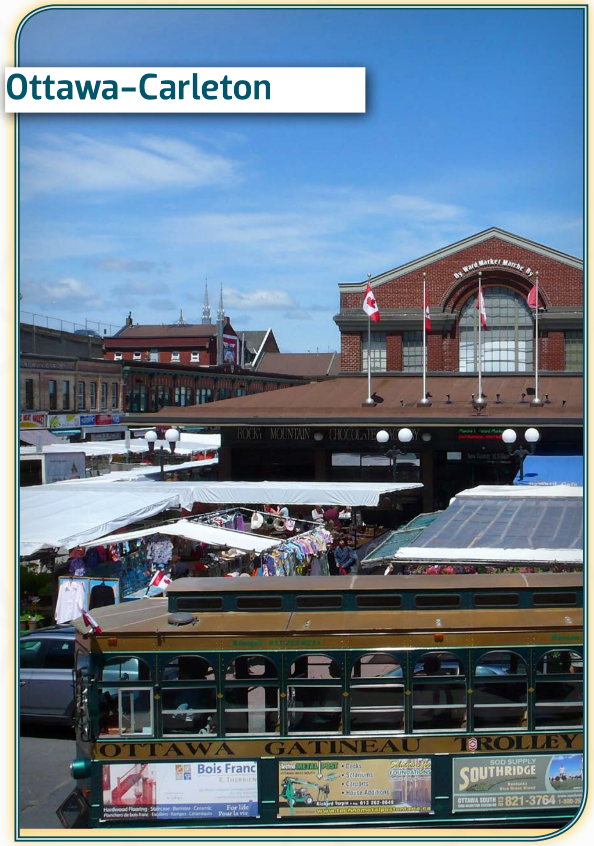
CITY (COUNTRY)	AGENCY	ADDITIONAL CAPITAL COSTS FOR PROVIDING REAL-TIME INFORMATION	NO. OF ELECTRONIC SIGN MONITORS	CAPITAL COST PER ELECTRONIC SIGN/ MONITOR	PREDICTION MODEL SOFTWARE COST AS REPORTED
USA (Los Angeles)	LADOT/LACMTA Metro Rapid System	600,000 USD	44 LED	5,000 USD	300,000 USD
UK (London)	London Buses	46,503,000 USD estimated for 4,000 signs	4,000 LED signs	3,900 USD for sign, another 3,900 USD for data line provision and installation, 7,800 overall	N/A
Finland (Helsinki)	YTV	1,100,000 USD	11 LED, 10 video monitors	5,000 USD	250,000 USD
Ireland (Dublin)	Dublin Bus	97,900 USD	20 LCD	4,900 USD	81,000 USD
USA (Oregon)	Tri-Met	750,000 USD	9 LED	3,500–4,000 USD	
Italy (Bologna)	ATC Bologna	782,600 USD	130 LED	1,956,500 USD	Developed with Internal resources

Figure 15. Additional Capital Cost Of Providing Real-Time Information

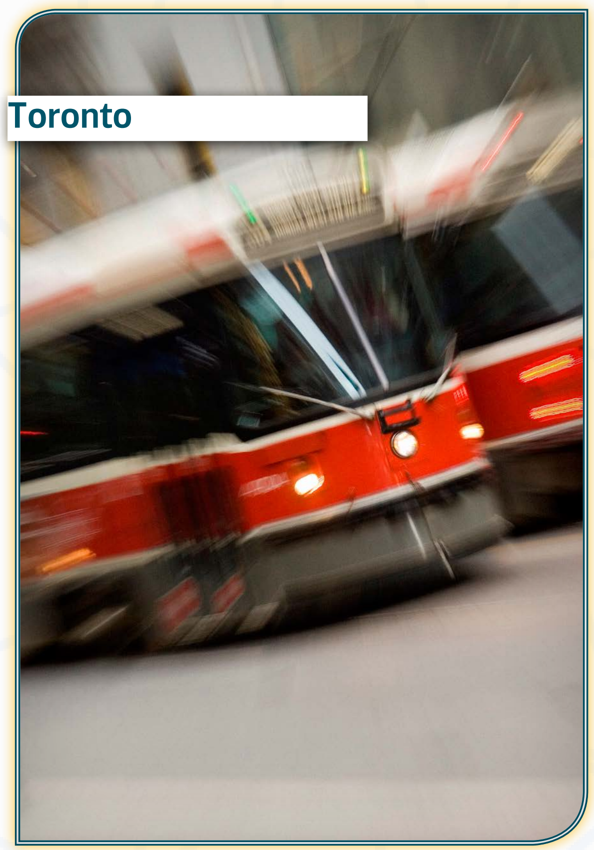
Source: Transit Cooperative Research Program

London

Ottawa-Carleton



Toronto



California

Concerning the **benefits**, studies have identified that service reliability and punctuality are perhaps the most important issues that influence the perception of a public transport system. The presence of traveler information systems can significantly contribute to this perception. For this reason, agencies believe that the main motivations to deploy devices and to offer real-time information services are increasing customer satisfaction and improving perception of transit system, although benefits associated with their deployment are difficult to quantify. Possible key indicators are the number of compliments or complaints about the media used.

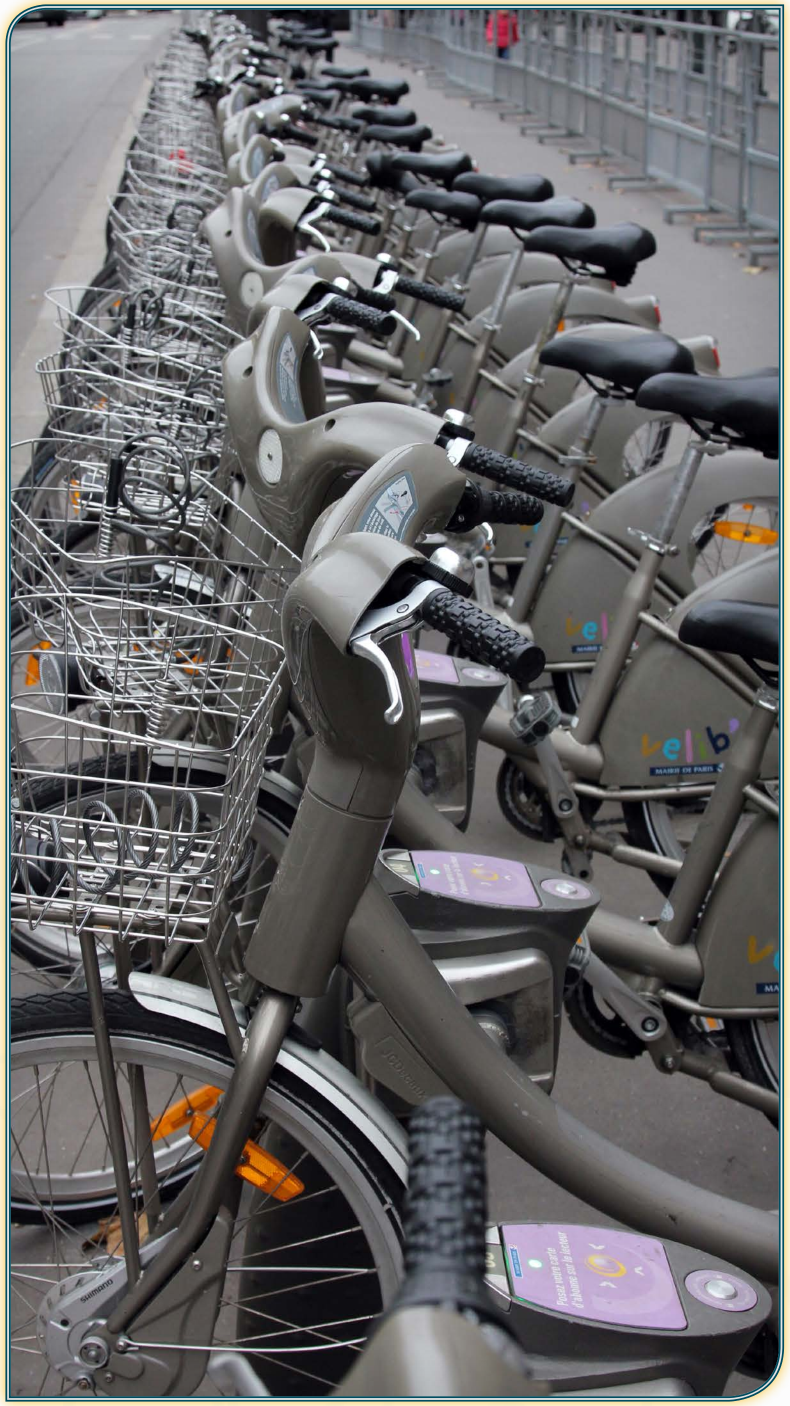
Some benchmarks collected by Research and Innovative Technology Administration US Department of Transportation[56] are the following:

- In London, arrival predictions make customers think that transit service has improved. Perceived wait times dropped from 11.9 to 8.6 minutes due to the Countdown System. In addition, a survey indicated that 30% of travelers who used a computerized route planning system and completed a trip, changed routes based on the information provided, another 10% decided to use public transport.
- In Ottawa-Carleton, Canada, an automated telephone transit information system (the "560 system") was tested. A comparison of routes with and without the "560 system" showed that the system contributed to an 8 percent increase in off-peak ridership.
- In Toronto, the introduction of a new feature called "Today's Service Updates" on the Go Transit traveler information website was well received by customers. When this feature became available, website usage increased from 3,500 to 6,500 visits per day.
- 70% of respondents to a survey of California's GoVentura website trip planning system said that the website helped them make a transit trip that they would otherwise have made by automobile.
- In Seattle a survey highlight that among the benefits of traveler Information are: reduced trip time (43%), more predictable travel (13%), less stressful conditions (12%) and safer Travel conditions (6%).

APPLICATION

SHARED MOBILITY SYSTEMS

Source: *flickr.com/photos/luisus⊠d/6636428609/*



GENERAL DESCRIPTION

DEFINITION

Shared Use Mobility describes a wide variety of new technology-enabled services and tools that give instant access to new services and travel information while complementing traditional modes like fixed route transit. These services include bike-sharing, car-sharing and taxi-sharing, new forms of ridesharing, technology-enabled shared ride services, new private forms of transit and travel itinerary services that ease the selection of travel options with a click of the mouse or a tap on your smartphone[18].

This report focuses on Shared Bicycles Systems, technological and organizational schemes that allow bicycles to be shared for a short period of time, as a solution to daily or eventual mobility. They provide users with a sustainable and environmentally-friendly form of public transportation, offering a self-service pick up and drop off.

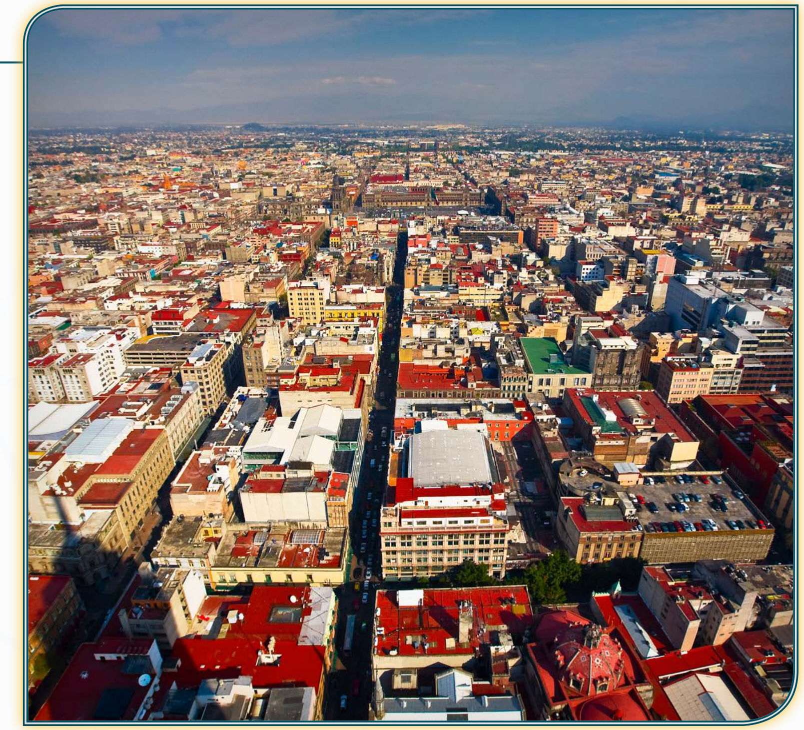
BENEFITS

Shared mobility systems, such as bike-sharing, car-sharing or taxi-sharing, are an alternative to private cars as a sole mean of transportation. They increase mobility choices and have the advantage of reducing traffic congestion, parking space unavailability and air pollution, optimizing the road network capacity or, in the case of the bicycles, reducing the number of motor vehicles in circulation.

These systems serve as a good complement to mass transit transportation systems (through mode sharing), and a more economic and sustainable solution for those journeys that are not serviced by transit.

In addition, bicycle-sharing highlights to promote sustainable travel and an environmentally-friendly tranportation:

- Implement a sustainable health inducing service fully integrated with the city's public transport system.
- Promote the bike as a common means of transport.
- Improve quality of life, reduce and noise pollution.
- Create a new individual public transport system for citizens' habitual travel need.



TECHNICAL DESCRIPTION

Stage of development

Relatively young solutions with a fast growing demand.

Components

The physical components of an automated **bicycle sharing systems** are:

Bicycles: Shared bicycles need to be easy to use, adaptable to users of different sizes, mechanically reliable, resistant to vandalism or theft and unique design to discourage theft

Modular station (New York City)

Pemanent station (París)

Source: commons.wikimedia.org/wiki/User:Coyau

Stations with docking points: The bike is locked to the electronically controlled docking point. The rental process takes place at the rental unit (terminal or at the docking point itself), which can include touch screen display, card reader, RFID-Reader printer and keyboard.

The components in **car-sharing** and **taxi-sharing systems** are the cars and taxis themselves

Technology

The technology in these systems is focused on offering: (1) Information in web sites or mobile apps, (2) Planningservices, such as automatic monitoring of the use of vehicles, in order to re-distribute the bicycles according to the demand or check the availability of taxis in a zone, and (3) Payment services, adding user registration and, in bike-sharing systems, the integration with other modes of public transport by using smart-cards.

Bike-sharing

Access technologies are diverse and depend on the size of the system, available financing and the technology used.

- **Cards:** the most common means of access is a (smart)-card. The bike can either be rented at a terminal or at the bike itself if the bike provides a card reader.
- **RFID (radio-frequency identification):** contactless communication gives the operator the opportunity to provide any physical form of means of access. RFID tags can be glued to ID Cards and mobile phones or mounted into key ring pendants.
- **Code-based rental:** the user calls a number or sends an SMS with the required data to a central number and gets an access code or any other access information onto their handset.
- **Key:** the users receive the key for a bike from a device or kiosk where they have to identify themselves before the rental.

Software: there are two basic sets of functions,

- The public side of the system, includes registration of users, rental, payment and subscriptions, general information about the system, and customer data management. It can also include website portals and apps for smart phones.
- The management side, where the implementing agency and operator receive the information required to run and manage the system: station monitoring, redistribution of bikes, defect and maintenance issues, billing, and customer data management.

Wireless communications are commonly used since they provide flexible station location.

Source: flickr.com/photos/pdinnen/3662926490/

Source:: flickr.com/photos/charclam

Source: flickr.com/photos/davidonformosa

Source: Chicoutimi-commonswiki

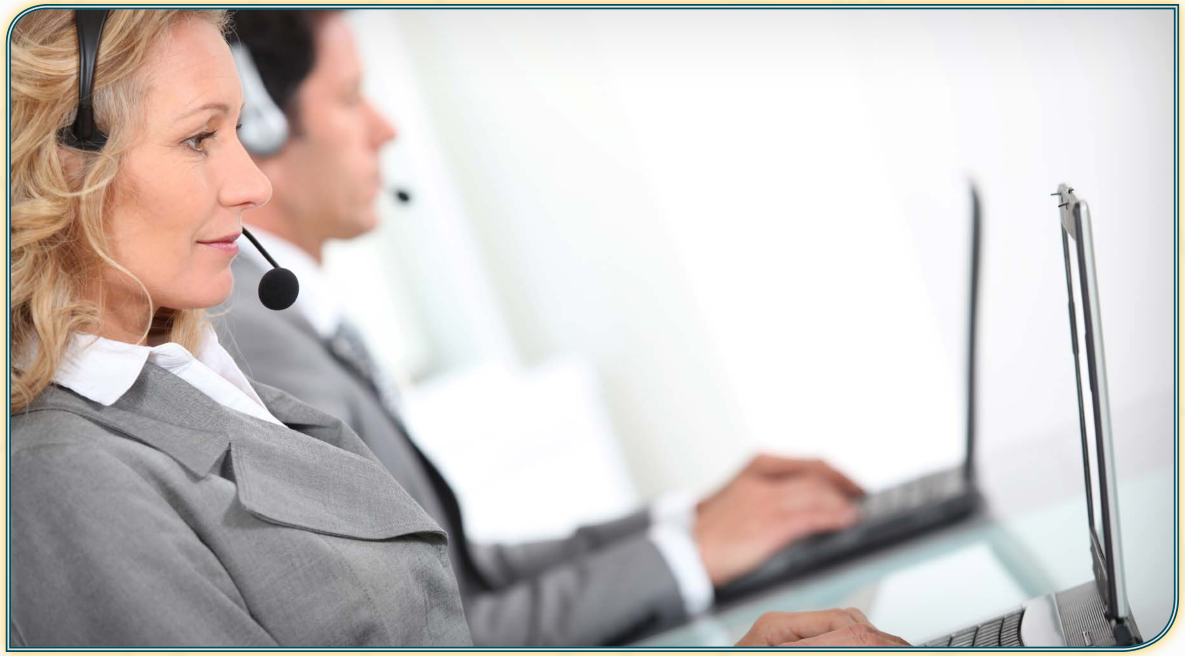
Car-sharing and Taxi-sharing

Such systems generally use three recent technological advances:

- GPS navigation devices to determine a driver's route and arrange the shared ride
- Smartphones for a traveler to request a ride from wherever they happen to be
- Social networks to establish trust and accountability between drivers and passengers

These elements are coordinated through a network service, which can instantaneously handle the driver payments and match rides using an optimization algorithm.

Institutions



In the bike share systems exist two main entities:

- The implementing agency: is the government entity that oversees the planning, implementation, and operations of the bike-share system.
- The operator is the entity that handles the day-to-day operations of the public bike-share system. Operators include local governments, public transport agencies, advertising companies, for-profit companies, and non-profit groups.

Car-sharing and taxi-sharing systems are based on private initiatives, without the known support of government entities,contrary to the case of bike-sharing systems.

INTERNATIONAL EXAMPLES

The table below shows several groups of bike-sharing international examples, according to the type of operator. Strengths and weaknesses of each of them are highlighted.

EXAMPLES	OPERATOR	STRENGTHS	WEAKNESSES
Buenos Aires	Government	Maintains control of legislative and public assets necessary to make bike-share successful; Has no ulterior motive other than to operate a high-quality system	Initial lack of expertise in bicycle sharing
DBRent (German systems)	Public Transport Authority	Has experience in managing transport-related services; Facilitates cost sharing with existing assets such as customer service, maintenance personnel and depots	Difficulty in accessing and working with other transport providers because they are seen as competitors; Bike-share system may expand such that it needs its own customer service, maintenance, and depot facilities
Santiago, Paris, London, Washington, D.C., Boston, New York	Private Sector	Generally achieves a high level of efficiency	Profit-oriented, which can conflict with maximizing the utility of system for the user; May reduce its efficiency due to financial constraints or suboptimal contractual conditions; Limited ability to push for policy and planning changes in government
Denver, Minneapolis	Not-for-Profit	Prioritizes the utility of the bike-share system to the user	Frequently financially constrained; Normally below-average business focus, leading to financial unsustainability

Figure 16. Bike-sharing. International Examples *Source: The Bike-share Planning Guide (ITDP)*[19]

Taxi-sharing services are offered in many cities and countries around the world through apps or web sites. Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay, Venezuela or Boliviaare examples in Latin America, where these apps are already operating: Uber, Easy Taxi, Cabify, Taxibeat, Yaxi, among others.

In the same way, car-sharing services are emerging in both Latin America and the rest of the world. This is the case of the web sites where drivers and riders are matched, such asAventones (operating in Mexico, Chile, Argentina, Colombia and Peru), Carpoolear or Sincropool in Argentina, or Roadsharing or Carpoolworld that include world wide users. Also car-sharing services companies, such as Carrot in Mexico or Zazcar in Brazil,are emerging in the LAC region.

KEY CHALLENGES DURING IMPLEMENTATION

Source: commons.wikimedia.org/wiki/User:Mariordo.

According to "The Bike-share Planning Guide", there are five key points for a successful implementation of a bike-sharing system:

- **Station Density:** A quality system needs 10-16 stations for every square kilometer, providing an average spacing of approximately 300 meters between stations. Lower station densities can reduce usage rates.
- **Bikes per Residents:** 10-30 bikes should be available for every 1,000 residents within the coverage area. Larger, denser cities and metropolitan regions with an influx of commuters into the area served by the system should have more bikes available to meet the needs of both commuters and residents.
- **Coverage area:** The minimum area covered by a system should be 10 square kilometers, large enough to contain a significant number of user origins and destinations.
- **Quality bikes:** Bikes should be durable, attractive and practical (with a front basket to carry bags, packages or groceries). The bicycles should also have specially designed parts and sizes, which discourage theft and resale.
- **Easy-to-use Stations:** The process of checking out a bicycle should be simple. The payment and authorization technology utilized should have an easy-to-use interface, a fully automated locking system, and real-time monitoring of occupancy (to track whether more or fewer bikes are needed for each station).

One of the key challenges of the other two types of ride-sharing systems is the development of algorithms for optimally matching drivers and riders in real-time. Although the main challenge is the integration of these services into the existing transportation network, in a way that provides equity and recognizes the interests of all parties.

Other considerations are about privacy regulations and laws regarding payment, as well as different requirements for keeping the customers' information secure. Most countries have established payment mechanisms, and it is best to work within those existing systems. For example, the integration of bike-share payment mechanisms into the payment systems used by other local modes of transport would be a good proposal.

COST/BENEFIT BENCHMARKS

Source: www.flickr.com/photos/alainrouiller

The costs of bike-sharing systems are broken down below:

- Infrastructure & implementation costs: bicycles, stations (including docking spaces and terminals), IT system components and control center.
- Running costs: service and maintenance of the system (equipment maintenance, redistribution vehicles, fare collection, service and website maintenance, etc.)

The details collected in "The Bike-share Planning Guide (ITDP)"[62] shows a broad range of costs data of international bike share systems, which are presented below:

CITY	COUNTRY	SYSTEM NAME	CAPITAL COST	REPLACEMENT COST OF BIKE	AVERAGE OPERATING COST PER TRIP
London	U.K.	Barclays Cycle Hire	4,000 USD	1,435 USD	4.80 USD
Paris	France	Vélib'	n/a	809 USD	n/a
Barcelona	Spain	Bicing	3,150 USD	n/a	0.86 USD
Montreal	Canada	Bixi	4,000 USD	1,270 USD	1.27 USD
Washington, D.C	USA	Capital Bikeshare	n/a	1,000 USD	1.52 USD
Guangzhou	China	Guangzhou Public Bicycle	n/a	69 USD	n/a
Mexico City	Mexico	Ecobici	3,400 USD	n/a	1.28 USD
Rio de Janeiro	Brazil	Bike Rio	1,810 USD	550 USD	n/a
New York City	USA	Citi Bike	4,750 USD	n/a	n/a
Denver	USA	Denver B-Cycle	4,250 USD	n/a	3.22 USD
Minneapolis	USA	Nice Ride	4,487 USD	1,000	1.52
Madison	USA	Madison B-Cycle	5,000 USD	n/a	n/a
Boston	USA	Hubway	n/a	950 USD	3.09 USD

Figure 17 Bike-sharing. Cost benchmarks *Source: The Bike-share Planning Guide (ITDP)*

The major **benefits** of bike-sharing are: user cost savings, travel time savings, increased access, congestion reduction, emissions reduction, improved public health, and accident reduction. Many of them based on changes from motorized transport modes to bicycle-sharing.

There is limited data available on changes in mode of travel before and after the introduction of bicycle–sharing, in the four cases shown in the table below, the shift is mainly from public transport to bike, ranged up to 65%, while the shift from car or motorcycle range between 2 and 10%. As of November, 2012, for example, Washington, D.C.'s 22,000 bike share members had reduced the number of miles driven (in cars) per year by nearly 4.4 million. And numerous studies have shown that spending twenty minutes every day on a bike has a significant positive impact on mental and physical health[62]

Being technologies of recent introduction, there are not many car-sharing or taxi-sharing cost/benefits benchmarks, although the **results of some studies show** some benefits of these systems. Regarding car-sharing benefits, the survey "Real Time Ridesharing: Exploring the Opportunities and Challenges of Designing a Technology"[21] observed that at the metropolitan level there is a consistent, positive trend in the relationship between congestion and ridesharing, and that this trend is much more pronounced for large metro areas than for smaller ones. Along the same lines, a study conducted by the Senseable City Laboratory (SCL) at the Massachusetts Institute of Technology (MIT) shows that the negative impact of taxi on the city could be reduced by sharing taxis[22].

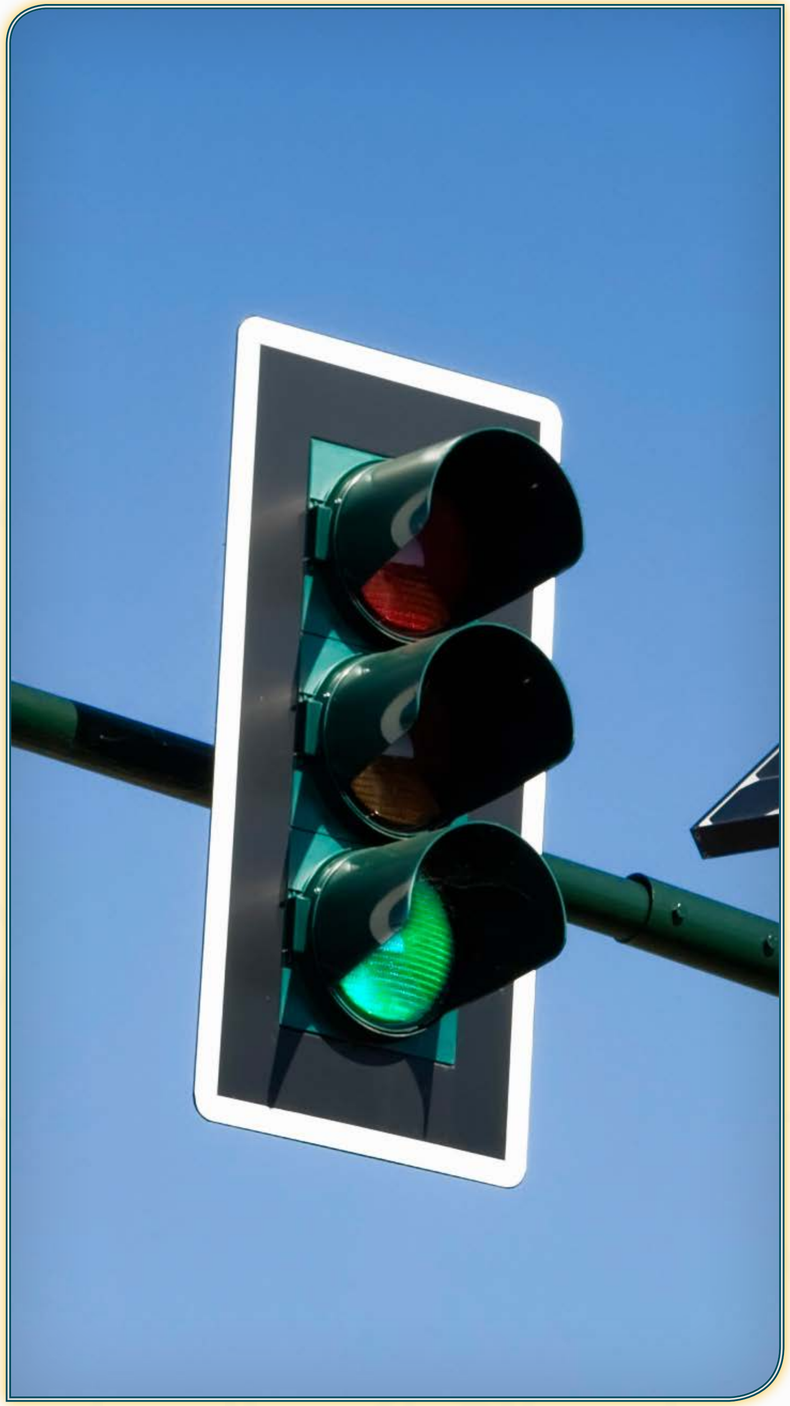
		BICING BARCELONA	BIXI	VÉLIB' PARIS	VÉLO'V LYON	ECOBICI MEXICO CITY	BIKE RIO RIO DE JANEIRO
Trips	**per Bike**	**10.8**	**6.8**	**6.7**	**8.3**	**5.5**	**6.9**
	per 1,000 residents	**67.9**	**113.8**	**38.4**	**55.1**	**158.2**	**44.2**
Type of Trip Replaced	**Bus or Metro**	**51%**	**33%**	**65%**	**50%**		
	Car or motorcycle	**10%**	**2%**	**8%**	**7%**		
	Taxi		**8%**	**5%**			
	Walk	**26%**	**25%**	**20%**	**37%**		
	Bicycle	**6%**	**28%**		**4%**		
	New Trip		**4%**	**2%**			

Figure 18. Type of Trip Replaced by bike in percentage in relation to Trips per Bike and Trips per 1000 residents
Sources: Bicycle-sharing schemes: enhancing sustainable mobility in urban areas (Peter Midgley, 2011)[20]

APPLICATION

URBAN TRAFFIC MANAGEMENT

Source: commons.wikimedia.org/wiki/User:Wheresmysocks



General Description

DEFINITION

Traffic management systems are being used in cities to improve the efficiency of urban roadways, using traffic detectors, traffic signals, and various means of communicating information to travelers. These systems make use of information collected by traffic surveillance devices and others sensors to smooth the flow of traffic along city corridors.

BENEFITS

Traffic Management Systems are designed to ensure optimal, safe and efficient use of the capacity of urban and inter-urban road networks. The general benefits of these systems are:

- Maximizing use of existing infrastructure to operate more efficiently.
- Reduction of traffic congestion through traffic information dissemination; thus, alternative routes are offered in order to avoid traffic jams or busy roads.
- Reduction of the fuel consumption in the vehicle and thus the level of gaseous and particulate pollutants emissions.
- Integration of Traffic Management of one region, including arteries, streets and highways.
- Enhanced communication in all aspects of transportation management (e.g., planning, design, implementation, operation, maintenance), improving the perspective and vision of traffic operators and traffic system management.
- Increasing compliance with speed limits, traffic signals, or other traffic control devices with enforcement programs.

TECHNICAL DESCRIPTION

Stage of development

Urban Traffic Management, in particular Traffic Control Systems, is one of the most used and widespread technologies in the world.

Components

Traffic Control Systems includes the integration of different traffic management and control technologies, mature or emerging, with the objective of managing in a dynamic way the traffic conditions in the urban areas. These systems have four basic functions:

- Automatic data collection of traffic volumes and speeds, using detection and surveillance technologies.
- Control of traffic signals based on this data.
- Provision of data for travel information services in variable message signs (VMS), Variable Speed Limit Signs (VSLS) or lane control sign based on up-date traffic conditions

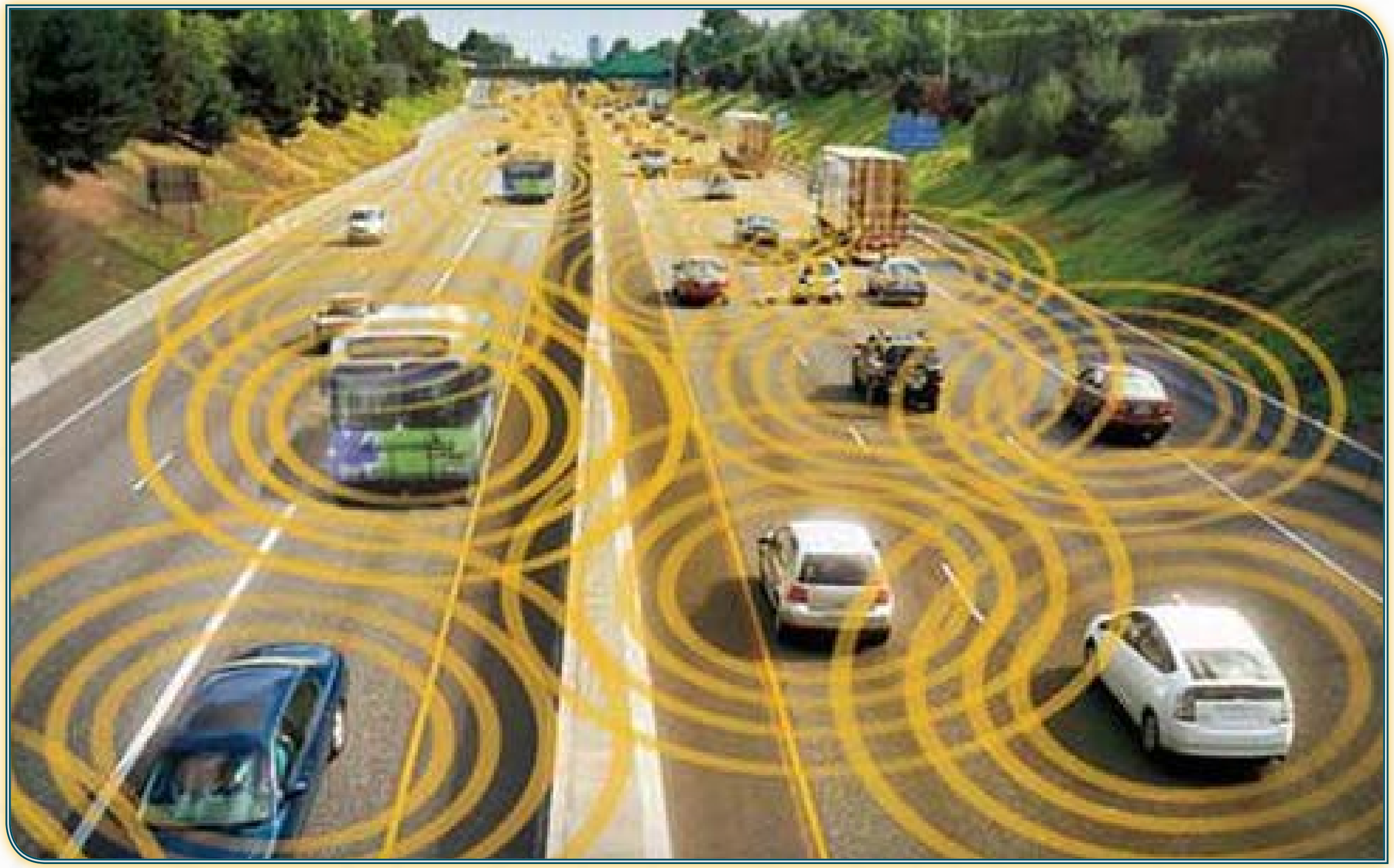
Signalized Intersections. Centralization of signalized intersections in order to improve flow traffic in urban areas may adjust time of green in determined streets according to time of day and the day based on the expected traffic conditions.

Components are detectors, signals and the control devices, the decisive component that controls the other ones. Deployment is usually accompanied by the installation of a traffic control and management center.

Traveler Information Systems

Dynamic route information: information about traffic situation offered to drivers in real time.

Public information: the traffic information gathered from the traffic sensors, presented on websites and apps to give an overview of the current traffic situation for public users and internally for traffic planning and control centers. By combining historical and real time data, the road network is optimized by forecasting the upcoming traffic volumes hours in advance, calculating the optimal distribution of traffic, distributing traffic by giving information before the congestions occur or giving information about road closures, accidents and obstacles.



Source: http://www.nistido.com/

Technology

Automatic collection of data

- Sensors; there are several types of sensors: inductive loop, magnetometer, magnetic induction coil, microwave radar, active and passive infrared, ultrasonic, acoustic array or video detection systems.
  Most measure count, presence, and occupancy. Some single detection zone sensors, such as the range-measuring ultrasonic sensor and some infrared sensors, do not measure speed. Microwave sensors do not detect stopped or slow moving vehicles. Magnetometer, magnetic, passive infrared and sound-based, acoustic sensor models do not classify vehicles.

- Video Surveillance, set of cameras which provide real-time view of urban traffic in different points from the city. Smart video surveillance uses computer vision and pattern recognition technologies to analyze information from situated sensors and offer data about traffic (number and type of vehicles by lane, detect infractions, incidents...)

Communications: traffic data obtained by either of the above technologies, must be transmitted to the central traffic management operation via a communications system, usually fiber optics, phone line and/or wireless.

Control Systems: specific software to analyze collected data, design traffic strategies (control algorithms) and control traffic signs according to this information. For Urban Traffic Control Systems the known control algorithms are:

- Intersections control by fixed time plans: determining and optimization the cycle of traffic lights at an intersection based on the time of day, and day of the week.
- Intersections control by actuated operation: the phases of traffic light are activated depending on the presence of vehicles by some access to the intersection.
- Dynamic intersections control (Adaptive Signal Control): is based on intelligent algorithms online, and based on real-time information, which tend to optimize the operation of network traffic intersections (or lights). The best known algorithms are SCOOT (Split Cycle Offset Optimization Technique) and SCATS (Sydney Coordinated Adaptive Traffic System).

In addition, there are a number of **technologies associated with Advanced Traveler Information Systems (ATIS)**, which may influence the behaviour of travelers, through the provision of information to assist the best decision from the point of view of management traffic, among others: Variable Message Signs (VSM), Dynamic Speed Control, Website and Social Networks. Even other **technologies associated with traffic management strategies** such as reversible lanes, incident management or special traffic plans.

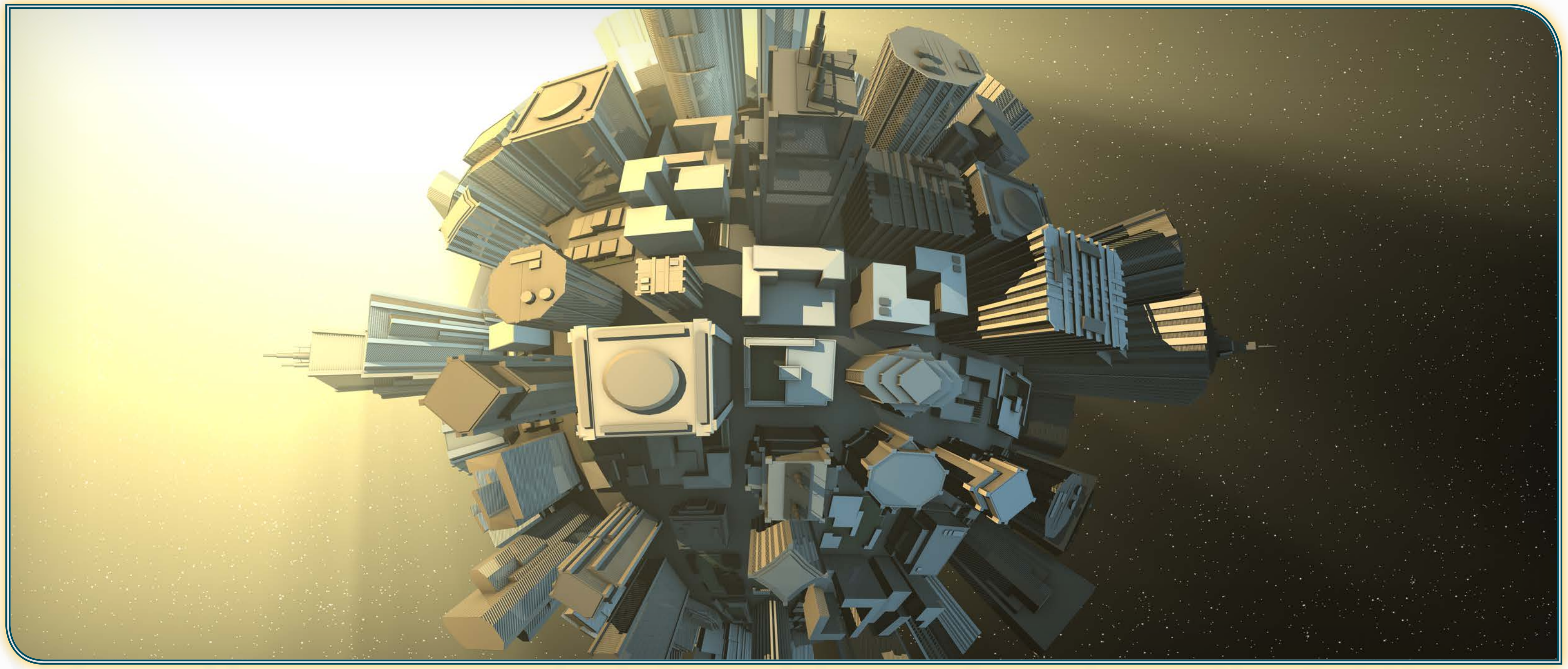
Institutions

The initiative about technologies deployment and strategies to follow for improving the urban mobility corresponds, in general, to the traffic and mobility authorities and administrations. Their direct concern is to manage traffic at a local or regional level and they are generally responsible for formulating, publishing and enforcing traffic regulations.

In addition to urban traffic management, traffic and mobility authorities and administrations in many cases will also be responsible for operating the traffic control and traveler information system, sometimes assisted by professional technicians from systems integrator companies.

INTERNATIONAL EXAMPLES

There are a large number of cities that have been adopting urban traffic management solutions throughout the world, among others are London (UK), Paris (France), Madrid (Spain), and the most mainland European cities; Beijing (China) and Mumbai (India) in Asia; Toronto (Canada), New York and Los Angeles (USA) in North America or Rio de Janeiro, Sao Paulo (Brazil), Santiago (Chile), Bogota, Medellin (Colombia) or Quito (Ecuador) in Latin America.



KEY CHALLENGES DURING IMPLEMENTATION

Multi agency co-operation and coordination: Urban Traffic Management Systems must be communicated with Interurban Traffic Management Systems of those highways that influence the urban environment, also with public transport centers and any other departments with relevant data that may affect the urban mobility.

Interoperability: for an effective and efficient co-operation, data interoperability and information sharing across departments, programs and jurisdictions should be enabled.

Standardization: Creating interoperability does not invalidate the importance of specification or even standardisation of components of ITS Services in order to fully exploit the benefits of the ITS systems.

Systems Operation and Maintenance: An adequate maintenance and support of installed equipment and systems is relevant for a good functional performance, particularly for the equipment that collect data for decision-making processes.

COST/BENEFIT BENCHMARKS

As a reference of the cost involved in these systems deployment, we will refer to these benchmarks:

Santiago de Chile. According to the ministry of transport from Chile (SECTRA)[23], the amount of investment to implement the Traffic Control Systems in this city was about USD 35 million. This project included control of 1,655 intersections, 300 intersections with dynamic control SCOOT, 35 CCTV cameras, Geographic Information System (GIS), 6 variable message signs, 40 detectors to count the number of vehicles and a web site with traffic information. They also refer to the operational and maintenance costs of this type of system, which are by 3 to 4% and by 10 to 15% of the annual amount of investment, respectively.

Source: commons.wikimedia.org/wiki/User: B1mbo

Quito. Traffic-light centralization system is being implemented by Metropolitan Public Mobility and Public Works Company (EPMMOP) of Quito[24]. The project has an investment of USD 27 million and a time schedule of 24 months and 3 additional years for configuration and optimization. Traffic-light centralization system includes the installation of adaptive traffic light system at 600 intersections in the city, which will be managed from the Center for Mobility Management, installed and implemented for this purpose. Furthermore, additional systems will include 1,511 video detection cameras (1,072 have been already installed), 185 digital video surveillance cameras (115 cameras have been installed), 8 variable message signs to inform motorists in case of detours by accidents or road works, 309 devices for public transport priority, control equipment of tunnels and 13 automated enforcement devices, which have already been installed.

The table below shows some cost references:

SYSTEM	SYSTEM NAME	UNIT COSTS APPROX.
Roadside Detection	Inductive Loop Surveillance	$7.5K to $13.3K*
	Remote Traffic Microwave Sensor	$14K*
	CCTV-Video Camera	$8K to $16K
Roadside Information	Dynamic Message Sign	$41K
	Variable Speed Display Sign	$3K-$4K
Roadside Telecommunications	Conduit Design and Installation – Corridor	$52K-$77K
Adaptive Signal Control	SCATS	$25K to $30K *
	SCOOT	$30K to $60K *
Signal Control	Retiming signal	$2K-$4K *
Roadside Telecommunications	Conduit Design and Installation – Corridor	$52K-$77K
	Fiber Optic Cable Installation	$21K-$54K
Transportation Management Center subsystem	Hardware, Software for Traffic Surveillance	$134K to $164K
	Software, Integration for Signal Control	$104K-$149K
	Software, Traffic Information Dissemination	$18K-$22K

** Per intersection.*

Figure 19. Cost references about Urban Traffic Technology.

Source: ITS Benefits, Costs, Deployment and Lessons Learned: 2011 Update[25]

Urban Traffic Management

Some **benefit** references are:

The **City of San Antonio,** Texas (USA), with an average travel time reduction (per each of 60 corridors) of 54 seconds, total annual delay savings (793 intersections) of 8.6 million motorist hours in traffic, and an annual delay savings of over 159 million USD[26].

Bucharest: The advanced integrated traffic management system for the City of Bucharest includes a new traffic control center, 140 intersections with video surveillance system (CCTV), a fully adaptive traffic control with 140 controllers and fiber-optic based communications.

The benefits obtained after implementation were: 20% travel time reduction in the controlled area; 10% less in CO2 emissions (= 600 tons / year) and 1.5 million EUR productivity gain per year[27].

New York: New York City Department of Transportation implemented Midtown in Motion (MiM). ITS investment includes the installation of a modern traffic management center in Queens, the introduction of a wireless communications network and the upgrading of intersection traffic signal controllers to identify and respond to traffic conditions in real time.

Results after the first phase of the program (2011) showed an overall 10% improvement in travel times on avenues. The average travel speed in the zone increased from 10.5 kmph to 11.6 kmph between 8 a.m. and 8 p.m. which was additionally confirmed by Taxi GPS data [28].

Mumbai implements an Adaptive Traffic Control System (ATCS) which modifies traffic signal cycles in real time by means of surveillance sensors or devices installed on site to respond to changing traffic conditions.

Consequently to this dynamic system that controls 253 street intersections, there has been a 10% increase in average traffic speed, 40% lower energy consumption as the result of the use of LED-type traffic signal lights, 17% of travel times reduction in Mumbai city

thanks to be able to adapt traffic management to traffic situation on real time and heighten road and drivers safety by reducing accidents rate[29].

Specific indicators of the most common adaptive signal control such as SCATS or SCOOT are reflected in the following table::

SYSTEM	SYSTEM NAME	TRAVEL TIME	DELAYS	STOPS
Adaptive Signal Control	SCATS	-20% to 0%	-19% to +3%	-24% to +5%
	SCOOT	-29% to -5%	-28% to -2%	-32% to -17%

Figure 20. Specific indicators of the most common adaptive signal control

Source: Eddie Curtis, FHWA Office of Operations / Resource Center.

APPLICATION

ENFORCEMENT IN URBAN ENVIRONMENT

General Description

DEFINITION

Automated enforcement systems are electronic devices that detect traffic violations and document, through photo or video evidence, the vehicle at fault. The owner of the vehicle is then notified of the infraction by mail or other means accepted.

The most common types of automated enforcement systems in an urban environment are associated with speed limit's compliance, red-light running and other signal violation (dedicated lane, illegal turn, etc.).

BENEFITS

Speed enforcement improves safety, reduces aggressive driving, and assists in the speed compliance enforcement.

Red-light camera enforcement enhances safety at signalized intersections by improving red-light compliance, resulting in a reduction of red-light running violations. According to the "Research and Innovative Technology Administration of the U.S. Department of Transportation", automated enforcement systems have reduced red-light violations by 20 to 60 percent and crashes by 22 to 51 percent.

TECHNICAL DESCRIPTION

Stage of development

Traffic Enforcement includes different types of technology, such as–widely used speed vehicle detection (radar or microwave) or the latest technologies, which use digital video recording with advance image processing (deployed for the detection of other types of violations besides speed limit compliance). All of them are widespread deployed.

Components

Road equipment: equipment to detect and capture traffic violation (speed, red light, etc.). Include sensors to detect the vehicle (radar, laser, inductive, optical, video...), camera to capture the number plate and the instant of the infringement, and other elements such as a lighting device (infrared normally), system clock, communications elements (Ethernet output or wireless communications, GPRS or UMTS), storage system, service terminal, location system and a central processing unit, mainly. In red light enforcement is also needed a traffic light cycle sensor.

They can be fixed on the road or mobile equipment in the law enforcement vehicles.

Automatic Violation Report Processing Center: Center where data and photos of violations are decoded and matched with the vehicle owner through the license plate database. Once the vehicle and its owner have been identified, the penalty notice is automatically sent by mail to the vehicle owner with the photo that evidences the violation, date, time, etc.

Source: commons.wikimedia.org/cameramann

Source: commons.wikimedia.org/Bidgee

Figure 21. Examples: fixed and mobile equipment

Technology

Technologies for detecting violations, identifying the vehicle and identifying the owner of the vehicle must be differentiated.

Some technologies are common to systems for detecting different violations, whereas others are particularly tailored to the detection of specific kinds of violations.

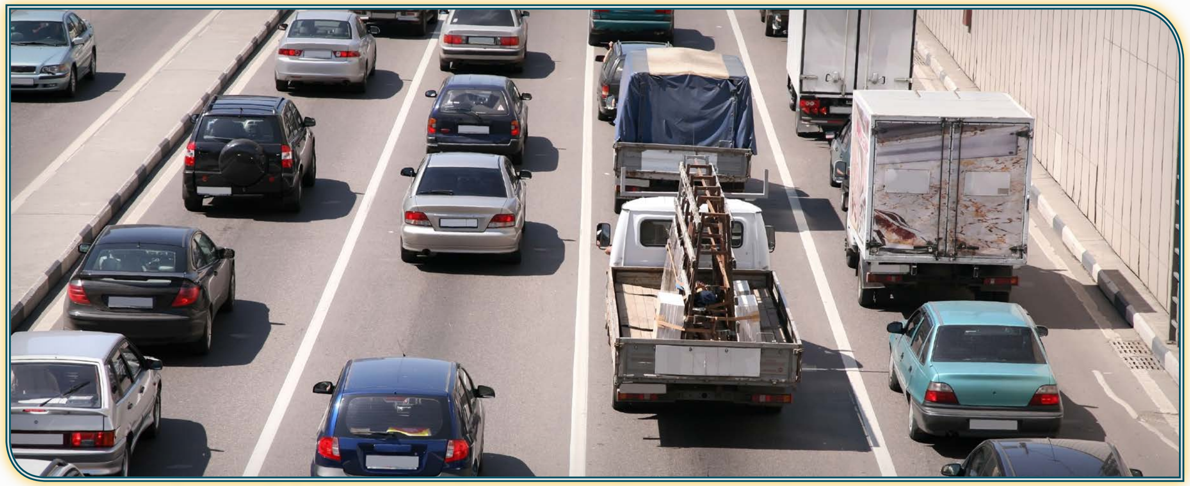
Technologies for detecting violations:

- **Radar** (Radio Distance And Ranging), **Microwave,** and **LIDAR** (LIght Distance And Ranging): are mature and widely used technologies that have been used to calculate vehicle speed for decades. A sensor emits radio waves (radar), microwaves, or a laser beam (LIDAR), which reflects off vehicles and *measures spot speed.*
- **Inductive loops** in pavement, typically used to measure traffic data such as count, presence, and occupancy, can also be used for speed measurements although in a less reliable way than the previous ones.
- **Optical sensors** are used to some extent as well, based on the reflection of infrared beams from special reflectors in the road bed. A detector records when a passing vehicle crosses the beam, and records speed and headway.

For enforcement purposes, all previous technologies must be combined with a video image system for vehicle identification.

Technologies for identifying the vehicle:

- **Automatic License Plate Readers (ALPR):** Optical cameras capture images of license plates of offending vehicles and software "reads" the information. It is a mature technology (over 30 years).
- **Machine vision:** Cameras with embedded software that mimics human vision, with the capability to analyse images of the environment, including automatic license plate readers. Thus, it can be used as detection and identification technology at the same time, making it suitable to detect and document violators as speeding, lane occupancy, illegal turn u other signal violation (stops, pedestrian crossings).



Source: en.wikipedia.org/wiki/Agência_Brasil

Source: commons.wikimedia.org/wiki/User:Niagara

Figure 22. Radar, Lidar and Inductive loops technologies

Technologies for identifying the owner of the vehicle

Using software tools to connected ALPR or machine vision cameras with license plate database, where the owner's address is retrieved and the letter to the owner is produced without manual intervention, permit the whole process automation, from detecting to fining the violator.

Source: http://1080plus.com

Institutions

The public agency in charge of promoting the urban enforcement is the traffic or transport department in the municipality who control and oversee the urban traffic management and the correct application of enforcement law (fines and other penalties) supported by national traffic agency. Although exist diverse types of business models to installation and operation management, the most common are:

- Public implementation and operation of urban enforcement.
- Public implementation and private operation with remuneration on the basis of fines processed.
- Private concession to implement and operate the urban enforcement systems in exchange for a percentage of the fines collection.

INTERNATIONAL EXAMPLES

Automated Traffic Enforcement (ATE) has been deployed in many urban and suburban settings around the world as a cost-effective way to reduce speeds and crashes.

Regions where ATE has been more frequently used worldwide are in Australia, Canada, Europe, Singapore, and the United States. The last one had 502 individual communities using light cameras and 140 using speed cameras in August 2014, among them Washington DC, with 7 types of Automated Traffic Enforcement at present: Automated Red Light Enforcement in 48 intersections, Automated Speed Enforcement in 170 locations, Gridlock in 20 intersections, Stop Signs in 32 points, Pedestrian Right of Way in 16 locations, Intersection Speed in 24 intersections and Oversized Vehicles with 7 restricted areas[30].

In Europe, London is an international example to consider, with ATE in 300 points and in the City's borough, CCTV cameras are used to detect vehicles that are parked illegally or to enforce moving traffic infringements (banned turns, no entry, yellow box junctions, no entry to pedestrian zone, illegal U-turns, blue arrow sign, bus lane)[31].

In Latin America there are also many cities with ATE, for instance Guadalajara in Mexico, Lima in Peru, Medellin in Colombia and Quito in Ecuador, among other. Rio de Janeiro in Brazil should be highlighted: in 2013, the Municipal Secretary of Transport (SMTR) operated 235 speed enforcement equipment, 128 red lights and 24 lane dedicated enforcement, all them integrated in the Operation Center of Rio.

KEY CHALLENGES DURING IMPLEMENTATION

6

ENFORCEMENT IN URBAN ENVIRONMENT

An important **prerequisite** for an efficient automated enforcement system is the availability of a centralized register of vehicles and their owners at a national level in order to have an effective tool for prosecuting offenders for the law enforcement officials.

Concerning **implementation**, Traffic Safety criteria must be used to determine where automated traffic enforcement will be used. These criteria include, among others, high-risk, high frequency, high-collision and high pedestrian volume locations.

Among the **technical considerations**, features and limitations of each technology must be taken into account in order to choose in every case. For instance, it should be noted that ALPR cameras require a direct sight line to license plates, so they must be installed above the roadway or on the roadside in locations that minimize visual obstructions (e.g., from surrounding traffic) and avoid off-axis angles that could reduce recognition accuracy.

COST/BENEFIT BENCHMARKS

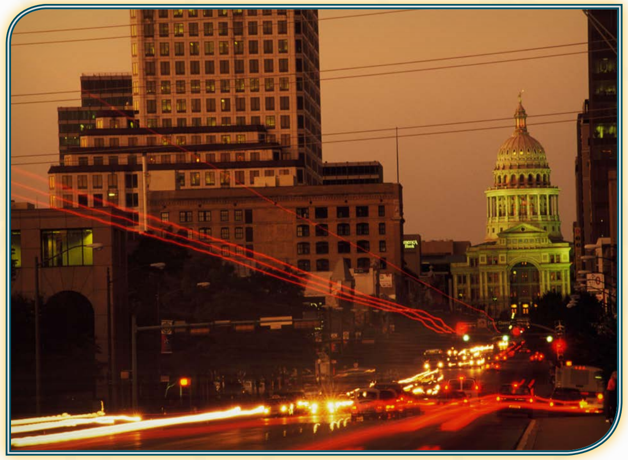
The main challenge of urban enforcement is to reduce crashes caused by speeding, red light running and other traffic infractions, thus, analysis data about crashes and their severity before and after ATE installation is a good indicator of this application effectiveness. Below are some benefits references:

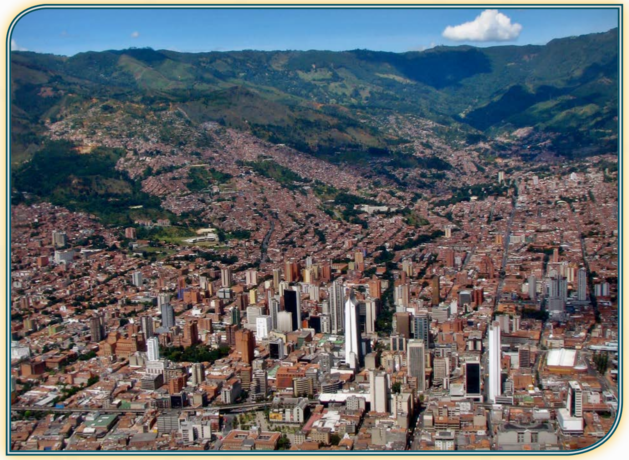
Chicago (USA): Red-light cameras were gradually installed at accident-prone city intersections, beginning in 2003 and today there are 380 cameras in 190 intersections. According to Chicago Department of Transportation between 2005 and 2012: crashes of all types were down 33% at intersections with cameras, dangerous right-angle crashes decreased by 47%, rear-end crashes a 7% and both crashes resulting in serious injuries and pedestrian crashes were down a 22%[32].

Texas (USA): the 2011 study for Traffic Operation Division Texas Department of Transportation, Evaluation of photographic traffic signal enforcement systems in Texas, analysed the number of crashes before and after the installation of the automatic traffic enforcement system, and obtained a reduction in the number of red light related crashes for the treatment site intersections of 23% during the first year, 27% over the 2 year group period and a 21% over the 3 year group period[33].

London (UK): Transport for London indicates that roads with speed and red light cameras enforcement fell by a dramatic 50% the number of people killed or seriously injured. That means the cameras help prevent 500 deaths or serious injuries each year[34].

Medellin (Colombia): the accumulated incidents rate was reduced in a 18.6% in two years, in the area of enforcement influence[35].





Source:commons.wikimedia.org/ seth pipkin

The following table show **unit cost references** to offer an approximated idea about cost of Enforcement Systems:

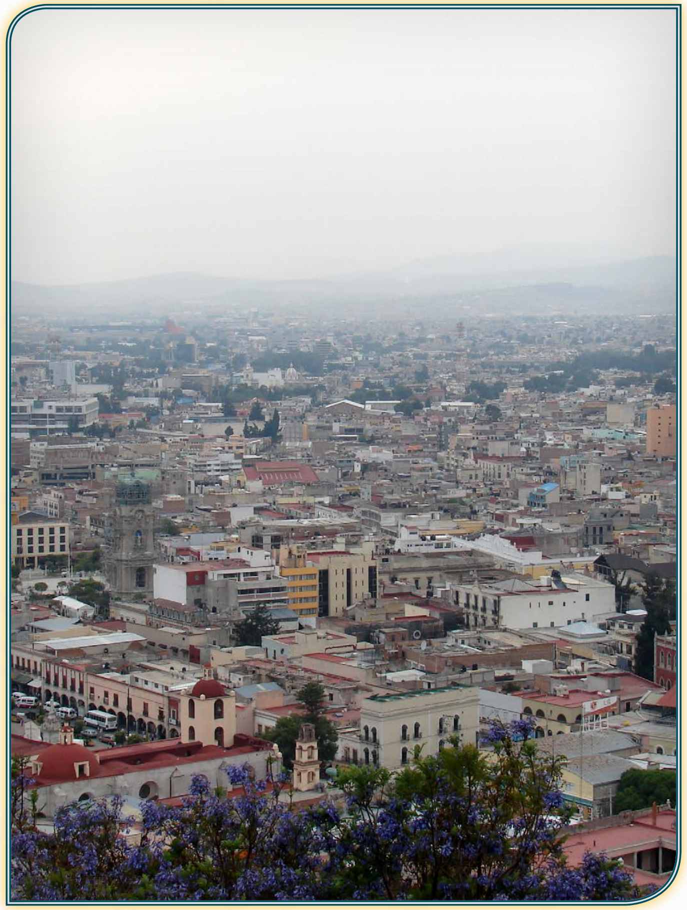
SYSTEM	SYSTEM NAME	UNIT COSTS APPROX.
Roadside Detection	**Portable Speed Monitoring System**	**$4.1K-$12.2K**
	Traffic Camera for Red Light Running Enforcement	**$60K-$109K**
Roadside Information	**Variable Speed Display Sign**	**$3K-$4K**
Roadside Telecommunications	**Conduit Design and Installation – Corridor**	**$52K-$77K**
	Fiber Optic Cable Installation	**$21K-$54K**

Figure 23. Unit cost references of Enforcement Systems
Source: ITS Benefits, Costs, Deployment and Lessons Learned: 2011 Update [66]

In a more general way, here are some **cost** benchmarks:

Callao (Peru) with an investment of 15 million $ in its current enforcement systems and 7% of this amount in maintenance each year. It has ATE in 42 points which are managed by a concession. The monitoring infringements are: speeding, red light and pedestrian crossing running. A Control Centre processes all infractions. The results obtained show that in the points with ATE, the infringements committed have decreased a 91%, from a 2.4% in 2007 to a 0.4 in 2011. This fact becomes even more important bearing in mind the increase of traffic from 1.3 million to 1.5 million in the same period. (Source: Consorcio Tránsito Ciudadano)[36].

Pachuca (Mexico): Inside "Secured Destiny" project, a private firm invested 30 million Mexican pesos (approx. 2.21 million USD) to install speed enforcement (24 speed control panels, 3 mobile radars and 2 fixed radars) and red light cameras (6) in the city, and to operate the systems during 36 months, in exchange for 85% of the collected revenues through the fines. After this period the equipment will be transferred to council ownership[37].



Suorce: datuopinion.com

APPLICATION

INTERURBAN TRAFFIC MANAGEMENT

General Description

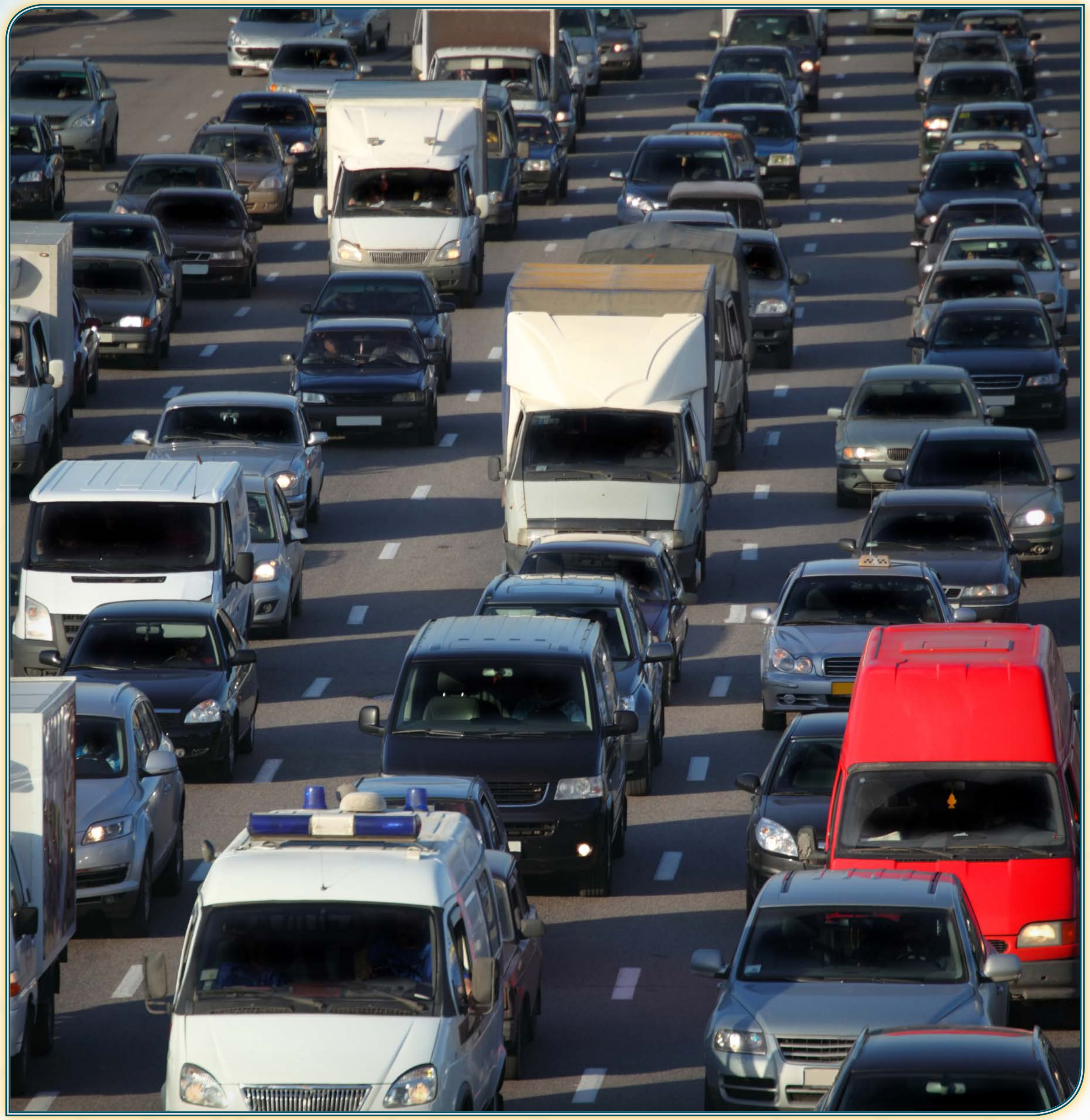
DEFINITION

Interurban traffic management systems are being used on a local and regional network level to maximize the effectiveness and efficiency of a roadway and result in improved safety, trip reliability and throughput. These systems provide updated information from an operations center that receives and processes field information picked up continually by sensors on main roads.

BENEFITS

Road signs often provide redundant, contradictory or out of date information. Telematic systems, such as Variable Message Signs, are designed to correct this situation, allowing the same panel to provide information continuously updated by remote control from a control center. This enables strategic network control, re-routing users or allowing them to choose the best route based on up-to-the-minute information, thus reducing the impacts of congestion, delays and pollution.

Traffic control and management systems have also been implemented and justified in terms of accident reduction and travel–time savings, increasing safety by alerting drivers of upcoming hazards or maximizing network capacity by providing traffic information to drivers. Therefore, safety and efficiency are also considered benefits of interurban traffic management application.



TECHNICAL DESCRIPTION

Stage of development

Mature technology that has been largely deployed on highways.

Components

Capture of information elements: set of sensors that collect road data about road traffic situation such as presence, speed, queue occupancy levels, traffic volume and density, average speed, vehicle classification, incident detections or others about environmental and weather conditions.

Disseminating information and user support elements: key elements of ITS deployment to provide relevant real time traffic pre-trip and on-trip information to travelers, thus allowing well-informed travel decisions (pre-trip information) as well as information during the journey (on-trip). Among this group, components to communicate the road operator with the user and vice versa are also included, as for example SOS posts.

Information management elements. Traffic Management Centers: collects and consolidates information received from surveillance and detection equipment, in order to manage the road network.

Communications infrastructure: facilitates data transmission between devices along roadway corridors and the operations center.

Figure 24. Traffic Management Centers.

Source: First figure- Traffic tech; Second figure – flickr.com/photos/highwaysagency

Technology

Capture of information technologies: closed circuit television (CCTV) cameras to monitor traffic conditions and inductive loops as traffic detectors are the most commonly used, although there are other technologies as Bluetooth, video image processor, microwave radar sensors (presence detecting and Doppler), laser radar sensors, passive infrared sensors, ultrasonic sensors, passive acoustic sensors or even devices that utilize a combination of these technologies.

Disseminating information and user support technologies. Information can be provided to end-users with different technologies:

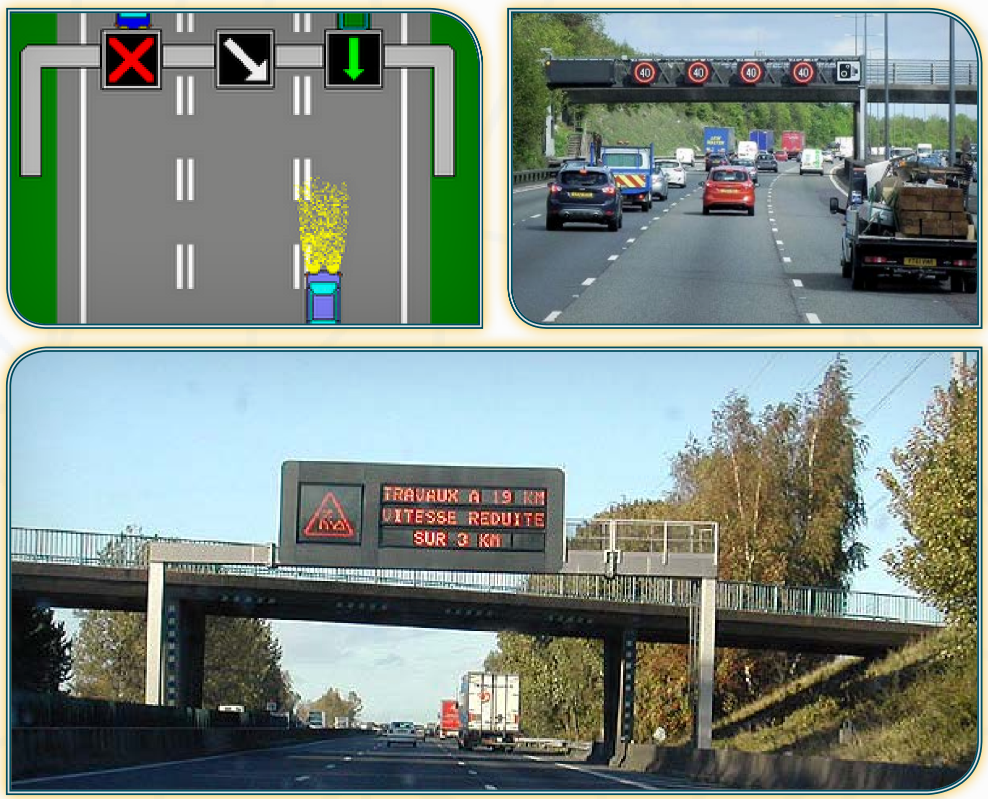


Figure 25 VMS, VSLS and Lane Management Signs
Source: www.geograph.org.uk/photo/3731624

- Signalling Equipment that used a LED matrix that displays text and graphics as the Variable Message Sings (VMS), variable speed limits as Variable Speed Limit Signs (VSLS) or that enables a temporally modifiable allocation of lanes as the Lane management Signs. Only on-trip usage is valid, since the installation is on the road.
- Highway Advisory Radio (HAR), a specific application of FM RDS used for broadcasting real-time information. Data messages are received silently and decoded by a Traffic Management Center equipped navigation system or radio and offering dynamic route guidance.
- Website or internet portals mainly used as pre-trip information about warnings, weather conditions or traffic conditions that show on maps, as text or as images from roadside CCTV.
- Also SOS posts that provide drivers with a direct link to the Control Center and assist them in any emergency on the road.
- And others as navigation systems or mobile devices that offer update information on route and pre-trip, respectively.

Communications technologies: Most road traffic systems use fiber optics, or copper cable as the primary communications transport medium, although wireless communications are also possible in case of a limited number of equipment and depending on the area conditions.

Information management technologies: software and management programs that enable strategies and management plans from the data collected and analysed, to smooth traffic flow in the road network. These technologies offer duration or distance of traffic disturbances, e.g. incidents, accidents, weather, works on road, closure of a lane or other relevant events; consequences on traffic conditions, e.g. delays, and recommendation of alternatives, e.g re-routing; but also travel times or other useful information from historic traffic data used for predicting traffic flows.

Institutions

In the deployment of interurban traffic systems, the Public Works Ministry and the Traffic Authorities are involved as public entities, and the concessionary companies as private entities.

In LAC region usually a private concession is the responsible for building, operating and maintenance the interurban highways and their ITS systems implemented; the business model in which the public entities are in charge of operating the interurban road equipment is also used.

INTERNATIONAL EXAMPLES

ITS technologies in interurban road networks have been deployed in many countries around the world with the objective of maximizing road network safety and efficiency.

There are multiple examples mainly in Europe, USA, Canada, Japan or Australia. For example, the Netherlands, where dynamic route information has been provided since 1990, over 100 gantries display informational panels across the country on major motorways are in use since 2010; Germany, where the 80% of all trips on the motorway network use real time traffic and traveler information; or Spain where there are 7 TMC to manage traffic control and traffic law enforcement on all interurban roads.

In Latin America countries there is also ITS equipment in the interurban road network, although nowadays are concentrated in particular motorways, for example the highway Nueva Necaxa-Ávila Camacho in Mexico, with 16 VSM, 140 cameras of CCTV, 40 SOS posts, 5 weather stations, 3 traffic evaluation remote station, 2 dynamic weighing station and speed radars, in a section of100 km length between Nuevo Necaxa and Tihuatlán.

KEY CHALLENGES DURING IMPLEMENTATION

Key challenges for the successful implementation of urban traffic management shown in a previous section of this report, are also applicable for the interurban traffic management, as the following:

Multi agency co-operation and coordination: Interurban Traffic Management Systems must be communicated with Urban Traffic Management Systems of those urban environments that impact in the highways network, also with private concessions of freeways, tunnels, bridges, etc. which may be accessed from the network managed.

Interoperability: for an effective and efficient co-operation, data interoperability and information sharing across departments, programs and jurisdictions should be enabled.

Standardization: at the country level standardization is important in terms of communication (for example, radio frequencies, location coding, coding for data exchange between different organizations and centers) and of information to road users (for example, pictograms on VMS, legal meaning of signs such as speed limits on VMS signs).

System Operations and Maintenance: all equipment must be checked and maintained, especially detectors to assure reliable and accurate readings, which are the basis of a high quality information and management.

COST/BENEFIT BENCHMARKS

Following table include some cost references about technology:

SYSTEM	SYSTEM NAME	UNIT COSTS APPROX.
Roadside Detection	Inductive Loop Surveillance on Corridor	$2K-$6K
	Remote Traffic Microwave Sensor on Corridor	$8K-$11K per sensor
	CCTV-Video Camera	$8K to $16K
Roadside Information	Variable Message Sign	$28K-$136K
	Variable Speed Display Sign	$3K-$4K
	Highway Advisory Radio	$15K-$36K
Roadside Control subsystem	Software for Lane Control	$25K to $50K
	Lane Control Gates	$66K to $100K
Roadside Telecommunications	Conduit Design and Installation – Corridor	$52K-$77K
	Fiber Optic Cable Installation	$21K-$54K
Transportation Management Center subsystem	Hardware, Software for Traffic Surveillance	$134K to $164K
	Software, Integration for Signal Control	$104K-$149K
	Software, Traffic Information Dissemination	$18K-$22K
	Labor for Traffic Information Dissemination	$ 116K-$142K (annually)

* On Corridor.

Figure 26. Unit Cost references about Interurban Traffic Technology

Source: ITS Benefits, Costs, Deployment and Lessons Learned: 2011 Update[66]

As a reference, in **Washington** the implementation of the SR 14 traveler information system was 511,300 USD, with a first phase that cost 300,000 USD and included 2 VMS, a highway advisory radio (HAR) station and one Road Weather Information System (RWIS) station with a CCTV camera. In addition, a second phase was 211,300 USD, which included a HAR station and a VMS[66].

Here are some benchmarks **benefits** collected from the report "ITS Benefits, Costs, Deployment and Lessons Learned: 2011 Update, and Synthesis of Active Traffic Management Experiences in Europe and the United States, both reports issued by U.S. Department of Transportation"[66]:

- VSL: The experience of Germany resulted in lower accident rates and in a modest (5-10%) increase in roadway capacity. The use of VMS as dynamic re-routing showed, on Nuremberg area freeways, the ability of redirecting to 40% of through-traveling vehicles. The implementation of this technology on the A5 motorway between Bad Homburg and Frankfurt/West, was associated with a 27% reduction in accidents with heavy material damage and a 30% reduction in personal injury crashes. England has also applied VSLS as speed harmonization. Results on M-42 showed a 7% percent increase in capacity and less overall congestion over the 12-month study period. A VSL system on the I-270/I-255 loop around St. Louis reduced the crash rate by 4.5 to 8 percent, with a standard deviation of 3.4 percent due to more homogenous traffic speed in congested areas and slower traffic speed upstream.
- Lane Control: These techniques have demonstrated a 20% increase in rush-hour capacity and reduced air and sound pollution along Munich (Germany) area freeways. In the Netherlands, by 7 to 22% of capacity increase, by decreasing trip travel times from 1 to 3 minutes and increasing traffic volumes through the area up to 7% during congested periods.
- VMS: The use of VMS as dynamic re-routing showed on Nuremberg (Germany) area freeways, the ability of redirecting to 40% of through-traveling vehicles. The Dutch have estimated a 5% improvement in overall system performance associated with dynamic re-routing.
- Traffic surveillance, lane control signs, VSLS, and VMS in Amsterdam, the Netherlands, have led to a 23% decline in the crash rate.

APPLICATION

ROAD SAFETY IN INTERURBAN ENVIRONMENT

General Description

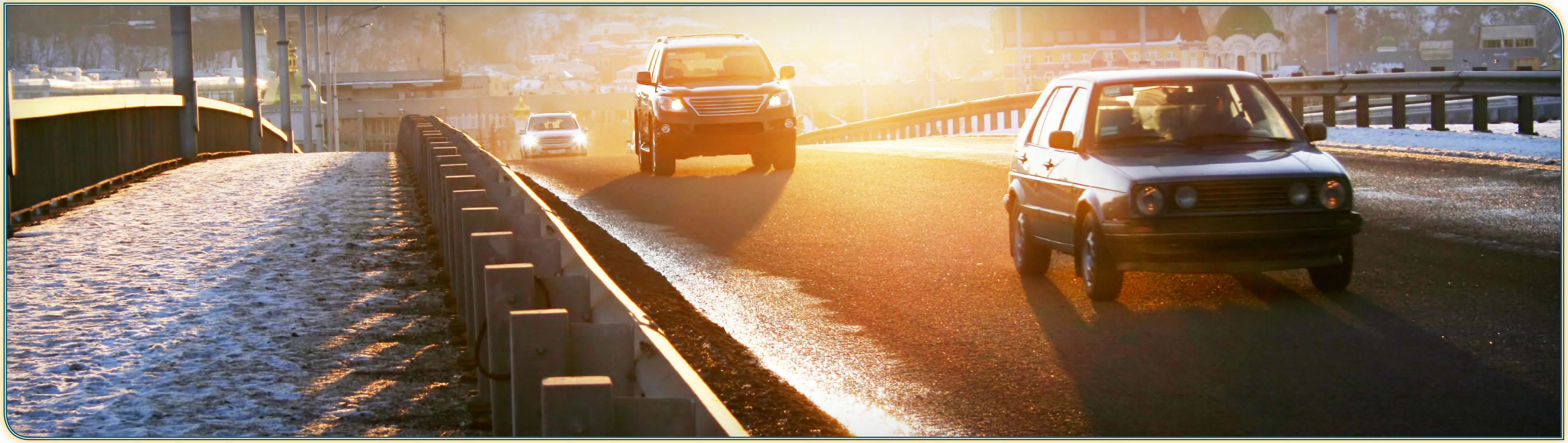
DEFINITION

On one hand, speed enforcement is used to monitor and enforce speed limits. On the other hand, Surveillance and weather and roadway conditions monitoring enable the appropriate management actions to mitigate the impacts of any weather related risk, which will be especially important in all those mountain stretches, tunnels, long bridges and viaducts, etc. Informing users on conditions changes is one of the actions to mitigate the impacts on those locations with higher potential risk. For this reason, surveillance, monitoring, and prediction of weather, are complemented with driver information systems as variable message signs (VMS) and variable speed limit signs (VSLS) to warn drivers.

BENEFITS

Safety: this may be more critical in interurban environments where speeds are higher. Speed enforcement can be a very effective tool to reduce the number and consequences of car accidents, smoothing traffic flows, reducing stop–start conditions, and at the end improving safety. Roadway monitoring and warning drivers about possible risks, also contribute to a higher safety on the road, especially in areas with bad weather conditions as mountain passes or risk zones as tunnels.

Traffic optimization: whereas in cities is mainly based on traffic signal control, in interurban roads the interaction with traffic is through communications directed to drivers, either daily or at special circumstances such as weather conditions, special events or severe incidents.



TECHNICAL DESCRIPTION

Stage of development

Technologies to enhance road traffic in general, and road safety in particular, have been developed for decades, and nowadays are widespread deployed throughout the world.

Components

Surveillance, Monitoring and Prediction Elements: detection sensors and observing systems for processing data, in order to identify and prevent dangerous road-traffic situations as speed compliance, adverse weather conditions (rain & flooding, snow & ice pavement, fog & low visibility, high winds &stability of vehicles, etc.) or incidents in tunnels, all of them situations in which is especially important to know the current road conditions and give a quick response.

These elements allow the detection of vehicles that exceed the speed limit in a particular point or in a section of the road, measuring its instantaneous speed or its average speed, respectively. They also allow the detection of whatever situation that might affect users safety in a tunnel, from pedestrians, obstacles and stopped vehicles, to congestion, opacity, excess of CO_2 inside the tube or fire. And in relation with the climate conditions, they allow transportation managers to gather information on prevailing and predicted conditions.

Decision Support, Control and Treatment Elements: decision support systems, control strategies, and treatment strategies that are employed by transportation managers to improve safety, mobility and productivity.

Three types of Road Safety Management strategies may be employed in response to detected threats: advisory, control and treatment strategies. (1) Advisory strategies provide information on prevailing and predicted conditions to both transportation managers and motorists. (2) Control strategies alter the state of roadway devices to permit or restrict traffic flow and regulate roadway capacity. (3) Treatment strategies supply resources to roadways to minimize or eliminate weather impacts (application of sand, salt, and anti-icing chemicals to pavements to improve traction and prevent ice bonding), to stop or punish vehicles speed excess or to evacuate the tunnel.

Information Dissemination Elements: elements that are used by transportation managers to disseminate road information to travelers, according with one of the strategies of the previous paragraph.

8 Surveillance, Monitoring and Prediction Technologies:

For capturing weather data, Environmental Sensor Station (ESS), a roadway location with one or more fixed sensors measuring atmospheric, pavement and/or water level conditions. Atmospheric data include air temperature and humidity, visibility distance, wind speed and direction, precipitation type and rate, air quality, etc. Pavement data include pavement temperature, pavement freeze point, pavement condition (e.g., wet, icy, flooded), pavement chemical concentration, and subsurface conditions. Water level data include tide levels as well as stream, river, and lake levels near roads.

Related to safety in tunnel, technologies involved with this function are: cameras CCTV along the tunnel and in their portals for traffic monitoring and Data Collection Stations to gather information from the detectors. As we have seen in other previous applications of this report the more common sensors are inductive loops, although are also available radar, laser or optical technologies for this purpose. Among the technologies for tunnel management, AutomaticIncident Detection (AID) system is an essential video tool for detecting events leading up to incidents in road tunnels that use algorithms to discern between typical traffic flow and activity and the circumstances associated with an incident or crash, in which case an alarm is issued. Also Fire/Smoke detection, an integral part of a control loop which is set up by sensors, alarm triggering equipment, transmission cabling, evaluation units, etc., and which taken together are generally referred as a fire alarm system.

Figure 27. Information Dissemination Technologies

Source: www.sadecocoslada.com

Figure 28. Speed enforcement in interurban roads

NOTE: For the speed enforcement, the reader is referred to the application "enforcement in urban environment" of this report where the same technology is described, but in this case applied to a road section.

Decision Support, Control and Treatmen Technologies:

The technology involved in this part is mainly related with the integration of environmental and traffic data with traffic monitoring and control software in a Traffic Management Centers (TMCs), from where the equipment installed on the infrastructure is controlled. Traffic managers may access road weather and traffic data to make decisions about traffic control and motorists warnings and establish a strategy such as: reducing speed limits with Variable Speed Limit (VSL) signs and Variable Message Signs (VMS) when travel conditions are unsafe, or others as closing a lane with Lane Management Signs, adding light or switching on algorithms specific for the ventilation system in tunnels.

Among the systems deployed in the TMCs areTraffic Incident Management Tools, which make use of a variety of ITS technologies to quickly detect, notify, manage and clear traffic incidents, especially in tunnels where the consequences of the incidents are potentially more severe than on the open road.

Information Dissemination Technologies:

A variety of roadside technologies, such as LED technology used in Variable Message Signs (VMS), Variable Speed Limit Signs (VSLS) or Lane Management Signs can be used to inform users about a risk situation detected on the road. Also Highway Advisory Radio (HAR) or Specific Internet Sites may be implemented to provide travelers with weather or other relevant travel information. In tunnels, Public Address Systemsare alsoused to warn users in case of evacuation or to transmit a particular message in case of an incident.

Institutions

8

INTERURBAN TRAFFIC MANAGEMENT

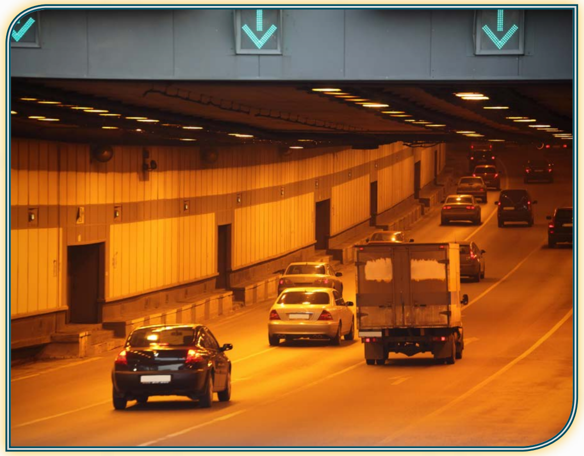
The institutions involved in the management of road safety applications are Public Works Ministry and the Traffic Authorities as public entities, and the concessionary companies as private entities. The first, in order to approve the deployment of ITS equipment in the roads managed, and the other two entities to implement, operate and maintenance that equipment; usually, Traffic Authorities are in charge of enforcement.

Other institutions involved are Meteorological Agency to provide information about weather forecast, Civil and Emergency Protection to assist emergencies and risk situations on the road or Police to run automatic speed enforcement.

INTERNATIONAL EXAMPLES

Speed management and control, were the primary concern is to reduce crashes and their consequential injuries and fatalities, in Europe, Australia, Canada, United States or Asia.

The state of Victoria, Australia was a pioneer on a large scale of automated speed enforcement (ASE) deployment in 1989. Soon after New Zealand and UK also implemented this kind of system, with a good result in terms of road traffic crashes reductions, and particularly those involving deaths or serious injuries. Asian examples highlight Korea, where National Police Agency has implemented the ASE and installed 853 units of fixed speed camera in road sections and 821 units of mobile-speed cameras in South Korea since 1997. In Europe, Finland, where 1,000 automatic speed cameras along approximately 3,200 km cover approximately 22% of the road network including one lane roads and 42% of the total vehicle mileage. Or Spain, where General Traffic Directorate (DGT) manages 855 fixed speed radars (Doppler and laser) around the 26,000 km approx., in addition to other hundreds of mobile speed enforcement equipment and a National Automatic Violation Report Processing Center, called ESTRADA. In Latin America, Brazil, one the first countries to use speed enforcement, beginning their actuations in 1992 and being today a successful example.



Road Weather Management is implemented in many roads across the globe, mainly in freeways, although highlight countries as North European countries, Canada or USA where the climate conditions are critical to Road Safety.

Regarding Tunnel Safety, there is a large list of international examples, from the Mont Blanc Tunnel between France and Italy, to the 40 km of tunnels of the ring M-30 in Madrid. But also new constructions in Latin America as the tunnels of Coviandes in Colombia or the tunnel of Sinaloense in Mexico.

8 INTERURBAN TRAFFIC MANAGEMENT

KEY CHALLENGES DURING IMPLEMENTATION

There are two fundamental issues in the Road Safety applications, mainly in tunnels:

- To ensure the availability of critical equipment (ventilation, fire detection, emergency lighting, etc.) with a minimum of functionality in case of a fault or breakdown. For continuous energy supplying and safety, a redundant power and communications network is needed.
- To detect when a fault occurs in the operating equipment and facilitate a quick response. (Detectors and alarm systems control).

The reliability of collection and treating data has to be guaranteed in general but even more when it comes to safety equipment. Therefore, for selection and localization of each technology, each one's features and limitations must be taken into account. In addition, the detection systems must be carefully calibrated to achieve the best compromise among a minimum non detection level, the minimum number of false alarms and a suitable detection delay time.

COST/BENEFIT BENCHMARKS

The table below shows some cost references about weather management technology. References about unit **cost** technology for Speed Enforcement and Tunnel Safety have been collected in the section Enforcement in Urban Environment and Interurban Traffic management of this report, respectively, because the technology applied is the same (although approach is different):

SYSTEM	SYSTEM NAME	UNIT COSTS APPROX.
Roadside Detection	**Environmental Sensor Station (Weather Station)**	**$25K-$42K**
	CCTV-Video Camera	**$8K to $16K**
Roadside Telecommunications	**Conduit Design and Installation – Corridor**	**$52K-$77K**
	Fiber Optic Cable Installation	**$21K-$54K**
Transportation Management Center subsystem	**Road Weather Information System**	**$9K**

Figure 29. Unit Cost references about Road Safety Technology

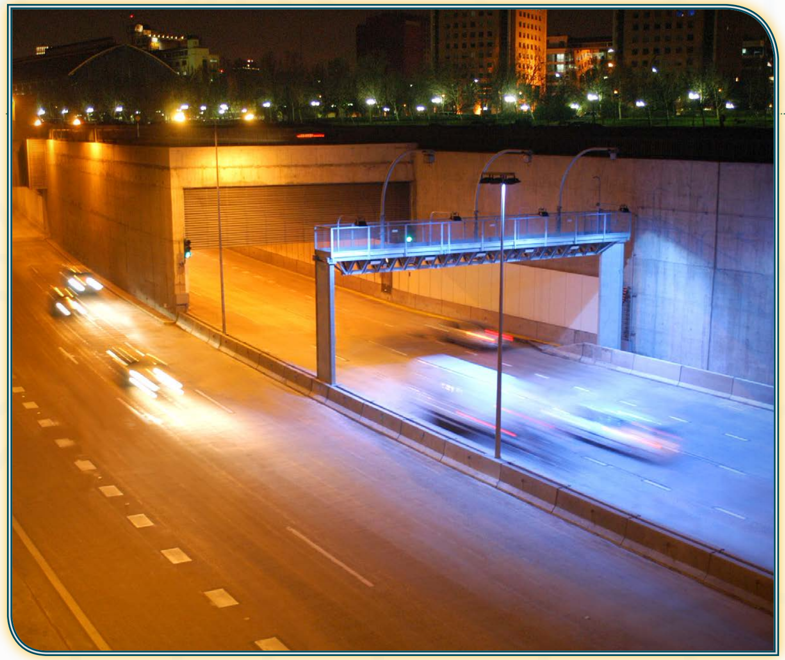
Source: ITS Benefits, Costs, Deployment and Lessons Learned: 2011 Update[66]

Following, some **benefits** benchmarks of the road safety applications.

In relation to **speed enforcement:**

- Finland: automatic speed enforcement decreases average speeds with 0.5–3.0 km/h on the whole road section equipped with automatic speed enforcement and an even greater reduction is shown close to the camera pole[80]. The reduction of speeds increases traffic safety in terms of less accidents as well as reduced consequences of accidents (according to Nilsson's "Power Model", a 5% reduction in the average speed represents a 20% decrease in fatal accidents, and a 10% decrease in accidents which produce injuries), but also has a positive effect on the environment in terms of reduction of traffic noise and emissions. Studies show that 4% less injury accidents and even 18% less fatal accidents occurred on roads with automatic speed enforcement than on comparison sites[40].
- Brazil: according to Department of Infrastructures and Transportation's (DNIT)[41], the use of automated speed enforcement in federal roads and urban sections contributed to a 70% reduction in traffic accidents.
- According to ITS International magazine, in 2005 an evaluation of the four-year benefit of implementing speed cameras in the UK found a positive cost-benefit of around 2.7:1. In the fourth year, the benefit to society from the avoided injuries was estimated to be in excess of £258million compared to enforcement costs of around £96million[42].

In addition to speed control, as stated in the report "Intelligent Transportation Systems and Road Safety" edited by European Transport Safety Council[43], the high accident risks caused by adverse weather conditions can be decreased by providing information, warnings and support to road users. For example, the assessment of the automatic fog-warning system, implemented on the M25 motorway in England showed that the net mean vehicle speed reduction was around 3 kmph, when the signals were switched on as a result of the formation of fog, similar to other Finnish study which showed that slippery road warning VMS decreased mean speeds by around 1–2 km/h when the signs were lit. Furthermore, accurate and timely road weather information helps maintenance managers react proactively before problems arise, which will also bring savings, for example the State of Utah in USA save more than 2.2 USD from reduced maintenance costs in the 2004–2005 winter season. The studies of benefit-cost ratios collected by the report "Intelligent Transportation Systems Benefits, Costs, Deployment and Lessons Learned: 2011"[66], ranged from 2.8 to 7 depending on the region, even to 36.7 resulting from the use of weather information to reduce winter maintenance costs.



APPLICATION

ELECTRONIC TOLL COLLECTION

General Description

DEFINITION

Electronic Toll Collection (ETC) is a mature technology that allows drivers to pay tolls without cash and without having to stop the vehicle at a control point.

ETC systems charge a toll to an established customer account without requiring any action by the driver as a vehicle passes through. The system electronically debits the accounts of registered car owners or identifies the license plate for later billing without requiring vehicles to stop.

BENEFITS

ETC is one of the most successful ITS applications with numerous benefits when compared to the traditional toll collection lanes (without ETC). Advanced technologies such as open road tolling (ORT) allow automatic processing of toll transactions at freeway speeds, thus reducing the need for tollbooth barriers and improving performance.

The main ETC benefits are:

- Vehicles do not need to stop at toll plazas.
- Increased safety and security at toll plazas.
- Fraud and handling money costs (coins and notes transport, deposits, etc.) are significantly reduced.
- Increased flexibility in toll fees: they can vary according to the time of day, traffic or operation conditions, among others.
- Better demand analysis and adjusted toll fees. ETC means of payment is similar to a loyalty card, as customers always use the same device in their transactions, so toll fees can be directed to specific targets.
- The same means of payment can be used in other applications, such as car-parks.

Source: commons.wikimedia.org/wiki/User:Mariordo

TECHNICAL DESCRIPTION

Stage of development

ETC electronic toll collection systems are already in use on toll roads throughout the world.

Components

ETC systems usually include vehicles equipped with transponders (electronic tags), wireless communication, in-road/roadside sensors, and a computerized system (hardware and software) to uniquely identify each vehicle, electronically collect the toll, and provide general vehicle/traffic monitoring and data collection.

On board systems (TAG):

Radio-frequency identification (RFID) devices placed in/on the vehicle, to identify the vehicle or the driver associated to its unique ID number, when the vehicle passes through an ETC Point.

Lane/Gantry Systems

Systems deployment in toll lanes or in toll gantries include the following:

- Automatic Vehicle Identification (AVI): The AVI systems properly identify each vehicle to charge the toll to a particular customer. This ETC method is typically done with various AVI technologies such as a bar coded label fixed to the vehicle, proximity card, radio or infrared transponder, and automatic license plate recognition. A majority of the AVI systems used involve radio frequency identity (RFID) and plate recognition technologies. The RFID system uses an antenna-reader to detect and communicate with a transponder in each registered vehicle and identify information about the vehicle and customer, while video tolling identifies the license plate and charges a customer or sends a bill to un-registered drivers assisted by the Department of Motor Vehicle's address database.
- Automatic Vehicle Classification (AVC): Systems to identify the configuration (vehicle height, number of axles, presence of dual tires, and vehicle weight) of the vehicle in order to classify (car, truck, buses, etc.) it and determine the appropriate toll to charge. There are various technologies used to make this, for example, inductive loops, pressure sensitive devices, weigh-in-motion devices, video image processing, scanning devices (ultrasonic, infrared or laser scanners), among others.
- Video Enforcement Systems (VES): This system serves a dual purpose: enforcement and video tolling. This system capture images of the vehicle, the number plate of the vehicles in particular, to identify those vehicles that did not pay the proper toll. VES is used to record the image information needed for the agency to pursue evaders, recover tolls and issue fines, thereby deterring toll evasion.

Source: commons.wikimedia.org/wiki/User:Cameramann

These systems are placed in each single lane of the toll plaza or, in systems known as multi-lane free flow, in gantries that cover all lanes in the road.

Management and/or Customer Service Center Systems

The Management Center handles the transactions database, consolidates and process all the information collected from each plaza host computer, as well as sends information on toll system configuration to toll plazas.

Through the Customer Service Center accounts are managed, customers are enrolled, tags are issued, violations are processed, inquiries are handled; it also serves as the facility management center.

Communications System

Allows data transfer between the plaza/gantry computer and the management center. It is usually implemented by a Wide area network –WAN– using fiber optic as physical transmission means.

Technology

ETC may be implemented in three different ways:

Electronic tolling added to conventional toll lanes

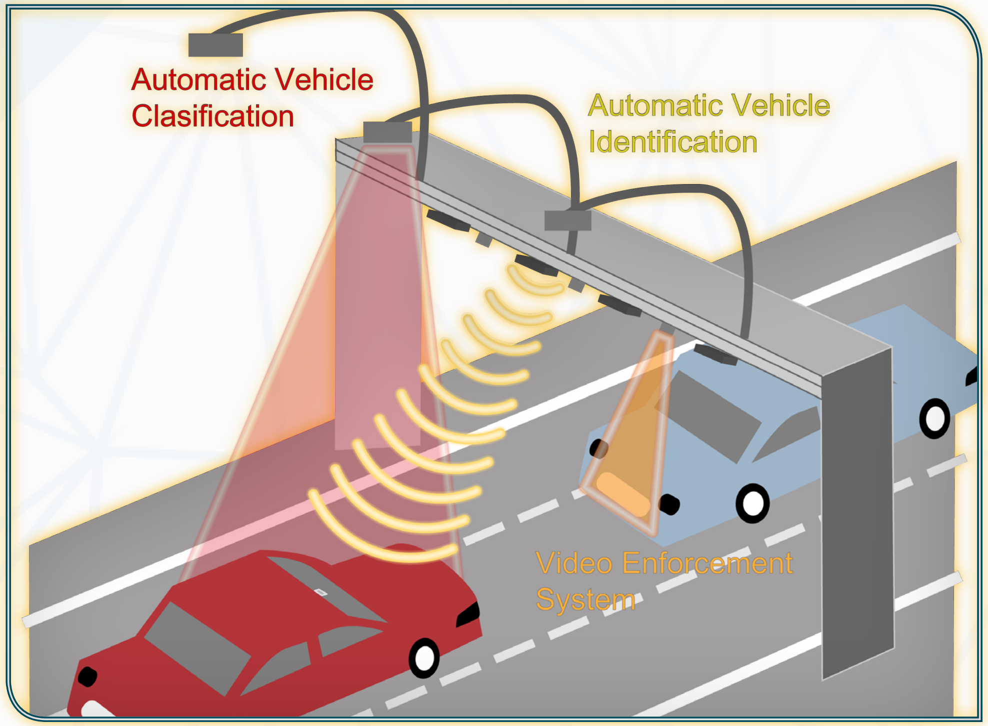
ETC is introduced in conventional stop-to-pay toll plazas with rows of tollbooths and a large canopy over each lane. Mixed mode tolling is allowed (cash, cards, OBUs) and queues are not avoided.

Electronic toll only lanes

Dedicated or transponder-only lanes are the next step forward in speeding up the toll collection process. The vehicles have to go through the dedicated lanes in the plaza toll, reducing the speed without stopping to do the payment.

Open road tolling – Multilane Free Flow Tolling

The next stage in the application of electronic toll technology is the so-called open-road tolling (ORT) or Multilane Free Flow Tolling. ORT is defined as the collection of tolls by purely electronic means, through the installation of gantry-based electronic tolling and enforcement systems designed to enable unhindered passage of vehicles through the toll gantry at normal highway speeds. ORT is ETC toll collection without any toll plazas. Transponders can be read at 110%160kmph (70 or 100mph), so motorists do not have to reduce their speed.



The possible technologies in ETC are:

- DSRC = Dedicated Short Range Communication
- Video, ANPR (automatic number plate recognition), LPR (License Plate Recognition)
- Tag / Transponder / RFID – Recognition (electronic license-plate)
- GNSS (Global Navigation Satellite System)
- W-LAN / W-MAX

Technologies for vehicle classification: Inductive loops; Laser scanner; Weigh-in-Motion; Video; Tags/RFID.

Institutions

The usual concession model is Build-Operate-Transfer (BOT), in which tolls are deployed by the private sector; this private sector operates the infrastructure during a period of concession and then it is transferred to the government. In some cases, the government can decide to extend the period of concession in order to cover at least road maintenance expenses.

INTERNATIONAL EXAMPLES

COUNTRY	CITY/STATE	ORT SYSTEM NAME	COUNTRY	CITY/STATE	ETC SYSTEM NAME
USA	California	SR 91 Express Lane	Portugal	n/a	Via Verde
USA	Texas	Westpark Tollway	Spain	n/a	VIA-T
Canada	Toronto	Highway 407	Italy	Autostrade motorways	TELEPASS
Australia	Melbourne	Melbourne City Link	Norway	n/a	AutoPASS
Israel	-	Cross Israel Highway	Turkey	n/a	OGS
Chile	Santiago Chile	Autopista Central	Mexico	CAPUFE Network	IAVE
Chile	Santiago Chile	Costanera Norte	Brazil	São Paulo	Sem Parar / Via Fácil
Chile	Santiago Chile	Vespucio Sur	Brazil	Rio de Janeiro	Sem Parar
Chile	Santiago Chile	Vespucio Norte Express	Argentina	Autopistas del Sol	PASE

Figure 30. Some International examples.

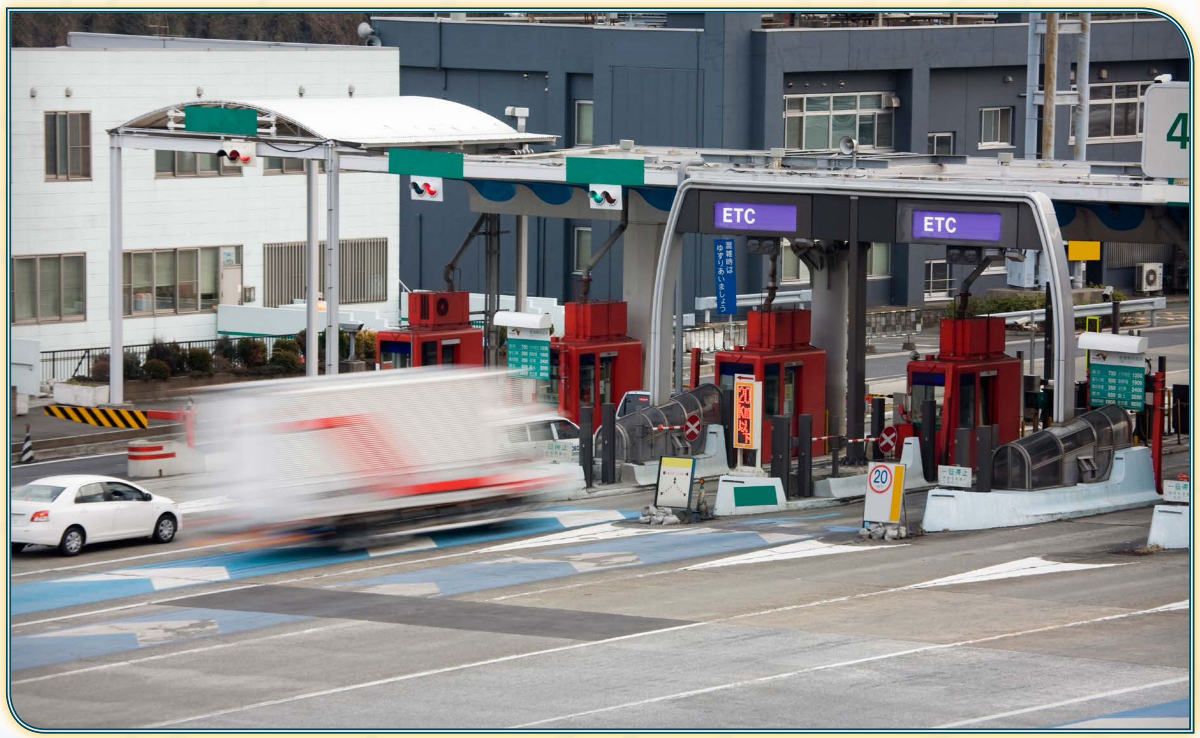
Source: Own elaboration

KEY CHALLENGES DURING IMPLEMENTATION

ETC systems should be technologically solid, reliable and secure, ensuring that internal fraud is prevented and detected. Indeed, they are revenue collection systems.

There are three important issues concerning ETC systems deployment:

- A **legal context** should be developed, in order to regulate omissions, and monitoring or even infringements sanctioning. It is also needed to regulate the use and access to the information generated by such systems. This issue is highly encouraged in case of ORT.
- Standardization of tags and equipment related to these systems will simplify their deployment.
- In line with the above, it is strongly recommended the system interoperability, or the usage of a single means of payment in all enabled facilities for small payments associated with the mobility of vehicles (toll and car-park fees usually). To pursue this, all involved payment devices should use a common protocol of recording data and transactions for all potential issuers, as well as the field equipment should be compatible and standardized for it.



COST/BENEFIT BENCHMARKS

There are several **costs** in implementing an ETC system:

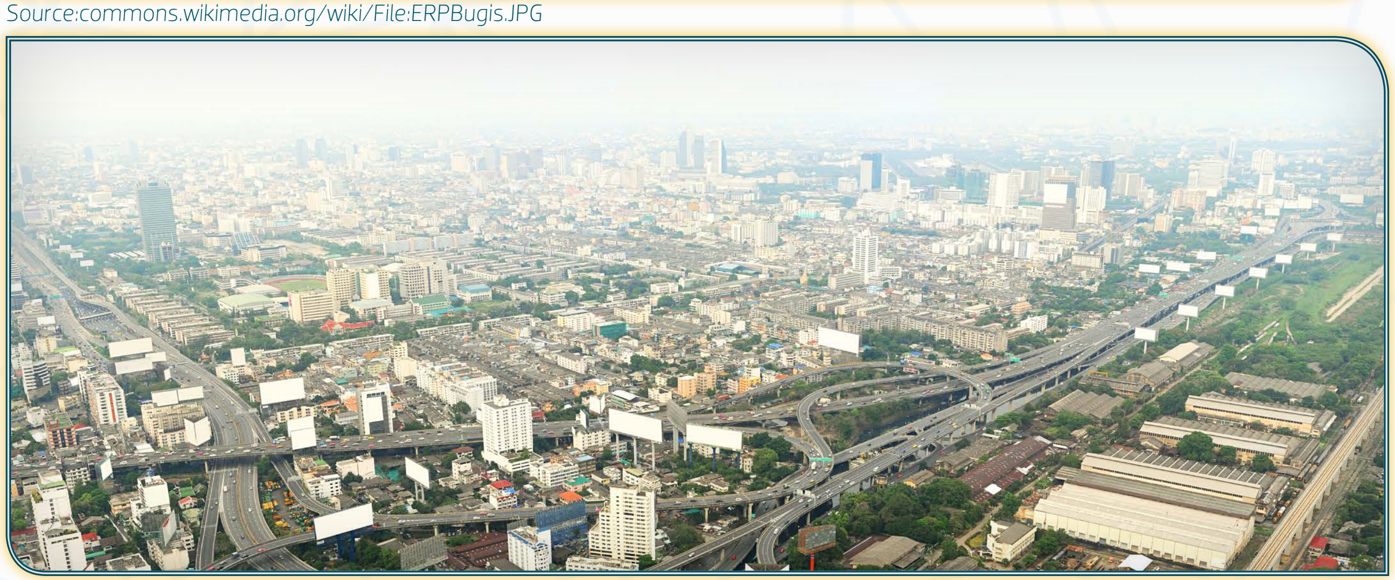
- Toll Agency Costs: According to a 2002 study by the California Center for Innovative Transportation, the cost per transaction of an ETC system is between 0.05 USD to 0.10 USD (Smith, ITS Decision, 2002). A manual toll cost per transaction is 0.35 USD to 0.45 USD. Not only are the costs per transaction usually lower in an ETC system, the number of transactions is far higher than in a manual system. Additionally, the number of people required to operate an ETC system is far fewer than required for a manual toll collection system[44].
- Costs for the User: Most facilities with ETC deployed require motorists to buy or rent the equipment (TAG). In addition, the motorist is also required to pay a security deposit, keep a minimum balance in his account, or even pay a monthly fee for the ETC equipment. Some systems also require motorists to keep a credit card balance.
- Initial Sunk Costs: The initial costs of implementing ETC or converting a manual toll facility into an ETC can be high. There are also significant ETC systems operational and maintenance costs that vary widely depending on the scope of the project. The following table reflects approximations obtained from I-70 Corridor ITS study as compilation from USA national averages of similar toll facilities:

ITEM	UNIT	COST
Toll Gantry	Per Gantry	300,000 USD
Toll Lane Equipment	Per Lane	200,000 USD
Toll Vehicle Enforcement System (VES) Data Host	Per Toll System	1.0 million to 1.5 million USD
Host Servers and Functions	Per Toll System	300,000 USD
TMC/Video Control	Per TMC	500,000 USD
Transponders	Per Transponder	10 to 40 USD

Figure 31. Unit Cost references about ETC Technology

Source: RITA - US Department of Transportation (http://www.itscosts.its.dot.gov)[45]

Source:commons.wikimedia.org/wiki/File:ERPBugis.JPG



Reported **Benefits** were the following:

- Increases throughput:
  - Manual toll collection lanes handle about 350 vehicles per hour and automatic coin machine lanes handle about 500 vehicles in the same time period. An ETC lane can process 1,200 vehicles per hour when the lane is located in a traditional plaza configuration with island structures on each side of the lane and up to 1,800 vehicles per hour in an Open Road Tolling (ORT) configuration [46].
  - In Japan, a field test found that conventional toll collection takes an average of 14 seconds per car, while electronic toll collection takes only 3 seconds per car[56].
  - Implementation of the E-ZPass electronic toll collection system on the New Jersey Turnpike reduced delays for all vehicles by 85 percent saving approximately 2.1 million hours per year[86].
- Cost effective:
  - Most ETC lanes are less expensive to build and operate than traditional toll collection methods. Cost data averaged for five toll facilities in five USA states showed electronic toll collection systems provide cost savings of over 40,000 USD per lane for equipment costs, and 40,000 USD per lane in annual operating and maintenance costs compared with automatic coin machines, and 135,000 USD per lane in annual operating and maintenance costs compared with manual tollbooths[87].
  - Oklahoma Turnpike, one of the first U.S. highways to use high-speed toll plazas, saw a 90 percent reduction in collection costs on ETC lanes[85].
- ETC lane usage can decrease emissions in the area. Practitioners have reported that the ETC system at three toll plazas in Baltimore, Maryland, with dedicated ETC lanes located in a traditional plaza configuration, resulted in a 40 to 63 percent reduction of hydrocarbon and carbon monoxide and approximately a 16 percent reduction of nitrogen oxide in the study area[87].

Suorce: flickr.com/photos/skalasinc/270186328/

APPLICATION

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

GENERAL DESCRIPTION

DEFINITION

ITS applications for commercial vehicle operations (ITS/CVO) are designed to improve the communication between motor carriers and regulatory agencies, concerning automation and report of regulation, monitoring, inspection and enforcement from transport authorities.

These technologies relate to some relevant issues on commercial vehicles, as the following:

- Safety Assurance: Programs, services and systems to guarantee safe commercial vehicles operations (driver, vehicle and freight). This includes roadside safety automated inspections, regular inspections to transport companies, security information systems, and safety monitoring on-board.
- Credential Management and Administration: Programs, services and systems for improving the administration procedures and systems related to carrier companies. Those include request, purchase and issuance of electron-iccredential applications, as well as automated payment, report and archive of taxes.
- Electronic Screening (E-Screening): Programs, services and systems to facilitate the electronic identification of size, weight, safety, and credentials data. These include the automated weight inspections of commercial vehicles in check stations and **international border crossings.**

- Carrier Operation & Fleet Management: Programs, services and systems to support motor carriers with their day-to-day operations: (1) automated vehicle location (AVL)/computer-aided design (CAD) technologies assist with scheduling and tracking of vehicle freight; (2) on-board freight monitoring alert drivers and carriers of potentially unsafe cargo conditions; and (3) traveler information help carriers in choosing alternate routes and departure times, avoid traffic congestion or bad weather conditions and arrive on time.

BENEFITS

ITS technologies applied to commercial vehicles are relevant to both public and private sectors. The essence of ITS involves systems integration to improve greater productivity, connectivity, safety, and environmental compatibility.

In general, benefits can be summarized in the following points:

- Improve the effectiveness of commercial vehicle safety enforcement activities by focusing on high-risk commercial vehicle operators.
- Congestion decreasing and improving efficiency in weigh stations and international border crossings.
- Reduce costs associated with commercial vehicle operations and compliance with national regulatory requirements for safe and legal carriers.
- Reduce administrative costs for agencies in charge of the motor carrier industry supervision.
- Improve economic competitiveness by reducing transport companies and agencies costs.
- Improve safety and productivity of commercial vehicles and drivers, reducing frequency and severity of accidents where commercial vehicles are involved.

Source: cronkitenews.azpbs.org

In particular:

- Safety information exchange (SIE) standardizes the exchange of vehicle and driver safety information, and makes the entire process simpler and faster.
- Credentials administration provides electronic registration and allows transport agencies and carriers to register online, decreasing delays related to the authorization approval.
- Electronic credentialing reduces form-filling and saves time and money.
- Electronic screening focuses inspections on possible violators and reduces time and cost of inspections

(both by inspectors and carriers) at the same time that speeds up customs clearance

TECHNICAL DESCRIPTION

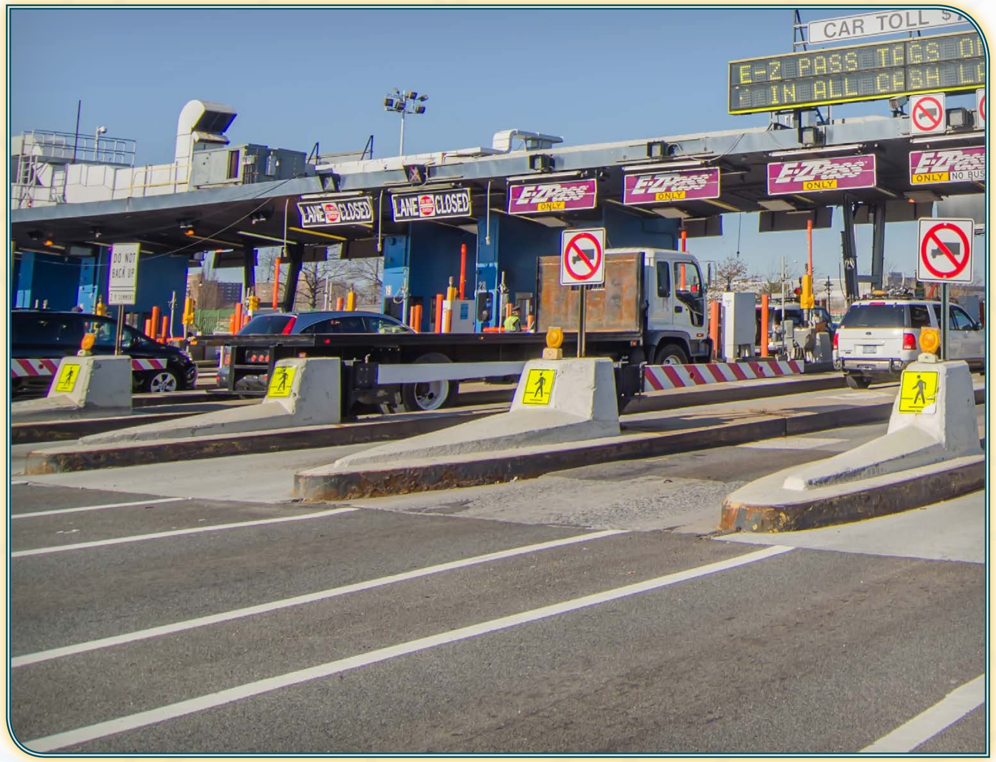
Stage of development

Operation.

Components

Clearance processes for known low-risk shipments through dedicated lanes programs, or E-Screening usually consists of Network servers and powerful databases, desktop personal computers, laptops or tablet devices, Weigh-in-Motion or WIM scales, in-vehicle transponders and roadside readers/transmitters (Automatic Vehicle Identification equipment and systems), telecomunication equipment between upstream sites and weigh stations, electronic signs for weigh stations, loop detectors, mainline compliance tracking systems, over-height detectors and remote cameras with video transceivers.

Therefore, E-Screening is a key combination of (1) In-vehicle radio-frequency transponders and roadside readers/transmitters, (2) High-speed weigh-in-motion (WIM) scales, and (3) High-speed, automatic, remote database queries.



Technology

Automatic Vehicle Identification – For this purpose, the trend is to use simple and inexpensive means, so RFID technology is rather appropriate (in-vehicle transponders and roadside readers/ transmitters). However, there are tolled border crossings, where using the same existing means of vehicle identification would be desirable (in order to simplify or not multiply devices on vehicles); this would be the case, for example, of interoperable DSRC tags. Another accompanying equipment for AVI is also feasible (ALPR for instance).

Transponders may be active or passive, and have four different functions for E-screening:

- Safety Screening: In-vehicle transponders can communicate with check stations and automatically transfer regulatory data to authorities as trucks approach check stations.
- Border Clearance: In-vehicle transponders can communicate with customs check points to pre-screen trucks for safety records, border clearance, and credentials.

- Weight Screening: In-vehicle transponders can communicate with weigh stations to pre-screen trucks for compliance with weight regulations. Weigh-in-motion (WIM) scales can be used for more efficient weight screening and, additionally, can increase safety.
- Credential Checking: In-vehicle transponders can communicate with weigh stations and customs check points to pre-screen trucks for proper credentials.Transponders.- They can be active or passive.

Weight-in-motion. Weigh-in-motion or WIM devices are designed to capture and record axle weights and gross vehicle weights as vehicles drive over a measurement site. There are three basic types: (1) Piezoelectric sensor, normal or Quartz, (2) Bending Plate and (3) Single Load Cell, and they are high-speed.

Institutions

Public Sector: all agencies with different responsibilities on safety and information on local or international borders, as Transportation, Public Safety (Police), Environmental Protection, Customs, Revenue Services, etc.

Private Sector: Shippers, Consignees, and Transportation Providers. Motor Carriers themselves, Industry and Associations, Brokers and Intermediaries.

INTERNATIONAL EXAMPLES

The most important experiences of Electronic Clearance at international borders are located in USA/Mexico and USA/Canada (FAST – Free and Secure Trade). There are also some interstate borders along the USA.

- FAST is designed for carriers of commercial goods and provides dedicated border crossing lanes and expedited clearance to truckers at the U.S. border with Canada and Mexico. To obtain a FAST card, drivers, carriers, and importers must undergo a risk assessment.
  The card may be used in either a FAST lane or other land border crossings. To use a FAST lane all persons in a vehicle must possess a valid FAST Commercial Driver card and the vehicle must be transporting eligible goods.
  Government officials are envisioning that within 10 to 15 years the border will be completely electronic. If this comes about all data about all parties will be available online, so there will be no need for drivers to stop and identify themselves or explain their loads.

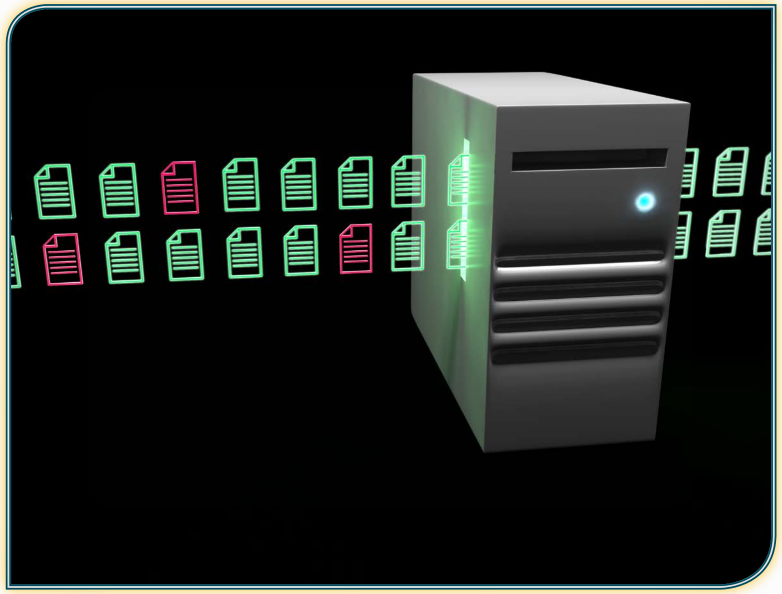
Source: en.wikipedia.org/wiki/User:UpstateNYer

There are some Electronic Screening Projects conducted by The International Border Program: a joint modal initiative between the Federal Highway Administration (FHWA) and the Federal Motor Carrier Safety Administration (FMCSA) that involves federal, state and local stakeholders in border regions as well as stakeholders in Canada (Northern Border) and Mexico (Southern Border, San Diego-Tijuana), both with implementation of the International Border Crossing - Electronic Screening System (IBC E-Screening) for trucks and buses.

KEY CHALLENGES DURING IMPLEMENTATION[86]

There are some key issues to consider in the process of implementing such applications, according to the results of some international experiences (mainly USA). The most relevant are the following:

- Roadside exchange data is crucial, in order to get the best time results; the information to be filled on line and real-time roadside checks are the application key.
- All the relevant state agencies and motor carrier industry should be involved in the Program since the beginning. Regarding international border crossings, a bi-national stakeholder forum should be established, to help reduce complicated institutional issues while applying technology systems at international borders.
- Data privacy should be protected by implementing user authorization levels for sensitive information, as all competitive companies are registered in a database.
- At international tolled border crossings, the use of an interoperable transponder to assure maximum benefits to both the private and public sector would be desirable.



Source: RITA – Research and Innovative Technology Administration (U.S. Department of Transportation)

COST/BENEFIT BENCHMARKS

There are several unit **costs** to consider in AVI – E-Screening deployment, the most important ones can be found in the table below:

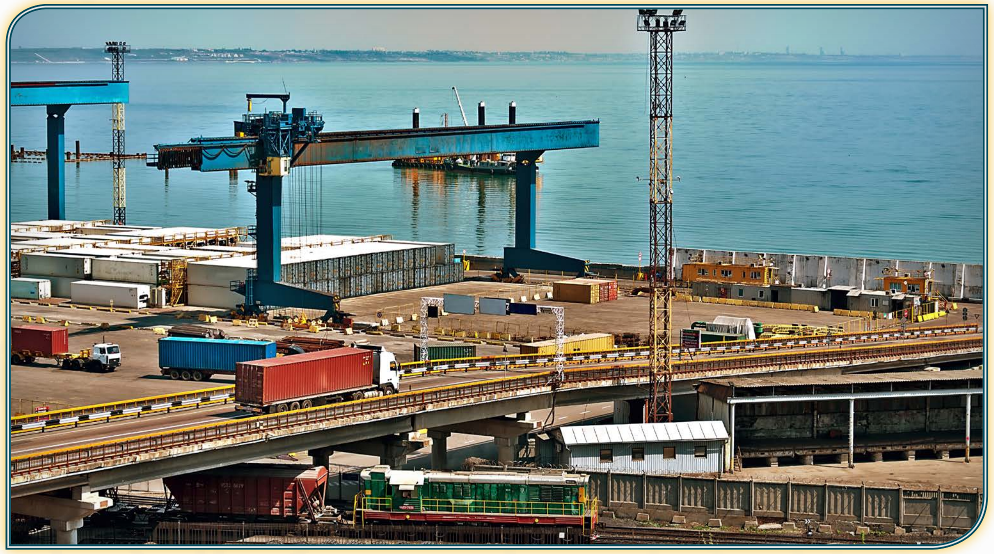
ITEM	UNIT	COST
Network servers	Per server	15,000 to 25,000 USD
Database license	Per License	25,000 to 65,000 USD
WIM scales	Per Scale	250,000 USD
In vehicle transponders	Per Transponder	10 to 40 USD
Roadside readers/transmitters	Per Reader/transmitter	80,000 to 150,000 USD
Telecomm equipment ups-weigh st.	Per Total	1,000 to 30,000 USD
Electronic signs for weigh stations	Per Unit	10,000 to 35,000 USD
Loop detectors	Per Site	2,000 USD
Over-height detectors	Per Unit	500 USD
Remote cameras and transceivers	Per Unit	3,000 USD

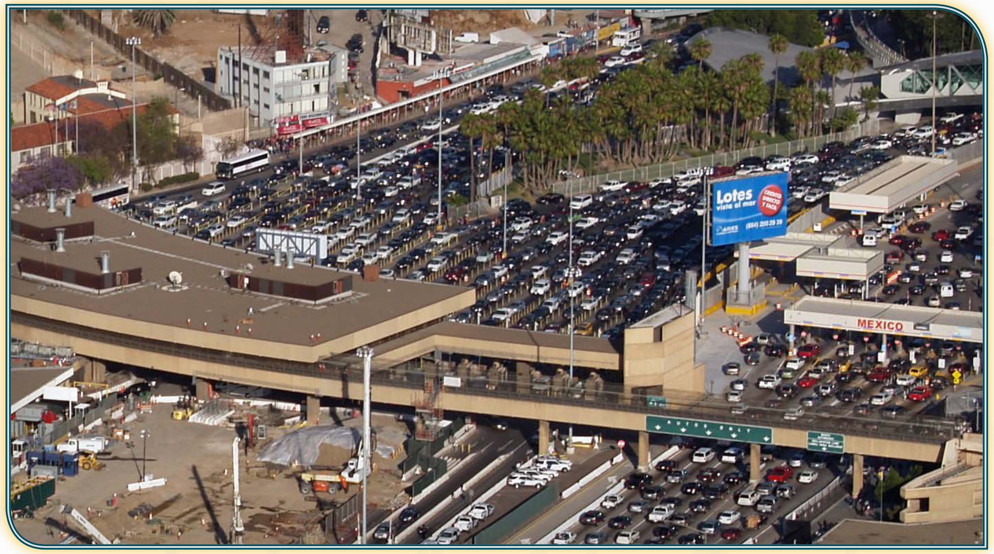
Figure 32. Unit Cost references about AVI (Border Crossing) Technology Source: RITA - US Department of Transportation (http://www.itscosts.its.dot.gov) – 2009[86]

Benefits:

According to results of the different experiences in USA concerning AVI and E-Screening at border crossings, the following benefits were reported:

- FAST (USA/Mexico and USA/Canada).- FAST members reported saving an average of 27 minutes when entering the United States and 18 minutes when entering Canada.
- Electronic Screening in Southern and Northern borders:
  - Full electronic verification of enrolled vehicles was routinely accomplished via the E-Screening system in less than 1 second, vs. the 15 minutes required to manually verify all items checked by the screening system.
  - On average, 237 vehicles per month were subject to full safety/compliance verifications of all criteria included in the E-Screening system. The number of vehicles screened for full compliance was increased 307%.
  - The system identified compliant/non compliant vehicles more than 99% of the time, enabling inspectors to focus their efforts on vehicles with –fail- reads and not transponder-equipped.
- Colorado.- In 1998, the United States Congress designated the I-25 Truck Safety Improvements Project (I-25 TSIP) to support transportation improvements in the State of Colorado. The throughput of goods, savings to the private sector, and emissions impacts can be directly measured from the automation equipment installed as part of this project. Ports of Entry (POE) automation included installation of weigh in motion (WIM), automatic vehicle locators (AVL), and associated computer and communications equipment necessary to perform electronic credentialing.
  The automated commercial vehicle pre-screening systems installed saved 48,200 gallons of fuel per month, and approximately 8,000 vehicle hours of delay per month.
- Oregon.- In Oregon, windshield mounted transponders were distributed to registered motor carriers and electronic screening systems were installed at 21 weigh stations. The program known as Green Light used weigh-in-motion (WIM) scales and automated vehicle identification (AVI) technology to enable truckers to bypass weigh stations at highway speeds if their truck passed an instantaneous check of size, weight, height, registration, road use tax account status, and safety records. Drivers were signaled with an in-cab device whether to "Report" to the station or "Bypass".
  The weigh-in-motion and electronic screening systems at 21 weigh stations can save motor carriers more than 600,000 USD per year in fuel costs and can reduce emissions of harmful particulate matter by 0.5 tons per year.





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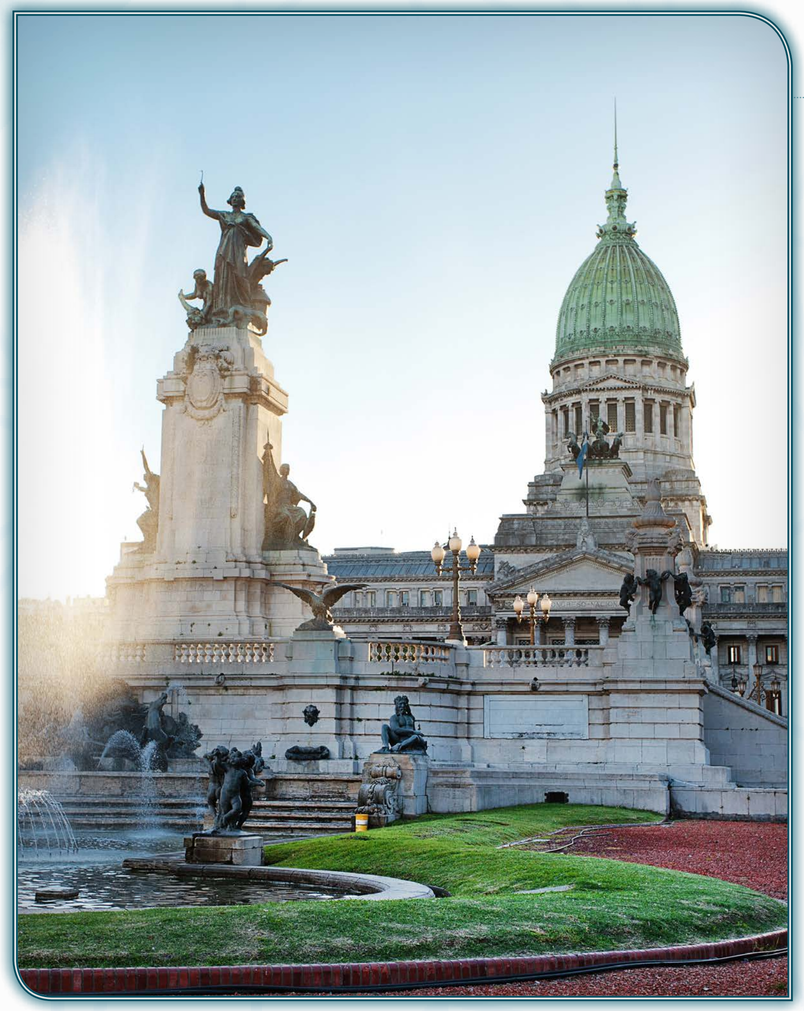
COUNTRY BY COUNTRY ANALYSIS



COUNTRY: ARGENTINA

SELECTED CITIES

Buenos Aires, Rosario

Añelo, Las Heras, Mar de Plata, Paraná, Salta

SOCIO-ECONOMIC INDICATORS [47]

Population	43,024,374 (2014)
Income per capita	$18,600 (2013)
% of public transport trips	Buenos Aires 40%; Salta 64%; Rosario: 34.3%[48]
No. of km of primary roads	Total: 231,374 km; 69,412 km paved (includes 734 km of expressways)
No. of cell phone users	58.6 million (2012)
No. of registered automobiles	11,476,548 (2012)[49]

<1>

DESCRIPTION OF ITS APPLICATIONS MARKET

In May 2009 the Government signed the Digital Agenda of Argentina[50], and in December 2009 the Ministry of Science, Technology and Productive Innovation (Ministerio de Ciencia, Tecnología e Innovación Productiva (MINCYT))[51] created the ICT Prospective Book. Although these two documents do not contain an specific axis on Intelligent Transportation Systems, for the first time it is possible to analyze ITS transversally within various chapters of these two documents. There is not a specific development policy at national level.

The main challenge for Argentina is to develop the ITS area as a strategic sector within areas such as ICTs, energy, environment and road safety. The objective is to bring together the Ministry of Science, Technology and Productive Innovation (MINCYT) and the Ministry of Federal Planning, Public Investments and Services (Ministerio de Planificación Federal, Inversión Pública y Servicios (MINPLAN)) in order to develop various financing instruments of research and involvement of local ITS stakeholders; and also, to link the Strategic Agendas to ITS implementation.

The recent concession contracts signed in the national road network incorporated innovative strategies such as the improvement of mobility and users' safety and freight traffic in existing road infrastructure, the implementation and maintenance of new construction works in conjunction with the implementation of ITS technology systems.

The Argentinean government is currently investing in road infrastructure projects, extending the capacity of domestic routes and carrying out maintenance of the paved net work complemented by the implementation of an "intelligent road infrastructure" aimed at reducing response times in emergencies, improving dynamic and travel costs of users, transport logistics and cargo, as well as reducing road accidents.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[52]

Argentina's road network has a total of 231,374 km, from which 69,412 km are paved roads and 161,962 km (2004) are unpaved roads. The network is divided into trunk roads, which are domestic routes with national jurisdiction; secondary provincial roads and municipal or communal roads. The road network carries over 90% of the freight transport in the country and almost 100% of the passenger traffic. Around 25% of the national network operates under a concession model through toll systems, and moves 65% of the total traffic.

Argentina's rail network has over 36,966 km of rail lines. The railway transport is regulated by National Commission of Transport Regulation (Comisión Nacional de Regulación del Transporte), a decentralized organization in charge of the control of the national rail and road transport[53].

The passenger transport sector was virtually liberalized in 1992, which led to over-investment and business failure. In 2002 new operators were no longer allowed without introducing appropriate regulations, with predictable effects on rates increases.

Urban transport in the country is based on bus services as well as subway lines, tramway systems and metropolitan railway lines of national, regional and municipal competence.

The international airport of Argentina is Aeropuerto Internacional Ministro Pistarini, located in Ezeiza, and the airport of Ciudad de Buenos Aires is Aeroparque Jorge Newbery, mainly used for domestic flights. All capital cities have their own airports, although most flights are concentrated to Buenos Aires – Córdoba – Mendoza y Bariloche.

Argentina has around 70 river and maritime ports throughout the country. The port system moves almost 130 million tons exported by the country, two-thirds by private ports of the Parana River (Rosario-Santa Fe), and the rest basically through Quequén and Bahia Blanca[54].

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES:
Main and emerging cities

BUENOS AIRES[55]

Transitway Modes:

BRT	METROBÚS[56]: · Metrobus 9 de Julio: 11 collective lines; 17 stations; 3 km; 200,000 daily passengers · Metrobus Juan B Justo: 7 collective lines; 21 stations; 12 km; 100,000 daily passengers · Metrobus Sur: 2 corridors; 23 km; 37 stations and 8 traditional stops; 250,000 daily passengers
Underground	METRO: 6 lines; 83 stations; 58.8 km; 700 million annual trips
Urban Buses	Buenos Aires Bus/Colectivo: 59 urban municipal lines; 1,700 million annual trips
Other	LIGHT RAIL: Tranvía del Este: 1.5 Km, 4 stations TROLEBUS RAIL: 840 km

ROSARIO [57]

BRT	Transporte Urbano de Pasajeros (TUP): 43 lines; 30 stations; 9 km; 60.000.000 annual trips
Underground	Metro in planning process
Urban Buses	Rosario Bus: 57 lines
Other	400 remises

AÑELO [58]

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	There is not an urban bus system, only interurban services operated by private bus companies

LAS HERAS [59]

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	There is one urban trolleybus line that connects Las Heras with Mendoza
Other	Metrotranvía of Mendoza is an urban train that connects the municipalities of Las Heras, Capital, Godoy Cruz, Luján de Cuyo and Maipú[60] There are also remises and taxis

MAR DE PLATA [61]

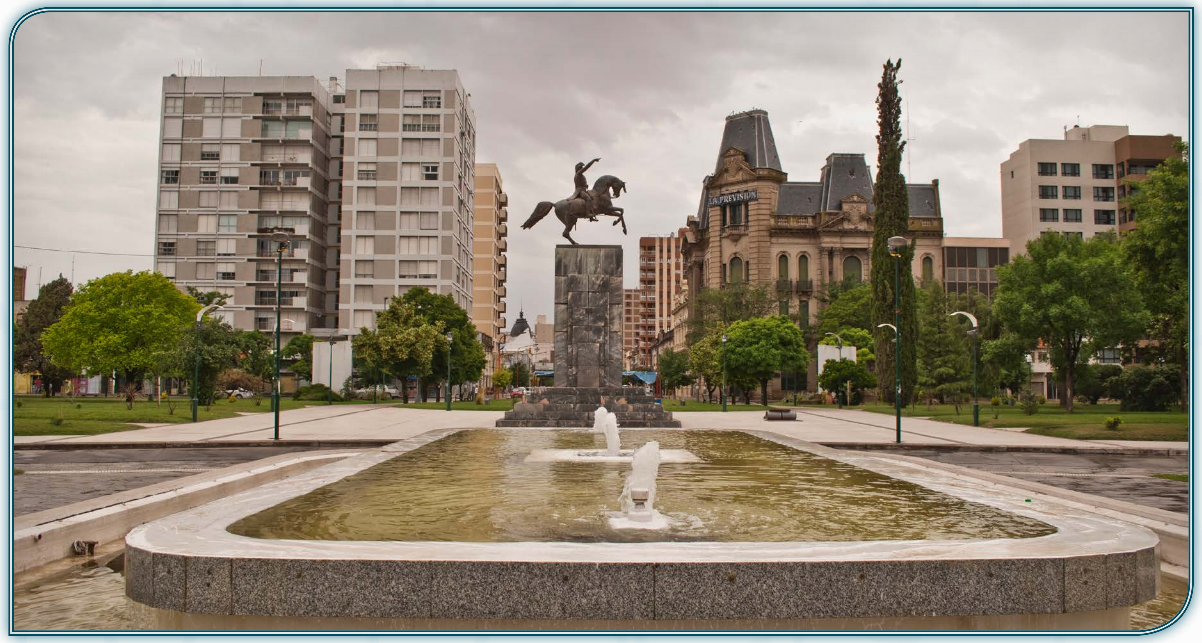
BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	32 urban and interurban lines (29 municipal concessions and 3 regional concessions); 84.613.000 annual trips

PARANÁ [62]

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	2 concessionaires of omnibus; 18 urban lines[63]

SALTA [64]

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	9 urban corridors; 33 urban lines



ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Buenos Aires[65]	Contactless Smart Card: Sistema Único de Boleto Electrónico (SUBE) Card	GPS Monitoring Center	Buenos Aires (BA) Movil: Smart Phones Application with real time transport information Website information through the application Mapa 2.0 with real time transit information	Ecobici 21 stations 4200 bicycle parking spaces 130 km of cycle lanes	Transit Control Center 3CT: 30 control center agents monitor the system in real time 1,200 Transit control agents Coordinated/synchronized traffic lights 384 Countdown Traffic Lights using LED technology 5 different types of traffic lights (flashing yellow at night, lane control lights, countdown timers pedestrian crossing lights, on-demand pedestrian lights, sound lights for visually impaired people). Variable message signals (VMS) Parking availability panels Metrobus Sur: traffic lighted intersections, 10 CCTV, 2 VMS	Daily red light controls in 25 locations of the city
Rosario[66]	Contactless Smart Card in BRT and Urban Buses	Monitoring Center Fleet control system through GPS: speed control, number of passengers, location and travel time monitoring 542 vehicles	Dynamic User Information System: 70 LED displays at bus stops and 20 self-inquiry posts in public places report the arrival of vehicles and travel time. Information through a special mobile application (either by text message or an app for smart phones) with over 56,000 daily queries	Public Bicycle System (under procurement, planned for January 2015) Investment: 1,174,000 USD 18 automatic stations 480 bicycles and 200 replacement bicycles Contactless Smart Card	Traffic Control Center (Centro de Monitoreo de la Movilidad (CMM)): The signalized network of the city has 783 intersections with traffic lights, of which 470 are monitored in real time by the Traffic Control Center 24 h control Synchronized traffic lights Variable message signals	10 Traffic enforcement cameras (red light) in rotating locations in 60 intersections Speed control in traffic light intersections 297 loops and 116 counting stations measuring vehicle speed 7 transit cameras and 83 security cameras

ARGENTINA

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Añelo[67]				NO		
Las Heras[68]	Contactless Smart Card: RedBus Card	AVLC	Dynamic User Infor mation System through applications in smart phones Real-time information about schedules and location of buses SMS information Website information	NO	Department of Prevention and Road Safety (Departamento de Prevención y Seguridad Vial), in order to prevent, control road safety	70 signalized intersections, 41 of which already have the LED high-tech system
Mar del Plata[69]	Contactless Smart Card			NO	Urban Road Safety and Transit Control Center: Comprehensive coordination of traffic lights with cameras and variable message signals system 238 coordinated lights 450 traffic lighted intersections	Red light crossing control devices through cameras in intersections
Paraná[70]	Contactless Smart Card: Tarje Bus	Bus Management and Operation Center, bi-directional communication with the driver in real-time		NO	Traffic Control Center (Centro de Control de Tráfico (CCT) 20 speed panels and Variable Message Signals (VMS) CCTV cameras LED traffic lights placed in the main corridors	84 traffic lighted intersections with around 400 coordinated traffic lights

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Salta[71]	Contactless Smart Card	Fleet Management System through GPS, bi-directional communication with the driver in real-time Monitoring of the fleet location 24 hrs.	Dynamic Information System (24 hr.)	NO	Traffic Control Center: 2 monitoring terminals, 2 staff members, 24 hr. 202 LED traffic lighted intersections 49 lighted intersections connected to the intelligent control system	Mobile speed control cameras/devices, PARVUS and VICE devices and tablets managed by transit agents

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[72]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

Autopistas Urbanas SA (AUSA), has applied SIGA/HORUS systems in Argentina, a software that provides data to the minute, traffic and travel times estimated automatically and transmit traffic conditions to drivers via variable message signs. The organisation is currently exploring the possibility of adding the Incident and Maintenance Management Systems, and speed control radar to try to prevent accidents and congestion.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)[73]

The National Road Safety Agency (Agencia Nacional de Seguridad Vial) is the agency responsible for reducing accidents in Argentina. Among their functions are the Participation in the regulation, implementation and monitoring of Satellite Monitoring System affected by motor transport and passenger vehicles.

The Agua Negra tunnel due to its planning, design, implementation and quality, represents a milestone in both tunneling history and the implementation of ITS systems worldwide. Control Systems will be integrated into a Tunnel Management Center, from which vehicular traffic will be monitored (including users, emergency vehicles and maintenance and operation).

Other systems related to road safety will also be installed. They will be integrated with other monitoring and control subsystems through incident detection video cameras, sensors and other applicable devices related to the vehicles passing through the channel.

ELECTRONIC TOLL COLLECTION[74]

Argentina counts with the Traffic Control Center of the Intelligent Highway (Centro de Control de Tránsito de la Autopista Inteligente). Its implementation involved an investment of 600,000 USD and allows multiple collection of information of what happens on the highway. The control center consists of a set of last generation technological devices that operates the system: it receives information through various sources placed on the highway that decodes, playback and stores data. The technical experts and the Road Safety Department (Departamento de Seguridad Vial) use this data to prevent accidents, detect poor circulation; control the performance of the teams working on the highway and collect statistics about traffic.

The system also allows to viewviewing and measuring whole sections of the highway through real-time cameras and sensors; inform; informing about drivers circulation; monitoring the level of services provided on the freeway; retaining a large selective image file; supporting the police to deter crime or coordinate operations. It is composed of 22 CCTV cameras, 53 data collections stations, including speed measuring sensors, accidents and traffic density, 6 electronic Variable Message Signals, 5 regulated traffic lights through sensors that determine the traffic density and automatically lengthen and shorten the waiting time, etc. The project includes the sections between Lugones Avenue to Ricardo Balbin, in the Avenida General Paz and from the latter to Avenida Marquez.

This initiative is complemented by the presence in Buenos Aires of an infringement collection system by photographic means, called "intelligent control system of infringements". The city has also implemented the operation of electronic toll systems on the motorways 25 Mayo, Perito Moreno or Autopista del Buen Ayre among others.The success of these experiences has driven the construction of a "smart highway" in the Province of San Luis.

In July 2014 was implemented the first Free Flow Tolling system enabled in an Argentinian motorway, a new access was enabled to transit from Ave Sarmiento to the new Illia Motorway (North direction)[75]. This is a free flow electronic toll (AUPASS / Pass / Toll / SIGA), and the payment is now made automatically through the AUPASS system (Autopistas Urbanas (AUSA)). AUPASS Red is the new system of HGV AUSA, to move in quickly and easily through urban expressway tolls, implemented in the La Plata-Buenos Aires Highway, West Access, North Access, and Ezeiza-Cañuelas Access and Camino del Buen Ayre. Since 1998, these highways are interoperable using TAG Amtech of 917Mhz antennas and proprietary technology.

Electronic Toll Plus systems are currently installed and working in the following toll stations: Cincovial: RN9 in Zarate, Buenos Aires and Lagos, Santa Fe, RN11 in Nelson, Videla, Florencia and Reconquista, Santa Fe, Autovía Rosario. Córdoba in Carcarañá, Santa Fe and James Craik, Córdoba. Corredor Central: RN8 in Larena and Solís, Buenos Aires and in Venado.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS[76]

Buenos Aires is planning to extend 100 km the Metrobus network. The extension of the BRT system will involve the implementation of additional ITS applications required for the correct operation of the public transport system.

In the city of **Rosario**, in the future, there will be the first automated bicycle sharing system, which will have 15 stations in areas of public interest such as the coast, universities, libraries and health centers. Furthermore, Rosario hopes to double the bicycle network, which will not only help relieve congestion car, but also contribute to the reduction of GHG pollution in the city.

A Metro system is in planning process in the city of Rosario. The construction of the underground system will involve the implementation of ITS applications required for the correct operation of the public transport system.

Within the Transport and Traffic Master Plan of **Mar del Plata**, it is planned the implementation of two projects: exclusive lanes for public transport and the extension of the bicycle paths network.

These actions are part of the Emerging and Sustainable Cities Initiative (ESCI) of the Inter-American Development Bank (IDB) and aims to improve the local urban mobility system of the city by enhancing ecological transport modes.

COUNTRY: BAHAMAS

SELECTED CITIES

Nassau

SOCIO-ECONOMIC INDICATORS[47]

Population	321,834 (July 2014 est.)
Income per capita	$32,000 (2013 est.)
% of public transport trips	N/A
No. of km of primary roads	Total: 2,700 km; 1,620 km paved
No. of cell phone users	254,000 (2012)
No. of registered automobiles	131,365 (2008)

DESCRIPTION OF ITS APPLICATIONS MARKET[77]

The government of Bahamas has not yet designed a national strategy or policy focused on ITS technologies in the transport sector. Following the IDB Country Strategy (2010-2014) which supported the Government's efforts to enhance growth by improving infrastructure and supporting Small Medium Enterprises (SME) development, some road improvements have been reported. However, the proposed IDB Country Strategy with the Government of Bahamas for the period 2013-2017 is focused on ensuring macroeconomic sustainability, social stability and employment, and increase resilience to the negative impacts of climate change.

Significant development is to be accomplished in The Bahamas in the field of transport as well as in the implementation of ITS applications to the sector, especially in terms of urban transport and road safety.

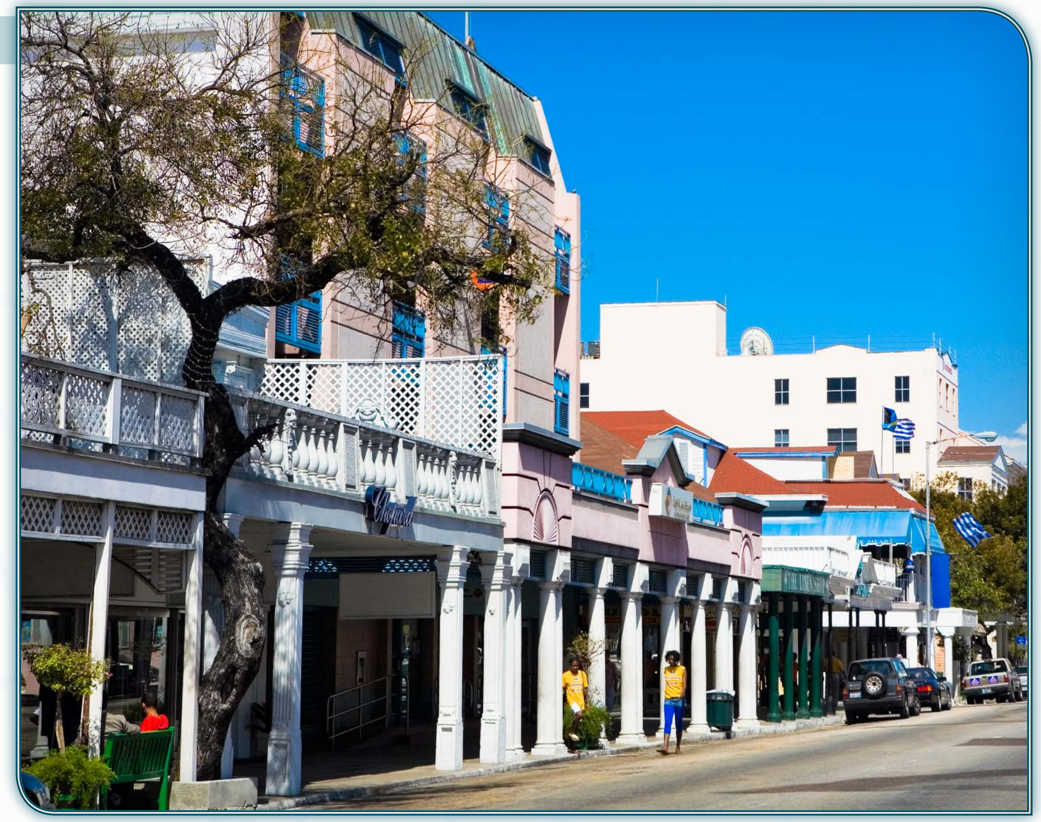
DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[78]

The transportation system in The Bahamas is strongly conditioned by geography, as the country consists of more than 700 islands and islets.

The Bahamas has 2,700 km of roads, of which 1,620 are paved. There are not railway systems in The Bahamas. Jitney services (bus services) are available on Nassau and Grand Bahama Island.

Most residents use private vehicles. Public transportation mainly based on buses is under-used.

There are approximately 57 airports throughout The Bahamas, including three international airports (on Nassau/Paradise Island, Grand Bahama Island, and the Exumas). Twenty-four of these airports are official ports of entry to The Islands of the Bahamas. There are countless government and private marinas throughout The Bahamas, twenty-nine of which are official ports of entry to The Islands of the Bahamas.



DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

NASSAU[79]

Transitway Modes:

BRT	There is no BRT system in the country
Underground	There is no underground system in the country
Urban Buses	There are 23 bus routes. Approximately 400 public buses ("Jitneys") in service privately owned and operated under individual licenses
Other	---

CITIES	ITS APPLICATIONS					
	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Nassau[79]	NO	NO	NO	NO	NO	-------------

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[80]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

There are no toll roads in Bahamas.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS

COUNTRY: BARBADOS

SELECTED CITIES

Brigdetown

SOCIO-ECONOMIC INDICATORS[47]

Population	289,680 (July 2014 est.)
Income per capita	$25,100 (2013 est.)
% of public transport trips	N/A
No. of km of primary roads	Total: 1,600 km; 1,600 km paved (2011)
No. of cell phone users	347,000 (2012)
No. of registered automobiles	133,835 (2010)

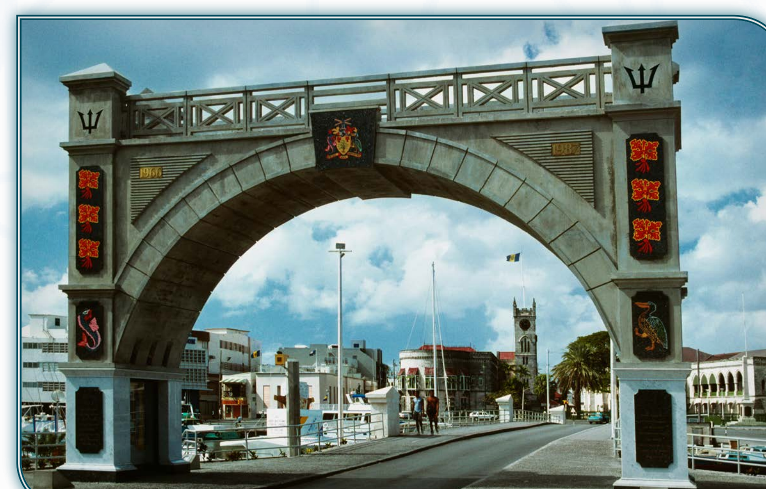
DESCRIPTION OF ITS APPLICATIONS MARKET[81]

The ITS applications market is under developed in Barbados. The government has not yet designed a national strategy or policy focused on ITS technologies in the transport sector.

There is ad-hoc research by individuals in the Transport Board and the use of technology has been applied to electronic ticket machines on buses, closed circuit television on buses, and Global Positioning Systems (GPS) to track buses.

Within the Ministry of Transport and Works, the synchronizing of traffic lights has started and some have been implemented; there are also plans for further expansion. The strips installed to count traffic and monitor speed on specific roads are used for monitoring road use. Researchers from the University of the West Indies (UWI) are investigating electronic tracking by planting devices on telephone poles

Therefore, the country offer spotential development and investment opportunities in the areas of urban transport, urban and interurban traffic and road safety.



DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[82]

Barbados has 1,600 km of public paved roads, and a very dependable highway system of main roads that stem from the country's capital, Bridgetown. The most popular highway throughout the island is the Adams/Barrow/Cummins Highway.

The Ministry of Transport & Works of Barbados oversees the affairs of the nation's roads, highways, and the public transport system. The Barbados Transport Authority is the public authority with competences in bus transportation in the country. Their primary function is to plan, monitor and regulate the public transport system in Barbados based on the provisions of the Transport Authority Act 2007-28. Transport Authority is developing the policy framework and guidelines for the operation of the Public Transport System.

Public transport services in Barbados include buses, taxis, shared taxis (Called "ZRs", privately owned minibuses), and car rentals. Some services run on a direct route to their destinations however, most public transport services require a connection through Bridgetown.

Source: commons.wikimedia.org/wiki/User:Postdlf

There are two types of buses in the island, large blue buses and yellow buses. The usually larger blue buses are government-operated by the Barbados Transport Board.

The system as a whole is currently working on establishing its personnel and augmenting its human resources. In addition to these activities, it will seek to cooperate with public service operators, taxi drivers and the public sector to ensure that concessions are properly managed.

The country has two active marine ports (Bridgetown Port and Port Saint Charles), remnants of a railway system, and one airport, Sir Grantley Adams International Airport, located in Christ Church.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

BARBADOS

BRIGDETOWN[83]

Transitway Modes:

BRT	---
Underground	---
Urban Buses	Bus network composed of 228 (2009) urban and interurban buses in the island (large blue buses and yellow), omnibus, microbus, 98 routes, 3 terminals, 2 of them in Bridgetown
Other	Minivans

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELE INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Bridgetown[84]	---	CCCTV installed in buses with 4 onboard cameras Global Positioning Systems (GPS) to track buses. Trans Tech, Quality Care Vehicle Maintenance and Commercial Vehicle maintenance to assist with routine maintenance to enhance bus availability		No	Started the synchroni-zing of traffic lights at some locations	Count traffic and monitor speed devices on specific roads

BARBADOS

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS) [85]

Works on the synchronizing of traffic lights have started with some in existence and the Ministry has plans for further expansion.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...) [86]

Within the Ministry of Transport and Works, the synchronizing of traffic lights has started with some in existence and plans for further expansion. The strips installed to count traffic and monitor speeds on specific roads are used for monitoring road use. Researchers from the University of the West Indies (UWI) are investigating electronic tracking by planting devices on telephone poles.

ELECTRONIC TOLL COLLECTION

There are no toll roads in Barbados.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS [87]

Barbados Transport Authority has plans to start implementing a next bus–electronic signaling system to inform users waiting at the bus stops when the next bus is coming, along with electronic scheduling.

There are plans for further expansion of traffic lights synchronization in the country.

COUNTRY: BELIZE

SELECTED CITIES

Belmopan

SOCIO-ECONOMIC INDICATORS [47]

Population	340,844 (July 2014 est.)
Income per capita	$8,800 (2013 est.)
% of public transport trips	N/A
No. of km of primary roads	Total: 2,870 km; 488 km paved
No. of cell phone users	164,200 (2012)
No. of registered automobiles	54,225 (2007)

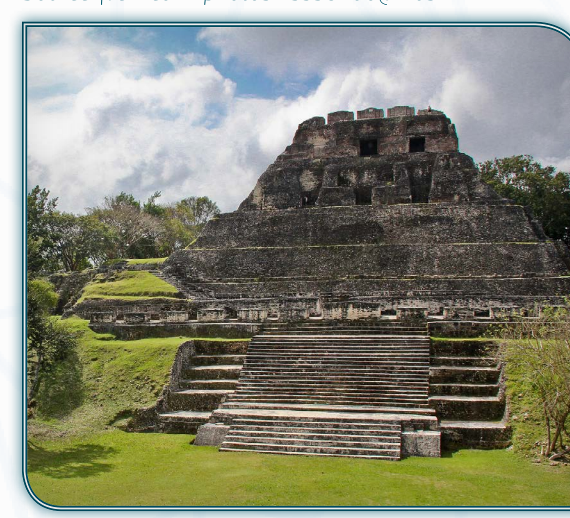
DESCRIPTION OF ITS APPLICATIONS MARKET

The 2013-2017 IDB Country Strategy aims to support the Government of Belize in improving public expenditure efficiency and effectiveness and promoting private sector development and sustainable export-led growth, by concentrating on four priority areas, among which is transport. The two main IDB strategic objectives in the country are the improvement of road infrastructure to facilitate trade and integration and access to emerging tourist destinations and the preparation of a medium-term Transport Master Plan.

The poor network quality affects the efficiency of public transport, which also suffers from poor regulation and oversight. The current system does not provide sufficient accessibility and mobility, is inefficient and results in high transport costs[88].

The ITS applications market is under developed in Belize. The government has not yet designed a national strategy or policy focused on ITS technologies in the transport sector. The ITS potential development is linked to the government priorities to create new standard Operating Procedures for Traffic Management. There are other ITS market opportunities linked to the need to improve public transport operations.

Source: flickr.com/photos/15558406@N03



DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM [89]

BELIZE

Belize has a total 2,870Km of roads, of those only 488km are paved roads, and 2,382 are unpaved (2011). There are four major asphalt-paved two-lane roads: the Hummingbird Highway, Southern Highway, George Price Highway, and Northern Highway. Most other roads are unpaved, rough and in poor condition.

Belize has no railways; they were dismantled and abandoned in 1937.

As buses are the primary mode of transportation for most Belizeans, routes run on regular schedules and will stop to pick up or drop off passengers at any location along the way. There are two types of bus services: (i) Regular, meaning buses stop for passengers anywhere along the route, and (ii) Express, which stop only at main towns. Buses in Belize operate daily. The Regular buses are old Bluebird school buses, not air-conditioned and are not well equipped to handle luggage.The government's priority at the moment is to create national policies to promote public transportation, walking or cycling

The country has two major seaports in Belize City and Big Creek and the Philip S.W. Goldson International Airport, which serves as the main gateway to Belize.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

Sourche: flickr.com/photos/scaturchio

BELMOPAN[90]

Transitway Modes:

BRT	NO
Underground	NO
Urban and Interurban Buses	There is a major bus terminal in Belmopan, bus services are regular or express services; vehicles are used Bluebird school buses; around 10 bus operators are authorized to operate
Other	---

BELIZE

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	Traveler INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Belmopan[91]	---	---	---	---	---	---

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)[92]

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY,...)[93]

There is a national road safety strategy, although with low speed limit enforcement level.

ELECTRONIC TOLL COLLECTION

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS[94]

One of the main priorities for the government is the creation of new Regulations for Revised Motor Vehicles and Road Traffic Act and the creation of new standard Operating Procedures for Traffic Management.

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COUNTRY: BOLIVIA

SELECTED CITIES

La Paz
Cochabamba

SOCIO-ECONOMIC INDICATORS [47]

Population	10,631,486 (2014)
Income per capita	$5,500 (2013)
% of public transport trips	La Paz 88%; Cochabamba < 30%
No. of km of primary roads	Total: 80,488 km; 11,993 km paved
No. of cell phone users	10,426,000 (2012)[95]
No. of registered automobiles	1,326,833 (2013)[96]

DESCRIPTION OF ITS APPLICATIONS MARKET

One of the priorities within the IDB's country strategies is transportation[97]. The Transport Development Sector Plan[98] designed by the Ministry of Public Works, Services and Housing (Ministerio de Obras Públicas, Servicios y Vivienda) in October 2009 already pinpoints the need to incorporate new technologies to the transport sector, such as mobile communications for traffic control centers, Global Positioning Systems (GPS), Automatic Vehicle Location Centers (AVLC), and integrated management systems.

The National Road Safety Plan of Bolivia (Plan Nacional de Seguridad Vial de Bolivia) 2014-2018 proposes the implementation of new technologies for the prevention and control of road incidents or casualties (GPS, electronic itineraries, monitoring centers, fixed and mobile speed cameras and video surveillance cameras, variable message signals) and the creation and update of communication platforms within the website of the National Road Safety Observatory (Observatorio Nacional de Seguridad Ciudadana)[99].

The implementation of electronic toll systems in Santa Cruz and Cochabamba and the Integrated Public Transport System in Cochabambawill also favor the implementation of ITS applications in the transport sector. Therefore, there is investment potential in the country in areas such as e-toll, urban transport, and urban and interurban traffic.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[100]

Bolivia is served by a road network with around 80,488 km, of which 11,993 km are pavedand the remainders are of gravel or earth. Only the cities of the Central Axis (La Paz, Cochabamba and Santa Cruz) are integrated by paved road structures.

The country has also a rail system consisting of two major networks: the Eastern Network (FCO) consists of 1,222 km which connects Brazil and the West Network (FCA) consists of 2,318 km that connects Chile and Argentina. These networks are not connected to each other.

As for maritime and river transport, although Bolivia has no connection to the sea, it has more than 14,000 km of navigable rivers. The main river ports are Central and Gravetal located in Tamengo Canal. Bolivia has signed several agreements for the use of ports in neighboring countries, through which it receives special access rights with Peru and Chile in the Pacific Coast and Argentina, Brazil, Paraguay and Uruguay over Paraguay Waterway Paraná that gives access to the Atlantic Ocean.

To compensate for the lack of roads infrastructures, the country has a comprehensive network of domestic flights connecting the various cities and remote locations through the 13 existing airports, of which only three are international (Viru Viru International Airport in Santa Cruz, International Airport Jorge Wilstermann in Cochabamba and El Alto International Airport in La Paz).

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

LA PAZ[101]

Transitway Modes:

BRT	LaPazBus; routes; 60 buses; 57 stops
Underground	There is no underground system
Urban Buses	Feeder lines to BRT
Other	MiTeleférico[102]. Cable transport, 3 lines; 10,37 km; 11 stations; 443 cable cars; max 18,000 passengers/hour; 17 hours/day

COCHABAMBA[103]

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	47 lines of minibuses and 33 lines of microbuses
Other	---

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
La Paz [104]	Contactless Smart Card in MiTeleférico Contactless Smart Card in LaPazBus	Monitoring and Control Center /Centro de Control y Monitoreo del Bus (3 cameras)	Webs, Apps and social networks with information LaPazBus Free WIFI in bus Electronic screen to inform travelers in bus	NO	Integral Monitoring and Control Center/ Centro Integral de Control y Monitoreo: Traffic light control Security cameras surveillance	Intelligent Traffic Light System, 197 intersections 30 security cameras in the urban area
Cochabamba[105]	---	---	---	---	Control and Monitoring Center / Centro de Control y Monitoreo	150 video surveillance cameras

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[103]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

In 2013 was created the National Directorate of Transit, Transport and Road Safety (Dirección Nacional de Tránsito, Transporte y Seguridad Vial), which centralizes the data of transit operation's organizations.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

An approximate amount of 100 fixed and mobile speed devices have been implemented in the country.

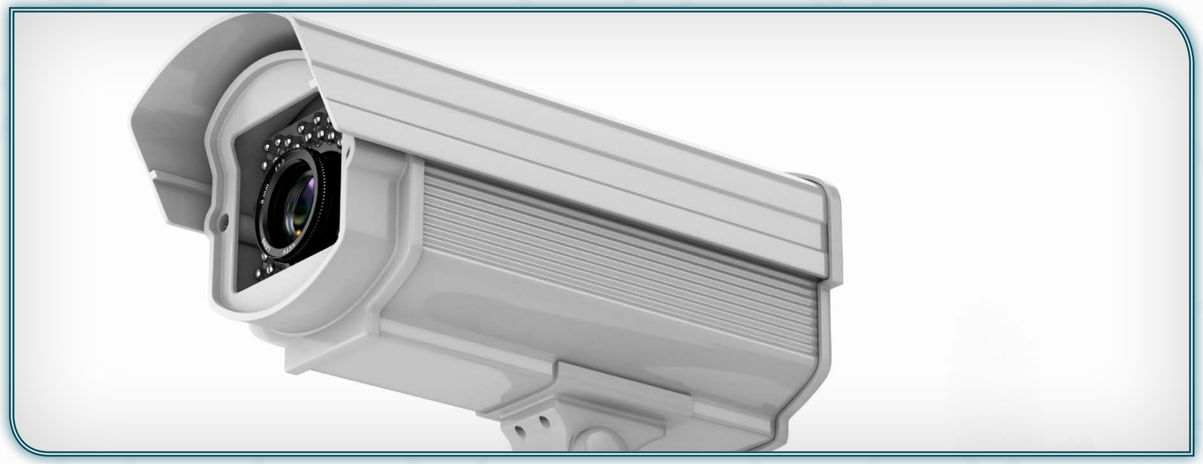
Android applications for smartphones (Transitabilidad y Noticias) to inform about traffic situation and other related news of National Road Administration (Administradora Bolivariana de Carreteras (ABC)) are also deployed.

ELECTRONIC TOLL COLLECTION

In 2011, implementation of an Automatic Toll System- SISCAP. According to data from 2012, there are 28 SISCAP devices.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

Cameras and control devices and safety surveillance in toll stations critical to vehicle identification in the Road Network.

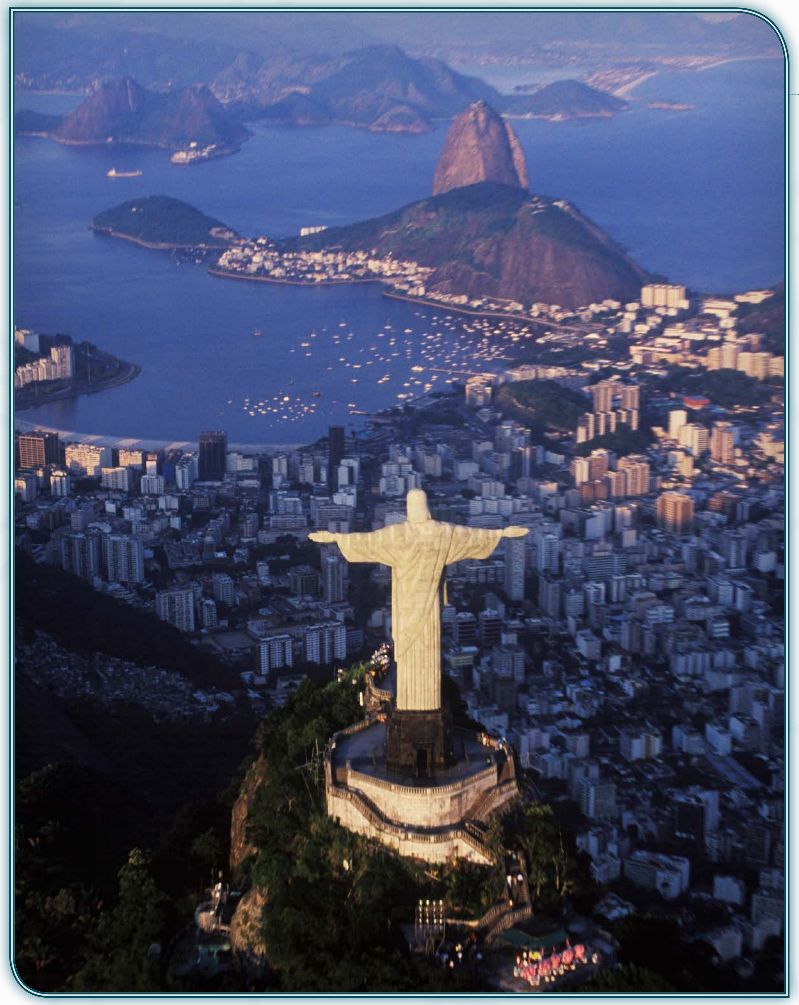


FUTURE DEVELOPMENTS

The National Road Safety Plan of Bolivia (Plan Nacional de Seguridad Vial de Bolivia) 2014-2018 proposes the implementation of new technologies for the prevention and control of road incidents or casualties (GPS, electronic itineraries, monitoring centers, fixned and mobile speed cameras and video surveillance cameras, variable message signals) and the creation and update of communication platforms within the website of the National Road Safety Observatory (Observatorio Nacional de Seguridad Ciudadana)[107].

There are electronic toll systems in urban and rural roads. Initial Project in Santa Cruz and Cochabamba. Operation start up is expected in November 2014[108].

Cochabamba: Integrated Public Transport System in Cochabamba. Study and Design Year 2014-2015 (in planning process)[109]. The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system.



COUNTRY: BRASIL

SELECTED CITIES

Brazilia, São Paulo, Río de Janeiro, Curitiba Florianopolis, Goiania, Joao Pessoa, Palmas, Vitoria (Espirito Santo)

SOCIO-ECONOMIC INDICATORS [47]

Population	202,656,788 (2014)
Income per capita	$12,100 (2013)
% of public transport trips	Río de Janeiro: 75%; Sao Paulo: 55%; Goiânia: 30%; Curitiba: 46%; Brazilia: 23%; João Pessoa; 37%
No. of km of primary roads	Total: 1,580,964 km; 212,798 km paved
No. of cell phone users	248,324 million (2012)
No. of registered automobiles	84,066,163 (2013)[110]

DESCRIPTION OF ITS APPLICATIONS MARKET[111]

The IDB country strategy clearly states transportation as one of the countries' priority sectors. The main goals are to expand and improve the quality and safety of state and federal road networks and the support to large and medium-sized Brazilian cities in their efforts to improving urban transportation.

There is a significant development potential of ITS applications implementation in Brazil. Given the upcoming hosting of the Olympics in 2016, Brazilian cities will have to invest heavily in the modernization and expansion of its transportation system. The country plans to invest in the construction of new metro lines, light rail train lines, and Bus Rapid Transit systems. At the same time, Brazil is seeking to increase private road concessions and implement Public Private Partnerships (PPP's) to generate new funds for investment in roads, rails, ports and airports.

BRASIL

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[112]

Transport infrastructure in Brazil is characterized by strong regional differences. The country has a road network of 1,580,964 km, of which 212,798 km are paved. The rail network of the country is composed of 28,538 km long.

Brazil has 37 ports, although the six main ones are: Port of Santos, Port of Rio Grande, Port of Itajaí, Port of Paranaguá, Port of Rio de Janeiro and Port of Vitória[103]. The Brazilian river network is one of the largest in the world, with an area of 50,000 km of navigable rivers.

Regarding air transport, in Brazil there are about 4,000 airports and airfields, of which 721 are paved runways. It is the second country with the largest number of airports. Guarulhos International Airport is the first airport of the country in passengers and tons transported. Brazil has 34 international airports and 2,624 regional.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

BRASILIA[114]

BRT	A BRT corridor is under construction (Expresso DF, with a total length of 43 km)
Underground	MetroDF: 2 lines with 29 stations (from which 24 are working) and a total length of 42.4 km; The system has 32 trains and 140,000 passengers per day; expansion is ongoing, with 27 new stations and 15 km planned
Urban Buses	TCB (Transporte Colectivo de Brazilia) composed by: · Conventional Lines: 799 lines (metropolitan and urban lines); the system has 2,337 buses and 14,470,623 passengers per month. · On-demand Transport: 350 microbuses · Rural Lines: 97 lines; 74 buses · Special services: 12 lines; 55 minibuses; 443,706 passengers per month
Other	BikeBrazilia: Shared bicycles: 10 stations and 100 bicycles Light rail. VLT (Veiculo Leve sobre Trilhos). Under construction. 2 lines; 31 stations; 32 km

SÂO PAULO[115]

BRT	3 BRT corridors are being planned
Underground	Metro SP: 5 lines with 64 stations and a total length of 74,3 km; 4,6 millions of passengers per day. In planning phase 92 new stations and 101 km
Urban Buses	SPTrans: 1,300 lines; 15,000 buses; 28 municipal and intercity terminals; 19,000 stops; 10 corridors; 16 consortia formed by companies and cooperatives under the management of Sao Paulo Transporte SA (SPTrans); 6,0 million passengers daily
Other	Trains: Companhia Paulista Metropolitana (CTPM). 6 lines, 260 km, 92 stations; 2,8 million passengers per day; Interurban Buses (EMTU). 7 corridors; 33 km; 9 terminals; 111 stops; 233 buses Bike Sampa. Shared Bicycles. 117 stations

BRASIL

RÍO DE JANEIRO[116]

BRT	Rio is developing a BRT system which is partially in service with the Transcarioca (39 stations) and Transoeste lines (2 corridors; 296 buses; 101 stations; 9.0 million passengers per month) The Transolimpico and Transbrasil lines are still in construction / planning stages
Underground	Metro Rio: 2 lines in operation; 35 stations; 13 integration points systems; 780,000 passengers per working day
Urban Buses	450 lines in 5 groups; 90.0 million passengers per month
Other	Supervia: Urban Railway with 152.3 million passengers in year 2013. The system includes: · 8 corridors; 102 stations; 270 km. · 1 cableway line (152 cabins and 3.5 km) Bike Rio: Bicycle Sharing System. 60 stations; 600 bicycles; 4,000 trips per day. 200 stations in planning phase Light rail – VLT is being planned. 6 lines, 30 km, 46 stops; 32 buses

CURITIBA[117]

BRT	Expresso Ligeirao and Expresso: 8 corridors, 72 km, 19 feeder lines. It is operated with 193 buses
Underground	Under construction: 1 line
Urban Buses	First level of the RIT (Integrated Transport Network / Rede Integrada de Transporte) has different types of buses and 36 integration points (23 terminals and 13 areas of concentration of lines). The whole system, including BRT transported 2,29 million passengers per day in 2012. The system has different types of lines: · BRT: Expresso Ligeirao and Expresso: 8 corridors and 193 buses · Interbarrios: 7 lines and 113 buses · Linha Directa: 18 lines and 392 buses · Alimentador: 221 lines and 799 buses · Troncal: 21 lines and 152 buses · Conventional Lines: 89 lines and 419 buses · Circular Lines: 1 line and 9 buses · Tourist Lines: 5 buses
Other	Metropolitan lines non-integrated.

FLORIANÓPOLIS [118]

BRT	3 corridors are being planned (BRT Volta o Morro, BRT Norte and BRT Sul)
Underground	There is no underground system
Urban Buses	SIM (Sistema Integrado de Mobilidade) composed by: 6 integration terminals: · Alimentadora: 120 lines · Paradora: 12 lines · Semi-directa: 21 lines · Directa: 13 lines · Interbarrio: 3 lines
Other	Hidroline. Hidrovía Cable Car - Sistema Integrado de Mobilidade is being planned

GOIÂNIA[119]

BRT	Eixo Anhanguera: 1 corridor; 14 km, 250,000 passengers per day. 2 more corridors are in planning phase
Underground	There is no underground system
Urban Buses	RMTC (Rede Metropolitana de Transportes Colectivos): 281 lines; 20 integration terminals; 1,478 buses; 850,000 passengers per day
Other	Citybus: 10 lines

JOÂO PESSOA[120]

BRT	1 corridor is being planned; 8 stations; 3,2 km
Underground	There is no underground system
Urban Buses	90 lines; 545 buses; 1,800 stations; 6 companies
Other	Light Rail: VLT line 1 in testing phase Urban Train: Companhia Brazileira de Trens Urbanos Pedala João Pessoa

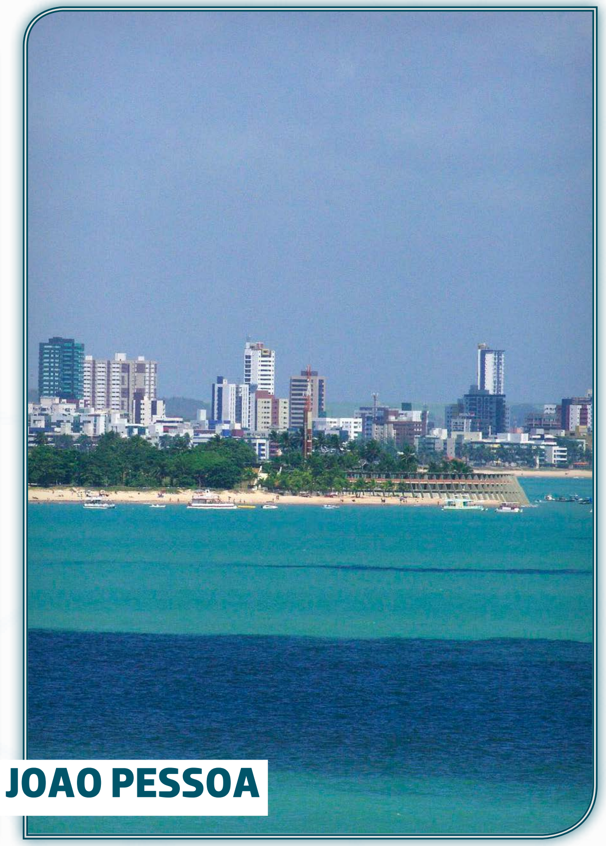
PALMAS[121]

BRT	In planning phase: 30 km; 2 corridors; 7 intermodal stations; 28 stops; 4 exclusive bus lanes
Underground	There is no underground system.
Urban Buses	77 lines; 1,845 km
Other	---

VITORIA, ESPIRITO SANTO[122]

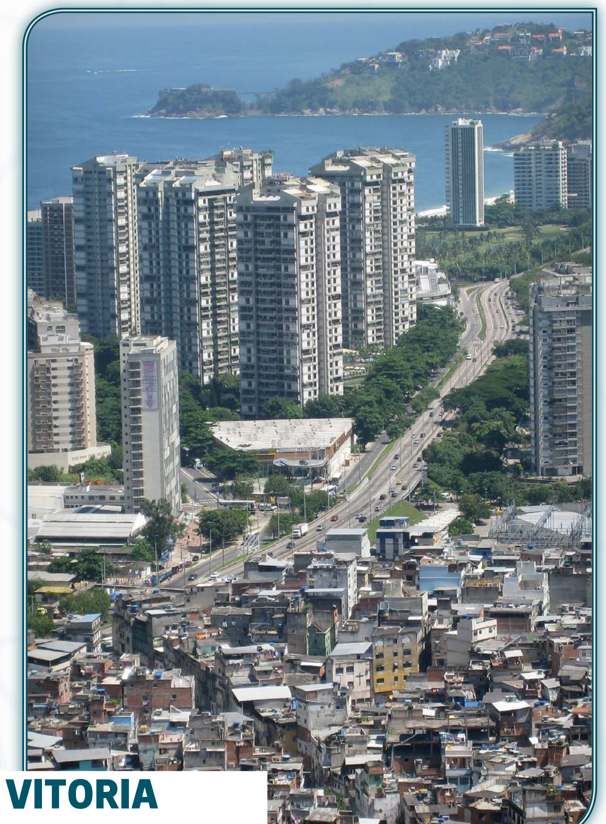
BRT	In planning phase: BRT Grande Vitoria: 31 km; 10 terminals; 41 stations; 22 buses; 640,000 passengers per day
Underground	There is no underground system
Urban Buses	56 lines; 342 buses; 120,000 passengers per day; 3 operators
Other	---

GOIÂNIA


JOAO PESSOA

Source: flickr.com/photos/55953988@N00


PALMAS


VITORIA

Source:commons.wikimedia.org/wiki/User:Flickr_upload_bot

BRASIL

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
BRASILIA[123]	Contactless card in Metro DF. Credits can be charged through Internet	Operational Control Center (OCC) in Metro DF	Web and social networks in TCB and Metro DF	BikeBrazilia system	DER – Departamento de Estradas e Rodagens	132 red lights radar 5 radars of time 99 speed bump radars 284 electronic barrier radar 21 mobile radars
SÂO PAULO[124]	Contactless smartcard for SPTrans, Metro and CPTM Application for recharge transport smartcard	Operational Control Center (OCC) in Metro SP	Web and social networks information in SPTrans Web, apps and social networks in CPTM Variable Messages Panels (PMV) with risk weather, incidents and road safety tips on roads	Bike Sampa Inte-lligent stations via wireless	CET- São Paulo	CFTV system Dynamic Traffic lights Control System
RIO DE JANEIRO[125]	Contactless smartcard "Rio Card" in bus, Metro Rio, Supervia, BRT, BRS	Operational Control Center (OCC) in Metro Rio	Web and social networks information in Metro DF, Onibus, Rio Bike. Supervia, BRT, BRS Apps for smartphones in BRS	Rio Bike 3G access system	Traffic Control per Area (CTA-RIO). Control and monitoring system of traffic lights in real time	500 cameras 2,500 signals
CURITIBA[126]	Contactless smartcard in RIT	On board GPS; RIT Ope-rational Control Center	RIT - Real time information to users	---	Centro de Controle Operacional de Trânsito e Transporte de Curitiba (SETRAN)	89 traffic cameras Fixed radars
FLORIANÓPOLIS[127]	Contactless smartcard (Sistema Integrado de Mobilidade)	---	Web and social networks information in Portal de Mobilidade Urbana de Florianópolis		---	---

BRASIL

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
GOIÂNIA[128]	Electronic pass to RMTC	CST (Central de Seçurança de Transportes) with CCTV system on buses and terminals and security cameras on board CCO (Central de Controle Operacional)	"Ponto de Parada" Dinamic information system of buses "Serviço de Informaçao Metropolitano, SIM" web site an social networks information for buses Call center for buses WAP system for buses information SMS system for buses information Google Maps for buses information	In planning phase	Traffic Lights Control Center (9 Areas)	48 Speed radars in urban streets 94 Surveillance device in red traffic lights 489 traffic lights 1 fixed speed radar
JOÂO PESSOA[129]	---	---	---	---	Centro de Control de Trafico João Pessoa (CTA- João Pessoa)	151 traffic lights 32 monitoring cameras 28 electronic spines 7 red light devices Speed radars Electronic Speed Reducers (LVE)
PALMAS[130]	---	---	---	---	---	Synchronized Green Wave Traffic lights - Onda Verdebetween LO-01 and LO-27
VITORIA[131]	Electronic Pass "Tarjeta Ciudadana"	Control and Monitoring Center	Web "Ponto Vitoria", social ne-tworks. Applications for smartphones in planning phase.	NO	Centro Municipal de Transportes, Tráfico e Infraestructura Urbana (SETRAN)	Induction loops to count vehicles on intersections 193 Synchronized intersections 1,611 Onda Verde traffic lights

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[132]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

The Federal Transport Department (Departamento Nacional de Infraestructura de Transportes (DNIT)) is performs permanent traffic counts based on the installation of 320 fixed traffic detectors. In addition, parameters are measured as total gross weight, weight peraxle, wheel base and instantaneo us speed of the vehicle.

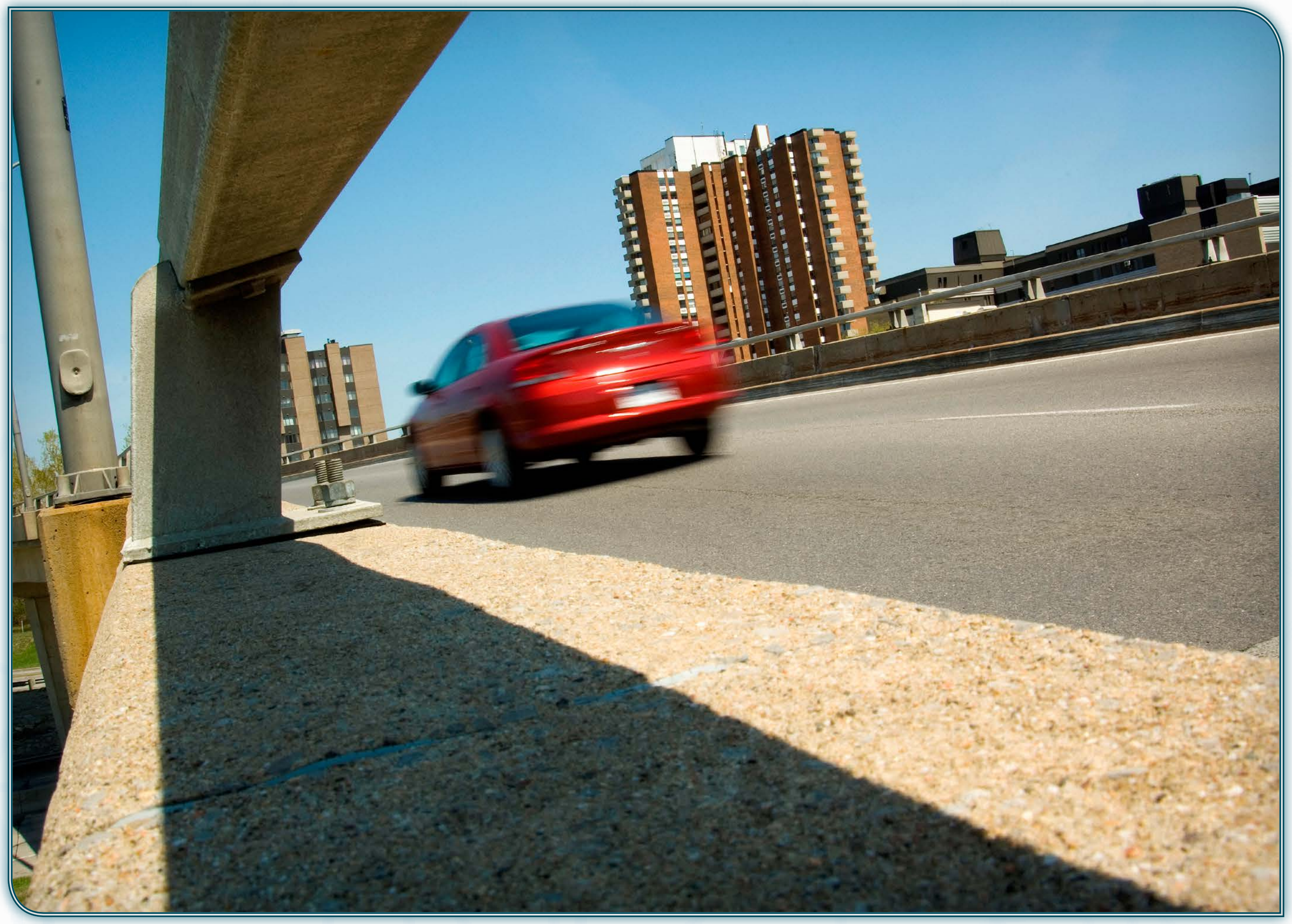
ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

The Federal Transport Department (Departamento Nacional de Infraestructura de Transportes (DNIT)) is implementing a National Plan for Road Speed Control launched in 2009 that foresees the installation of 2,696 speed control equipment that will allow the monitoring of 5,392 road stretches in the federal road network. The technological systems are basically fixed speed radars and surveillance device in red traffic lights. The DNIT has also implemented the system DNIT CIDAD'O, which provides electronic administration of fines.

The city of Sao Paolo implemented in 2010 the Telvent SmartMobilityTM Tunnel in the western section of new road, known as Mario Covas beltway, which allows for better management of traffic flows throughout the metropolitan region of Sao Paulo (RMSP).

ELECTRONIC TOLL COLLECTION

In the case of federal toll highways managed by Land Transport National Agency (Agência Nacional de Transportes Terrestres (ANTT)), nine out of fifteen have begun to operate electronic toll collection through DSCR. The Nova Dutra Highway (BR-116 / RJ / SP), Régis Bittencourt (BR-116 / SP / PR) and Fernão Dias (BR-381 / MG / SP) were the first to work with the new system. In October 2014 the



system initiated activity in the Rio-Niterói Bridge (BR-101 / RJ) and the Fluminense Highway (BR-101 / RJ), Eco101 (BR-101 / ES), ViaBahia (BR-116/324 / BA) and Concepa (BR -290 / 116 / RS). In the case of Ecosul (BR-116/392 / RS), the new system is currently under test.

There are several systems for electronic toll collection in place in the State of Sao Paulo, operated with DSRC (Dedicated Short Range Communication). They are being implemented by private companies (Conectcar, Dbtrans & SEM PARAR).

In 2009, the Brazilian Federal Agency for highways has regulated that all private roads use the National Transportation Communications for ITS Protocol (NTCIP) family of standards.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS[133]

Brazil has approved to implement plans for a nationwide automatic vehicle identification system based on the RFID ISO 18000 6C (6C) sticker tags, under the Portuguese language acronym SINIAV and the sponsorship of DENATRAN, the Transit National Department (Departamento Nacional de Trânsito) which installs electronic tags in vehicles in order to provide a tool for the police to quickly and efficiently identify vehicles which are involved in crimes, as well as stolen or unregistered vehicles. It is planned that all states within Brazil will roll out SINIAV within the next couple of years so that the entire vehicle population are tagged and that roadside infrastructure for automatic monitoring of vehicles is in place all over the country.

Brazilia: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system.

São Paulo: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system.

Río Janeiro: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system.

Curitiba: The construction of the Underground system will involve the implementation of ITS applications required for the correct operation of the public transport system.

Florianópolis: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system.

Goiânia: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system. (Audio system and TV on buses; displays on terminals; iCenter in integration terminals).

Palmas: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system.

Vitoria, Espirito Santo: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system (Electronic Information System for passengers and Electronic pass system).

COUNTRY: CHILE

SELECTED CITIES

Santiago, Valdivia

SOCIO-ECONOMIC INDICATORS[47]

Population	17,363,894 (July 2014 est.)
Income per capita	$19,100 (2013 est.)
% of public transport trips	Santiago 33.40 %; Valdivia 38.00%
No. of km of primary roads	Total: 77,764 km; 18,119 km paved (includes 2,387 km of expressways) (2010)
No. of cell phone users	24.13 million (2012)
No. of registered automobiles	4.168.980 (2013)

DESCRIPTION OF ITS APPLICATIONS MARKET[134]

The National Transport Policy was introduced in Chile in late 2013 and is intended to create the infrastructure and services necessary to provide the transport system for a comfortable base that enables an efficient growth.

The two main action lines of the National Transport Policy are as follows:

- To plan the structure.
- To ensure mobility.

There are three key objectives within the ensuring mobility line:

- All citizens have access to services through a high-quality public transport.
- Private transport users rely on a good number of roads, coverage and level of service for their trips.
- The design variables are based on international reference standards for quality of service and security.

The National Transport Policy is based on a total of 13 action lines and establishes a strong commitment for a massive incorporation of technologies applied to mobility, with special emphasis on transit management, information to users and security vehicles.

Concerning market size, a multimillion-dollar infrastructure plan was announced to modernize the whole country by mid-2014. This plan considers investments on connectivity infrastructures, water reservoirs and ports for about 18,800 million USD, and investments through concessions (mainly roads) for about 9,900 million USD.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[135]

Here are some relevant details concerning the National Transportation System:

- Transport sector delivers 7% of GDP (2011 data from Central Bank of Chile).
- Transport activities use 25% of the total energy consumed in Chile.
- Transportation is the largest CO2 emissions source in Chile (approximately 36% of the total emissions are due to energy consumption of the transport sector). Emissions could quadruple by 2020 if mitigation measures are not taken.
- Trucks are the main goods transportation mode, either domestic or transnational.

The national road network in Chile covers 77.764 km, of which 18.119 correspond to paved roads (2010). This network is supporting 61% of daily intercity movements and 84% of the country goods transportation needs.

Railways are owned by State Railway Company (Empresa de los Ferrocarriles del Estado – EFE), and the main intercity passenger services are managed by subsidiaries. Total railway network is 6,782 km long, supporting 27% of daily intercity journeys and 3% of the country goods transportation needs.

According to data from the Civil Aeronautic General Direction (Dirección General de Aeronáutica Civil – DGAC), Chile has 28 airports administered by the DGAC, 7 of them with international operations. In addition, there are 38 private airfields for public use, 198 private airfields, 6 military airfields and 53 aerodromes operated by other public institutions.

Due to the long and narrow geography of Chile, air transport is essential for fast, efficient and reliable connections in the country. Air transport in Chile represents 11% of daily journeys, being freight cargo insignificant.

Concerning maritime transport, all Chile regions have major marine terminals (only Santiago excepted), managed by the State and by private companies. Only 13% of domestic goods transportation is carried out by sea, however shipping supports around 90% of the foreign trade. Major ports include San Antonio and Valparaiso.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

Santiago

Source: flickr.com/photos/55953988@N00

Valdivia

Source: commons.wikimedia.org/wiki/User:Soulreaper

SANTIAGO[136]

BRT	No BRT, but Santiago has 105 km of segregated lanes and 31 km of exclusive bus lanes
Underground	108 subway stations with 5 lines covering 104 km in total
Urban Buses	7 different private companies that provide services to all areas of Santiago. The network has 2,766 km with over 374 routes and 11,165 stops in total
Other	---

VALDIVIA[137]

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	27 lines of Taxibuses operated by 6 different companies
Other	---

CHILE

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
SANTIAGO[138]	Contactless card in TRANSANTIAGO (bus and metro)	AVLC in TRANSANTIAGO	13 variable message signs. Information of incidents and traffic conditions through the UOCT website and twitter	BIKESANTIAGO Project started in 2013 Expected duration: 4 years. Estimated total investment: 15 million USD Operation 100% automated: online registration; B-card associate to bank account GPS monitoring 58 stations and 192 km of bicycle lanes	2.165 traffic light controllers centralized and managed through SCOOT system. A small percentage automatically managed with adaptive algorithms. 1.945 electromagnetic loops. 139 TV cameras.	Systems for automatic detection of vehicles on dedicated lanes for buses
VALDIVIA[124]	NO	NO	NO	23 km will be built by 2020	There is no traffic control center. The traffic lights respond to a time program	NO

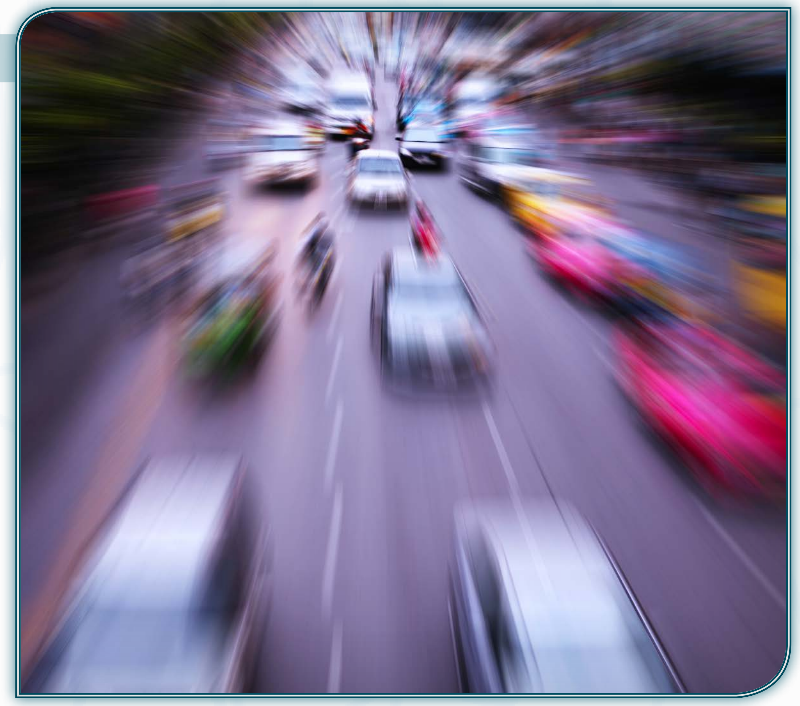
DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ITS Interurban traffic management is a reality in Chile, as highways concessions must deploy a control and management center for traffic management, communications, visual support and toll collection purposes, according to the contracts signed.

Highways like Antofagasta, Rute 5 Sur (Rio Bueno–Puerto Montt), Ruta 5 Norte (La Serena–Los Vilos), Ruta 68, southern access to Valdivia and southern to Santiago have implemented ITS technologies, such as CCTV, SOS posts (emergency roadside phones), variable message signs and others, which provide high levels of service and safety.

The main institutions behind these developments are the Public Transport Ministry (Ministerio de Transporte Público (MOP)), the Subsecretary of Transport (Subsecretaria de Transporte) and the Subsecretary of Telecommunications (Subsecretaria de Telecomunciaciones (MTT)).



CHILE

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)[138]

Speed control in the intercity area is in charge of the transit agents(Carabineros) of the Ministry of Interior (Ministerio del Interior).

Currently there are in operation 23 tunnels with a total length of 22.091 meters (the shortest tunnel is "Recto", with 142 meters, and the longest is "Las Raices", with 4.528 meters). Tunnels ITS equipment is diverse, all long tunnels have centralized control systems, ventilation, CCTV and environmental quality sensors. The tunnels of great length near Santiago also have variable signalling systems and automatic incident detection systems.

ELECTRONIC TOLL COLLECTION[140]

Other ITS large implementations began in Chile in 2006, as the urban highways deployment in the city of Santiago. Given the standards of service and safety required, and the presence of urban tunnels, the highways incorporate their own control centers and operation support systems.

Another important feature of these highways operation is the "Free Flow" Electronic Toll Collection deployment, the first experience of this kind in the country and in the region; there were relevant technological, legal and organizational challenges. An interoperable means of payment was deployed (transponder or "TAG") and is now in use in all highways, and each of them make their own billing and have its own customer care center. In the last year the use of TAGS was extended to parkings and tolls in a traditional "Stop&Go" mode. These devices are also used in goods vehicles traffic management in the Extension Zoneand Logistical Support (Zona de Extensión y Apoyo Logístico - ZEAL) of the Port of Valparaiso.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

This technology is not available in the country.

FUTURE DEVELOPMENTS[141]

As said in the National Transport Policy "intensive use of technology will be promoted on traffic management; information to users; programming services; vehicle safety; services indicators control, monitoring and measuring speeds. Additionally new possibilities of communication with users will be deployed".

Information to users will be processed from automatic data collection and will include at least alternative and more convenient routes, travel times and availability of public transport and waiting times.

ITS technology will also be used to process information and to produce value-added information to the users of different types: users travel data, industry data, other stakeholder's data, researchers and academics.

The information will be available to external entities that can generate cost-effective products and services (open access data).

COUNTRY: COLOMBIA

SELECTED CITIES

Bogotá, Medellin, Cali, Barranquilla, Bucaramanga, Cartagena, Pereira

SOCIO-ECONOMIC INDICATORS [47/142]

Population	46,245,297 (July 2014 est.)
Income per capita	$11,100 (2013 est.)
% of public transport trips	Bogotá: 69%; Medellin: 51%; Cali: 40%; Bucaramanga: 48%; Pereira: 46%; Barranquilla: 50%
No. of km of primary roads	Total: 142,000 km (2012); 27,000 km paved (2012)
No. of cell phone users	49.066 million (2012)
No. of registered automobiles	9,796,000 (2013)[143]

DESCRIPTION OF ITS APPLICATIONS MARKET[144]

In Colombia, the National Planning Department (Departamento Nacional de Planeación (DNP)) leads an initiative that aims to boost the transport sector by implementing technology. As a result of this effort, Colombia has developed the first version of the National ITS Architecture.

The National Planning Department (Departamento Nacional de Planeación (DNP)) of Colombia has made a clear commitment to the development of ITS applications in the country. This included the need to define organizational structures and policies as a base to establish the development and deployment of ITS in Colombia.

In order to determine the strategies to be carried out to develop Intelligent Transport Systems in Colombia, the DNP defined an implementation program for ITS Architecture and the Master Action Plan.

Likewise, the National Development Plan 2010-2014, outlines the importance of ITS as a solution to improve the operation, management, and transport

security under the direction and coordination of the Ministry of Transport to develop public policies on ITS. This plan considers the ITS program of Colombia, which provides a set of actions that will achieve a harmonious and integrated development of intelligent transportation systems nationwide. It also considers essential the creation of a coordinating entity for ITS Colombia and the development of a regulatory framework, as the first implementation phase of the program.

The Ministry of Transport (Ministerio de Transportes) issued in 2013 a decree establishing the standard technology to be used by concessionaires, based on the American system. The second step was taken when the contracts between the government and the concessionaires introduced clauses that require that all 4G motorways must be equipped with at least one toll booth enabled with electronic cards systems.

The ITS architecture in Colombia intends to integrate all transport modes and pretends to create a public body to lead and coordinate the ITS Development Program in the country and / or adopt standards and protocols, laws, rules and regulations to support the ITS legal framework, prepare institutional arrangements / agreements and identifying financing sources: public funding, private funding and performance indicators. The ITS Master Plan is initially structured in three phases:

Phase I: This phase includes the institutional dimension, ITS legal and regulatory aspects.

Phase II: This phase involves the definition of the technical framework, the adoption of standards and protocols.

Phase III: This phase intends to describe the ITS components at a detailed level.

Among the most experienced cities in the implementation of ITS systems are Bogota, Barranquilla, Cali, Bucaramanga and Pereira, which have made use of ICTs to improve the delivery of their public transportation systems, which is reflected in various benefits for the users.

Despite the progress that Colombia has shown upgrading its transport infrastructure in recent years, there are still potential and clear opportunities to improve the sector in terms of investment and regulation, to thereby achieve an integrated transport sector. The upcoming projects to implement electronic toll solutions, new traffic control centers, new metro and tramway lines and bicycle sharing systems will indeed require ITS applications.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[145]

In Colombia the main transport authority is the Ministry of Transport, in charge of the adoption of policies and plans. Apart from the Ministry of Transport, other entities have competencies within the sector, such as SUPERTRANSPORTE, AEROCIVIL, INVIAS and ANI.

The Government of Colombia has launched an ambitious expansion and improvement program of the transport infrastructure quality, based mainly in the private sector through a concession scheme. This development program has extended to all modes of transport and administrative levels (Central Government, Departmental, and Municipal) and has led to significant improvements in public passenger transport and road infrastructures.

The Colombian Road Network has 141,374 km, of which 14% is paved. Out of these, 16,776 are part of the primary network, of which 13,296 are competence of INVÍAS, and 3,380 km are under concession models (National Institute of Concessions – INCO); 147,500 km are secondary and tertiary roads distributed as follows: 72,761 Km (competence of the Regional administrations), 34,918 km are competence of the municipalities; and has also 27,577 km of national roads and 12,251 km of privately operated roads. Meanwhile, Colombia had 1,049 km of motorways in the year 2012.

Within the public transport subsector, the current investments have resulted in developing new Bus Rapid Transport (BRT) in Bucaramanga, Cartagena, Cali, Pereira, etc and also the expansion of the Transmilenio System™ in Bogota.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

COLOMBIA

BOGOTA[146]

Transitway Modes:

BRT	SITP: TRANSMILENIO: new routes scheme: trunk, urban, feeder, complementary, special Operation divided into 13 zones and a neutral one. 24 year concession 24 trunk lines and 21 feeder lines; 11 corridors; 131 stations; 115km of trunk lines operating; 565,100,000 (2013) annual trips
Underground	METRO: In planning phase, expected for the year 2019.
Urban Buses	SITP: Zonal system. Routes: 199 urban lines, 20 complementary lines y 14 special lines, 13 zones; 9 operators; 809 stations; approximately 50,000,000 annual trips (2013). Bogotá has over 498r outes of collective ("colectivo") urban public transport (bus, mini-bus, bus or minibus)
Other	Urban railway Taxis: 48.000 registered taxis

MEDELLÍN[147]

BRT	METROPLÚS: 2 corridors; 29 stations (22 Stations + 7 additional stops); 18 km; 18,000,000 annual trips
Underground	METRO: 2 lines; 27 stations; 28,8Km
Urban Buses	BUS, BUSETA and MICROBUS
Other	METROCABLE: 3 lines; 9,3 Km; 8 stations TRAMWAY:**Tranvía de Ayacucho** under construction

Source: commons.wikimedia.org/wiki/User:EEIM

CALI[148]

BRT	METROCALI, MIO (Masivo Integrado de Occidente): 6 corridors; 56 stations; 39 km of trunk corridors; 243 km of pre-trunk and complimentary lanes; 936 vehicles operating; 159,000,000 (2013) annual trips
Underground	There is no metro service in Cali
Urban Buses	NON-MIO traditional buses
Other	MIO Cable: under construction (opening April 2015)

BARRANQUILLA[149]

BRT	TRANSMETRO: 3 trunk routes, 19 feeder routes, 3 express routes; 15 Stations (566 stops in feeder routes); 14 km of trunk routes, 190 Km of feeder routes; 36,300 annual trips
Underground	There is no metro service in Barranquilla
Urban Buses	83 routes; 2,945 vehicles(2,913 buses, 340 busetas and 901 microbuses (2004))
Other	---

BUCARAMANGA[150]

BRT	METROLINEA: 1 corridor; 40 lines; 17 stations; 9 km; 237 vehicles; 21,600,000 annual trips
Underground	There is no underground system
Urban Buses	---
Other	---

Source: flickr.com/photos/27441534@N00

CARTAGENA[151]

BRT	TRANSCARIBE: under construction (opening 2015); 2 trunk corridors, 9 pre-trunk lines,21feeder lines; 13.4 km, 49 routes; 18 stations, 1 terminal, 237 vehicles; 334,000 trips daily
Underground	There is no underground system
Urban Buses	39 bus lines (14 have been abandoned), 1,936 public transport vehicles
Other	1.174 buses, 739 busetas and 73 microbuses (2004)

PEREIRA[152]

Transitway Modes:

BRT	MEGABUS: 3 Corridors; 35 lines, 40 stations, 147 vehicles; 31 kms, 37 stops; 31,500,000 annual trips
Underground	There is no underground system
Urban Buses	Buseta: 75 Routes
Other	---

COLOMBIA

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
BOGOTÁ[153]	TULLAVE Contactless Smart Card in Transmilenio buses only, CATI System to recharge cards	AVLC (modules ETRA Interandina) through TETRA Digital Platform in BRT only in more than 1.300 buses Goal Bus System Control Center, GPS CIBOR onboard that produces operation information of each vehicle ,TETRA communication system, to communicate with the control center 300 CCTV cameras (269 fixed and 31 mobile), connected to the control center 226 CCTV cameras operated and constantly monitored by Automatic Dispatch Center (CAD) of the Police	Variable Message Signals (VMS), Radio / TV, RDS / TMC, Phone Support, Website Travel Time information or automatic service level, information on parking occupancy, and incidents. TV and radio means use the information of the traffic control center	Pedalea por Bogotá 382 bicycles 3 stations 1 corridor + 3 corridors to be implemented soon 750 bikes shared daily Real-time follow up of the system operation (GPS) 9 bicycle parkings with 2.187 places	Traffic Control Center operated by Transmilenio SA CCTV with 300 cameras (368 fixed and 32 rotating), 24 stations Traffic Control Center: 3 Traffic Lights control centers, Dynamic Speed Control, Incident Management, Coordination of Special Traffic Plans Traffic information in real time, information on restrictions or road closures, incidents, road safety tips Analysis of camera images, and GPS info	Certain positions of the control center are occupied by police agents, who share the coordination with other operators by telephone Speed control cameras, red light crossing (photo-red) camera control to detect illegal left turn
MEDELLÍN[154]	Contactless Smart Card in BRT CIVICA Intelligent Card in METRO (1,8 million cards issued by 2013)	AVLC in 240 vehicles Public Transportation Control and GPS devices in 4.300 buses CCTV in Metro in 10 vehicles and 336 cameras installed in 46 vehicles	22 Variable Messages Signals (VMS) with weather risks, incidents and road safety tips Telephone assistance. Web information about traffic restrictions, road safety tips, speed control location points, cameras visualization. Social networks information: Twitter Facebook, Flicker & YouTube	EnCicla Initial investment: 1.100 million Pesos /600,000USD 13 stations + 32 new stations planned for 2015 145 bicycles, of which 115 are urban bikes and 40 rural bikes	Traffic Management Center: CCTV with 80 cameras (software DAI) managed in real time Dynamic Message Signs (DMS) in 22 locations Traffic video detectors: 300 devices in main intersections ARS installed in 9 traffic lighted intersections Own transit agents Operate 615 traffic lighted intersections: 70% connected to the Light Control Center	40 Traffic enforcement cameras in 70 rotating locations

COLOMBIA

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
CALI [155]	Contactless Smart Card in BRT (MIFARE)	AVLC called SIUR: GPS, Management and Operation Control System, Fleet Management	Sistema de Información Unificado de Respuesta/ Unified Response Information System (SIUR): Real time and web passenger information system in the bus stops and onboard the buses (IVU.realtime & IVU journey) High resolution video cameras	NO	Transit control center: 32 people monitoring and operation of electronic photo detection traffic violations, registration and control of electronic subpoenas, produced by officers with 200 devices, as well as monitoring and control of the electronic reporting of traffic accidents broadcasted in real time by 30 devices	46 fixed cameras and 6 mobile cameras
BARRANQUILLA [156]	Contactless Smart Card in BRT MIFARE 13.56 MHZ, ISO 14443A Unique fare 115,000 cards in use, 191,000 personalized cards 1,007,000 total sold cards	AVLC in 1,000 vehicles in urban buses approximately. AVLC in 284 (180 operating) vehicles in BRT approximately GPS controlled buses. Real-time vehicle monitoring.Vehicle/driver services monitoring Driver support functions Passenger counts Investment: >2.500 USD per vehicle	Real time information system Integration of messaging systems based on electronic reporting installed in stations and bus terminals Centralized management software in the control center	NO	Local Traffic Control Center Construseñales S.A. Functions: traffic light control, electronic detection of violations, dynamic traffic light control system, telephone coordination with the transit police. Bus Stations controlled through cameras connected to the Automatic Center of the National Police Station (CAD) 286 intersections (including 6 intersections with preventive lights) controlled by 184 local control devices, from which 31 devices are locally managed and are not connected to the transit center (these are isolated intersections outside the lighted corridors)	Electronic speed cameras Surveillance device in red traffic light cameras.

COLOMBIA

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
BUCARAMANGA [157]	TISA Contactless Smart Card (16.000 cards sold)	Variable Message Signals (VMS) onboard the bus Control Center GPS	Variable Message Signals (VMS): Panels to provide information to the user: schedules and frequencies, sales points, benefits of Metrolinea and general recommendations	NO	Traffic Control Center: Traffic lights in crowded places of the city	1 Speed camera installed (a total of 10 cameras, 3 mobile and 7 fixed ones) will be installed within the next 15 years 2 speed radars
CARTAGENA	Contactless Smart Card	AVLC in BRT, Real-time Fleet Management System Control system for public transportation Buses Investment: 370 million USD	Passenger information system, and fare card vending machines, with access locations spread throughout the territory	NO	Traffic Control Center: Departamento Administrativo de Tránsito y Transporte (DATT) Real time monitored traffic lighted intersections Dynamic traffic light system	18 traffic lighted intersections 100 intersections monitored with video cameras
PEREIRA [158]	Contactless Smart Card: MEGATARJETA Mifare cards and Calypso. Issued more than 1 million cards Not interoperable with other systems	AVLC in BRT Real-time vehicle monitoring Driver/vehicle services Driver support functions: emergencies bottom, audio communication. Investment: less than 2,500 USD per vehicle	Variable Messages Signals (VMS)	NO	Traffic Control Center (Instituto Municipal de Tránsito de Pereira): 138 traffic lighted intersections, whichare regulated by 72 traffic controllers. There are 442 traffic lights, 603 vehiclelights and 119 pedestrian signals. Traffic control wireless data network	

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)[159]

The interurban traffic control center is in planning process not yet implemented. The functions will be:

Traffic monitoring, incidents management, coordination of Special Traffic Plans, driver assistance through emergency telephones (S.O.S. Posts). User information through telephone support (Information about traffic conditions, road assistance, notification of incidents, complaints and claims) and information via Website (Traffic information in real time, camera images display, informati on ontraffic restrictions or incidents, road safetytips, location of speed checkpoints, historical records of traffic data) and social networks, such as Facebook.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)[160]

Colombia counts with a road safety policy plan: Road Safety Plan 2011-2016. The country has installed photo identification cameras. The Traffic Control Center (Centro de Control de Tráfico) plans to implement ITS technologies applied to road safety in the next five years: Intelligent Traffic and Transportation Control Center (Centro Inteligente de Control de Tránsito y Transporte) Center improved devicesto monitor trafficat critical points, electronic tolls to reduce waiting times, variable message signs in concessions.

In May 2014, Coviandes started the implementation of monitoring and con-trolling facilities of the Colombian road network, including an intelligent traffic and communications control system for 45 Km of the new highway from Bogota to Villavicencio in Colombia. The government is creating an advanced control center, equipped with the most advanced solutions to control 18 tunnels, 41 bridges and 3 viaducts.

The HORUS solution will integrate various intelligent traffic systems (ITS) that will be installed in the highways, such as closed circuit television (CCTV), traffic counters, traffic signaling, communications, emergency call boxes, fire detection, control lighting and sound system.

A video surveillance system with automatic accident detection and measuring equipment for air quality, fire detection and weather stations, using different alarms will alert in case of emergency.

The solution implemented also includes speed measurement, variable message signs systems which inform drivers about the real-time road conditions, speed limits and incidents. Tunnels will also have visibility sensors, a system of artificial lighting, emergency and evacuation, as well as power generators and backup power plants to meet any contingency.

ELECTRONIC TOLL COLLECTION[161]

The Colombian Decree 2846, dated 2013 – Establishes the requirement to implement electronic toll solutions from the date of publication, adhering to the ISO 18000 standard.

There are two national roads where advanced toll systems have been implemented:

- National Road Network competence of the National Roads Institute (Instituto Nacional de Vias(INVIAS)).
- National Road Network (under concession models) competence of the National Infrastructures Agency (Agencia Nacional de Infraestructura (ANI)).

There are 240 Km of tolled roads in the country. From these, 102 Kms are operated by private concessionaires. At national level, some infrastructures are using electronic toll systems (Active TAGs (CEN 5.8), Passive TAGs (ISO 18006)) with channeled payment booth toll plazas. Approximately 140,000 TAGS issued. The systems are not interoperable among them. All the new tolled infrastructures must use technology ISO 180006.

In Colombia; Coviandes has implemented Horus in the tunnel "Argelino Durán Quintero", 2.4 km long, linking Bogotá to Villavicencio, and has designed systems in another 19 planned new routes for the new Bogota-Villavicencio tunnels.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)[162]

Future investments are planned for the next 5 years to simplify more efficient processes to carry out automatic vehicle identification through online platforms in real time.

FUTURE DEVELOPMENTS[163]

In Colombia, the following toll infrastructure sections are planned for development within the next 5 years: San Jose del Fragua – Florencia, Ocaña – Alto El Pozo, Alto El Pozo – Sardinata - Cúcuta, Pradera – Florida – Palmira, Manizales – Fresno, San Gil – Barichara, Florencia – San Jose de Fragua – Pto. Bello Ruta 65, Duitama La Palmera Málaga, La Uribe – Granada, Barbosa – Vélez – Landázuri, Tumaco Junín Tuquerres Pedregal, Puerto Boyacá –Otanche –Chiquinquira, Málaga – Presidente – Pamplona, San Roque – La Jagua – La Paz, Pitalito – Mocoa, Tame – Arauca, Granada – San José del Guaviare, Florencia – Puerto Rico, Mocoa – Villa Garzón – Santana – San Miguel, Valledupar – La Paz.

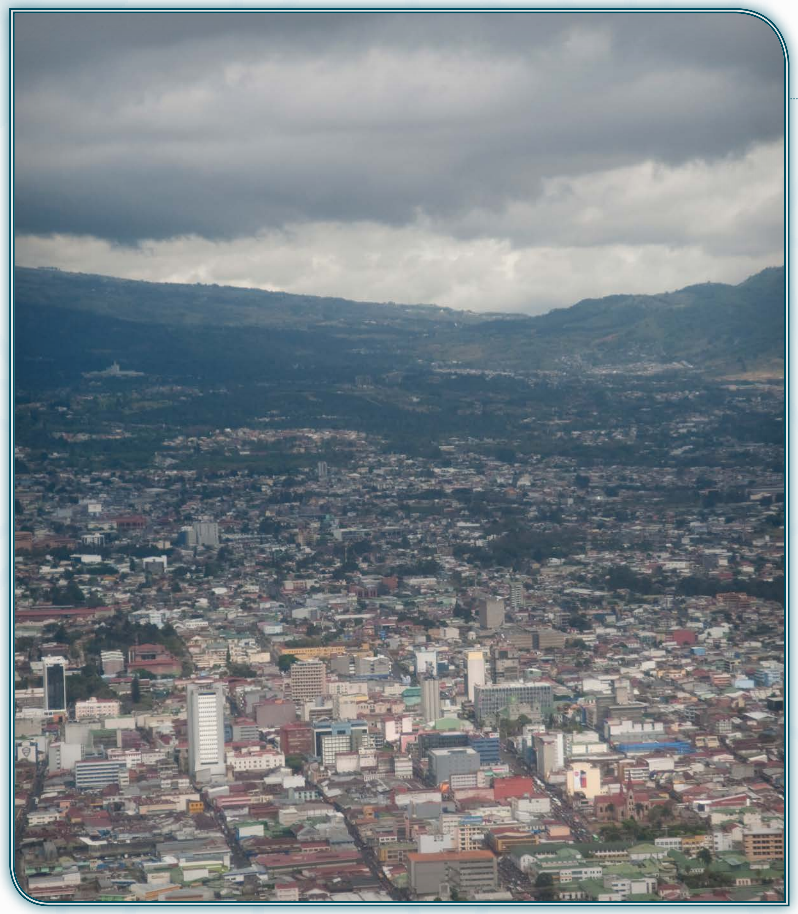
The municipality of Bogotá is performing the design of the 1st metro line of the city. The line will be 26.5 km long, with 18 intermodal stations and 40 trains. The Transit Fare Collection system will be extended in the next 5 years to integrate it with the public transport system.

Future investments are planned for the next 5 years to simplify more efficient processes to carry out automatic vehicle identification during border crossing through online platforms in real time.

The Traffic Control Center plans to implement ITS technologies applied to road safety in the next five years: Intelligent Traffic and Transportation Control Center, improved devices to monitor traffic at critical points, electronic tolls to reduce waiting times, variable message signs in concessions.

Pereira's Traffic Control Center is planning to implement the speed monitoring photo system in 2015, investing in technology such as mobile application systems.

In 2019, according to the Decree issued by the Ministry of Transport at the beginning of 2014, the technology to be used at toll plazas would be the American system, based on electronic cards. This technology will be used in the Four Generation Motorways (4G) where at least one of the cabins will be equipped with e-toll systems.



COUNTRY: COSTA RICA

SELECTED CITIES

San José

SOCIO-ECONOMIC INDICATORS[47]

Population	4,755,234 (July 2014 est.)
Income per capita	$12,900 (2013 est.)
% of public transport trips	San José 75%
No. of km of primary roads	Total: 7,770 km; 5,082 km paved
No. of cell phone users	6.151 million (2012)
No. of registered automobiles	923,591 (2012)

DESCRIPTION OF ITS APPLICATIONS MARKET[164]

The Public Transport Council (Consejo de Transporte Público), the Costa Rican public transport authority is specially engaged in the promotion and modernization of the countries' public transport system by introducing ITS technologies in the transport sector and integrating the fares system and operation of services. One of the main priorities of the Councils' strategic axis is the implementation of electronic payment methods first in the San José Metropolitan Area, and afterwards to extend it to the entire country.

The entity is also aiming at introducing ITS solutions in urban and interurban roads, as well as railway and ships. The Council also established in the Article VI of the Concession Agreement 2007-2014 which refers to the Operator's Specific Obligations arising of the Modernization of Public Transport, among the duties, obligations and commitments that the operators must observe during the term of the agreement are to accept the fare and operation integration of the services through the use of electronic cards, the implementation of the appropriate technologies to facilitate the integration of information, fleet management, etc.

According to the Progress Report of the electronic payment system project in the public transport sector of Costa Rica, the Ministry of Public Works and Transport (Ministerio de Obras Públicas y Transportes (MOPT), the Regulatory Authority for Public Services (Autoridad Reguladora de los Servicios Públicos (ARESEP)) and the Central Bank of Costa Rica (Banco Central de Costa Rica (BCCR)) is planning to implement an electronic payment system on buses circulating in the capital. The government is also planning the implementation of electronic toll systems in various road infrastructures within the next 5 years. These projects represent important ITS market opportunities for the near future[165].

COSTA RICA

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[166]

Costa Rica has a total of 7,770 km of roads, from which 5,082 km are paved and 2,688 km are unpaved. There are only 278 km of railway lines in the country.

The Public Transport Council (Consejo de Transporte Público), is the institution created to take over functions that had traditionally been developed by the Ministry of Public Works (MOPT) and Transport, through the Department of Public Transportation. One of the objectives of the Public Transport Council (PTC) is to promote the modernization of the public transport sector by including a clause in the concession contracts that requests operators to implement a pre-payment system (smart cards).

During the concessions renewal process of 2007, following the Executive Decrete 28813 the MOPT considered important the operation and fare integration of the San José Metropolitan area, aiming at improving the system and extending the development of the rest of the country.

Public transport in Costa Rica consists almost exclusively of bus travel. The bus system is government-subsidized.

There are a total of 47 airports with paved runways and two major seaports in the Atlantic Ocean (Caribbean) Puerto Limon Seaport, and in the Pacific Ocean, Caldera Seaport.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

SAN JOSÉ[167]

Transitway Modes:

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	Public Direct buses and Collective Buses. Fleet composed of 4,000 buses
Other	Tramway system in planning phase

COSTA RICA

	ITS APPLICATIONS					
CITIES	TRANSIT FARE wCOLLECTION	AVLC	TRAVELER INFOR-MATION SYSTEMS	SHARED BICYCLES	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
San José[168]	NO	NO	NO	NO	Transit Control Center, Departmentof Traffic Lights Au-tomatic Traffic Light System 8 Variable Message Signs (VMS) 410 interconnected traffic lights 180 traffic lights with video cameras and virtual transit detectors to count vehicles in 5 measurement stations	10 video cameras in main streets of San José and 4 monitoring systems in the main entrances of the city 22 vehicle counting systems 28 laser devices with camera incorporated to control the road speed (Transit Police)

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)[169]

One of the objectives of the transit police of Costa Rica is to introduce new technologies to improve road safety. Along the year 2014 the existing centralized traffic light system of the city has been extended to the metropolitan area, to the Alajuela, Heredia y Cartago roads, and 50 intersections in the central areas of these provinces were also to be implemented.

There are 96 radial intersections connected to the network, and 4 Variable Message Signals (VMS) located in the radial accesses to the city of San José.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)[170]

The Road Safety Council (Consejo de Seguridad Vial (COSEVI)) is the entity in charge of the formulation, organization and control of road safety related projects in Costa Rica.

The General Directorate of Traffic Engineering (Dirección General de Ingeniería de Tráfico (DGIT)) deals with the study and analysis of proposals and traffic problems, and the formulation of traffic policies. Another function is the development of standards, specifications and procedures to solve traffic and road safety problems.

The COSEVI developed a "Strategic Plan for Information Technology" for the period 2005 and 2010. However the plan referred only to development goals for 2005 and 2006, and it was not linked with the "National Road Safety Plan 2007-2011".

For the area of Traffic Control and Surveillance, the Plan specified actions such as "Introducing new technology to strengthen monitoring and control within the transit system", for example: red crossing automatic control systems, radar and digital cameras.

According to General Controller of the Republic (Contraloria General de la República (CGR)), in April 2010, of the 910 traffic officers on duty, 54% (498 officers) uses the Handheld device for processing information on accidents and casualties on the roads.

In 2008, Costa Rica invested around 4.6 Millon USD to implement a Centralized Traffic Control System for the city of San Jose. The purpose of this system was to integrate new technology infrastructure systems and transport vehicles in order to reduce congestion and improve safety and road productivity. The intersections that were included in the Centralized Traffic System have modern traffic light systems connected to traffic control devices.

According to the information available there are 6 video cameras within the business area of the city of San Jose.

ELECTRONIC TOLL COLLECTION [171]

There are 240 Km of tolled roads in the country. From these, 102 Km are operated by private concessionaires. At national level, some infrastructures are using electronic toll systems (Active TAGs (CEN 5.8)) with 105 channeled payment booth toll plazas. Approximately 140,000 TAGS issued. The approximate unitary cost of an electronic toll channel lane was 50,001 a 75,000 USD. The systems are interoperable among them. The money raised from EFC must be accredited in state banks.

Below are some examples of advanced electronic toll systems implemented in Costa Rica:

- Toll station Zurqui, national route # 32
- Toll station Tres Ríos, national route # 2
- Autopistas del Sol, national route #27

For example, Autopista del Sol San José-Caldera (Route 27, operated by Globalvia), links the capital of Costa Rica, San José, with the country's main port, Caldera.Operation Control Center was implemented to supervise the variable signal panels (8 electronic panels distributed throughout the road), monitors CCTV, controls capacity of the roads and follows up on other intelligent systems 24 hours a day.

The equipment installed in their 85 toll lanes allow payment by cash, card and using an electronic system that avoids having to stop.

In addition, the control center uses the radio IQ, 93.9 FM frequency, to inform about incidents, accidents, detours, alternate routes and any other situation that arises in the path and the user needs to know. They also use Social Networks such as Twitter (autopdelsol).

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

This technology is not available in the country.

FUTURE DEVELOPMENTS[173]

In January 2014 the Ministry of Public Works and Transport (Ministerio de Obras Públicas y Transporte (MOPT)), the Regulatory Authority for Public Services (Autoridad Reguladora de los Servicios Publicos (ARESEP)) and the Central Bank of Costa Rica (Banco Central de Costa Rica (BCCR)) have announced that they will implement an electronic payment system on buses circulating in the capital. An agreement has been signed for the implementation of the project in three phases.

The project is part of the National Transport Plan 2011-2035, which considers electronic payment is essential for the integration of public transport services and will provide better facilities to users and operators.

According to the planned strategy for the implementation of the electronic payment system, the electronic system will start in 2016 in the intersectorial urban lines and in the following years it will be extended gradually to the San Jose city center. The project will conclude in 2019 with a national coverage within the intermodal scheme (buses and train).

IDB is carrying out a project called "Modernization of the land cross-border areas of Costa Rica· ("Modernización de los Pasos de Frontera Terrestres de Costa Rica" (CR-L1066)) to modernize cross-border points in the country. The objective is to provide the borders with the infrastructure and equipment to respond effectively to the procedures proposal for passengers and freight control.

Costa Rica is also planning the implementation of electronic toll systems in various road infrastructures within the next 5 years:

- Costanera Sur, national route #34
- Alajuela y Naranjo, national route #1
- Cañas-Liberia, national route #1

The implementation of a radar vehicle counting systems is in process. This system will communicate the control center with the counting stations, which will provide volume, speed and vehicle classification information. 22 stations are located in different places throughout the country in the main routes.

COUNTRY: DOMINICAN REPUBLIC

SELECTED CITIES

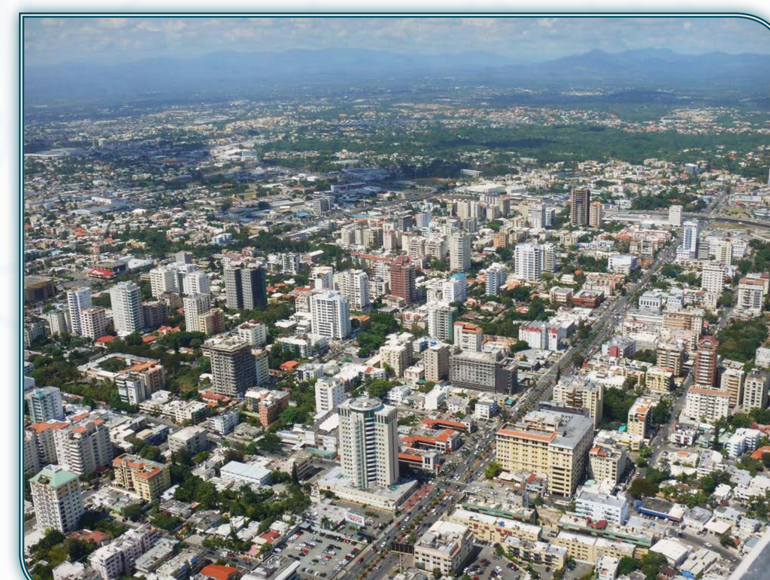
Santo Domingo, Santiago de los Caballeros

SOCIO-ECONOMIC INDICATORS[47]

Population	10,349,741 (2014)
Income per capita	$9,700 (2013)
% of public transport trips	N/A
No. of km of primary roads	Total:19,705 km; 9,872 km paved [280]
No. of cell phone users	9.200 million (2013)
No. of registered automobiles	3,215,773 (2013)[176]

DESCRIPTION OF ITS APPLICATIONS MARKET

The Ministry of Economy, Planning and Development of the Dominican Republic (Ministerio de Economia, Planificación y Desarrollo) designed in 2010 the National Strategy of Development for the period 2010-2030 in order to set the development objectives of the country for the 20 year period. This strategic document already recognized the need to expand the coverage and improve the quality and competitiveness of infrastructures and transport and logistics services, orienting them to the integration of the territory, to the support of production development and competitive insertion in international markets, as well as achieving universal access and productive use of technology information and communication technologies (ICT). This goal encouraged the use of Information and Communication Technologies as a competitive tool in the management and operations of the public and private sectors.



Although there is not a concrete mention to the ITS application systems in the transport sector, the policy document pin-points the need to establish a legal and institutional framework that defines competencies for the design and implementation of the

transport system policies and regulations, as well as to ensure its effective enforcement; and develop an efficient and financially sustainable system to maintain transport infrastructure and logistics, including adequate signaling. This should serve as the basis for development of this type of IT technologies to be applied to the transport sector.

The Metropolitan Bus Service Office (Oficina Metropolitana de Servicios de Autobuses (OMSA)) is the government entity that offers public transportation in Santo Domingo and Santiago. They have begun a process to acquire ITS applications for controlling their vehicular units (GPS) and the fare collection (Smart Cards)[177].

As a result, it is observed that the country offers potential investment opportunities in the areas of urban transport, urban and interurban traffic, basically linked to the planned extension of the metro system and the potential BRT system.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[178]

In Dominican Republic almost all transport is carried out by road. There is not a railway network. The road network has 19,705 km.

The country has a transport system based on road and metro systems. The metro service has two lines and one more is in planning stage. It is the largest metropolitan rail system in Central America and the Caribbean[252].

The bus urban passenger transport is carried out by buses and by public cars called "concho" cars or public cars circulating on specific routes that pick up and drop off passengers. Intercity transport is done through buses or by plane.The urban transportation is also performed by "motoconcho" or "moto taxi", which is offered by motorcycles in all sectors of the evaluated locations.

There are eight international airports spread throughout the Dominican Republic, in Santo Domingo, Punta Cana, Puerto Plata, La Romana, Samaná, Santiago y Barahona, and four smaller domestic airports.

The Dominican Republic, due to its geographical location in the center of the Caribbean, has a privileged location for the development of an optimal port system. It is estimated that approximately 96% of the international and local trade is done by sea through twelve sea ports, located in Santo Domingo, Azua, La Romana, Barahona, Montecristi, Samaná, Puerto Plata, San Pedro de Macorís and Pedernales[179].

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

DOMINICAN REPUBLIC

SANTO DOMINGO[180]

Transitway Modes:

BRT	SITRAM; in planning phase; 6 corridors; 38 feeder lines; 67.5 km; 54 stations; 1,127 articulated buses; 1,000 normal buses
Underground	Metro de Santo Domingo; 2 line s and 1 more line in planning stage; Line 1 (North-South corridor) is 14,5 km long, has 16 stations; Line 2 (Corridor West-East) has a 34 km length, 34 stations, and is divided into two sections (Line 2-A and Line 2-B)
Urban Buses	234 lines; 19,386 vehicles. OMSA (6 corridors; 168 buses)
Other	Motoconcho (2011): 3,692 motorcycles, 691 breakpoint

SANTIAGO DE LOS CABALLEROS[181]

Transitway Modes:

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	3 corridors; 235 stops; 42 lines, 28 interurban lines y 14 sub-urban lines;6,827 vehicles (2014)
Other	Tramway in planning phase is planned to have 1 line; 12 stations; 6 trains. Moto concho (2011): 144 breakpoints, 1,734 motorcycles

ITS APPLICATIONS						
CITIES	TRANSIT FARE CO-LLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
SANTO DOMINGO[182]	Contactless Smart Card in Metro Santo Domingo	---	Web, social networks (Twitter, Facebook, Youtube) OPRET	NO	Traffic Light Control Center	180 devices for tra-ffic control
SANTIAGO DE LOS CABALLEROS[183]	---	---	---	NO	---	---

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[184]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

The interurban transportation and freight enterprises use GPS to control their units individually and privately.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

These systems are not use in the country's roads.

ELECTRONIC TOLL COLLECTION[185]

E-toll system called "Paso Rápido" implemented in some motorways. The most modern toll stations are Autopista Duarte, Autopista November 6 and Carretera Sanchez which are managed by the Reserves Bank (Banco de Reservas) and have available six lanes with "Paso Rápido" while at the Toll Station Autopista Las Americas there are only two lanes with "Paso Rápido" and still works with cash exchange.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

The use of Automatic Vehicle Identification systems was suggested for the motorcycles but it has not been executed yet.

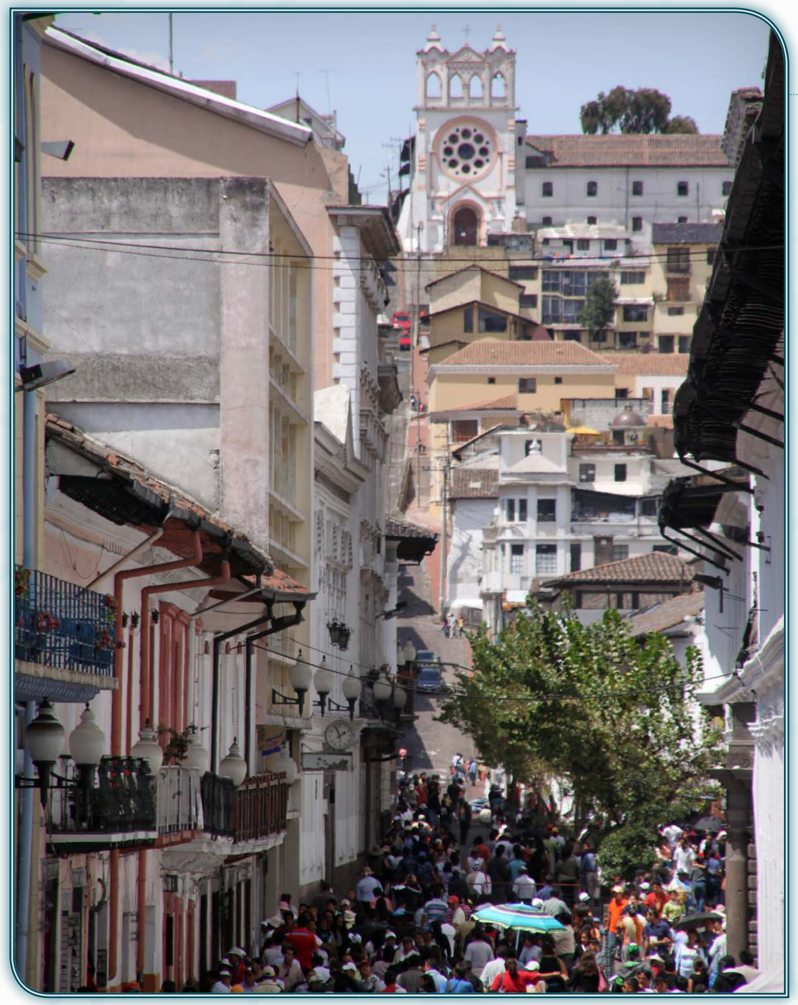
FUTURE DEVELOPMENTS[186]

The future implementation of the Land Transport Management Information System (Sistema de Información en Gestión de Transporte Terrestre (SIGETT)) has as an essential task the automatization of all the information on the different public transport modes in the Dominican Republic. The objective is to create more agile, reliable, timely data through an excellent tool for designing and planning land passenger transport policies in the country.

Santo Domingo: The construction of the BRT system will involve the implementation of ITS applications required for the correct operation of the public transport system.

Santo Domingo: The Transport Metropolitan Authority of Santo Domingo (Autoridad Metropolitana de Transporte de Santo Domingo (AMET)) is preparing for the installation of a new traffic control system in Santo Domingo. This tool also helps to change the traffic management in the capital, will also have a major impact on reducing traffic related accidents.

Santiago de los Caballeros: The construction of the Tram system will involve the implementation of ITS applications required for the correct operation of the public transport system.



COUNTRY: ECUADOR

SELECTED CITIES

Quito, Cuenca

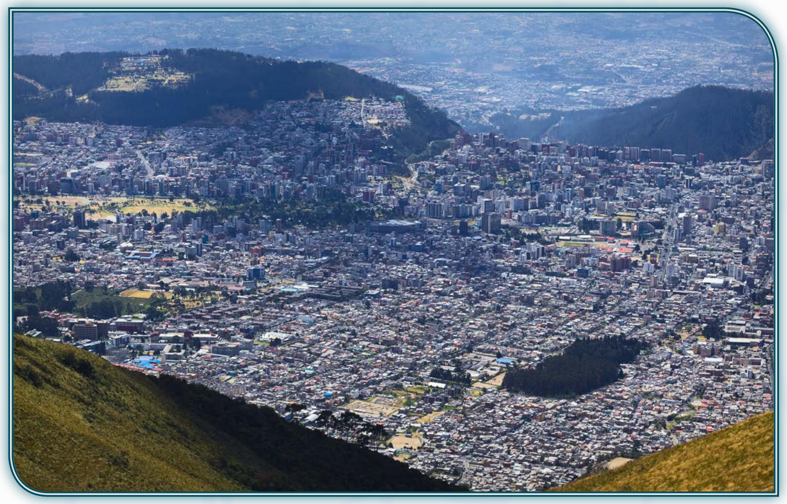
SOCIO-ECONOMIC INDICATORS[47]

Population	15,654,411 (2014)
Income per capita	$10,600 (2013)
% of public transport trips	Quito 73%; Cuenca 65%
No. of km of primary roads	Total: 43,670 km; 6.472 km paved
No. of cell phone users	17,430,000 (2013)[95]
No. of registered automobiles	1,722,728(2013)[187]

DESCRIPTION OF ITS APPLICATIONS MARKET[188]

The city of Quito is living an accelerated process of restructuring and innovation in all intervention areas, initiating a process of implementation of ITS solutions to address the needs of public and private transport systems. This process is described in the project "New Adaptive Traffic Light System" which defines the base technologies and systems that can be deployed throughout the city.

The infrastructures' projects currently in its planning phase (among which are the implementation of traffic control applications, the Metro of Quito and Shared Bicycle Systems in Cuenca) will require the implementation of ITS applications in the country. Therefore, there is a development opportunity in the e-toll, urban transport, urban and interurban traffic as well as commercial vehicles in cross-border areas.



DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[189]

The road network of Ecuador has currently 43,670 km, of which 6,472 km are paved. The Panamerican highway is especially important; it crosses the country from north to south; and also the Amazon highway that crosses the Ecuadorian Amazon from north to south.

As for the rail network, it consists of 965 km of railways, competence of the government and operated by the state railway company. It is currently being rehabilitated and at the moment only some sections of the previous infrastructures are working.

The National Traffic Agency (Agencia Nacional de Tránsito) is the entity in charge of regulating and controlling the transport, traffic and road safety competences in Ecuador.

The main ports are Guayaquil Ecuador and Freedom, and also Esmeraldas, Manta and Puerto Bolivar. Some of the rivers in the country are navigable without being dredged, such as the Guayas River, Duale and Vinces.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

QUITO[190]

Transitway Modes:

BRT	Metrobus-Q: 5 Corridors; 101 Stations; 83,8 km and 41 feeder lines; 310 buses, 869,763 passengers in 2012
Underground	Under construction. Metro de Quito will be opened in 2016. It will have 1 line with 15 stations in operation and 5 reserved, 22 km
Urban Buses	The urban bus network is part of the Urban Metropolitan Transport System of Quito (SITM-Q). In Quito has 150 lines; 2,047 buses; 46 companies; 2,2 million passengers
Other	BiciQuito (BICIQ): 25 stations; 625 bicycles; 4,000 trips per day; TelefericQo- Tourist Attraction. 2,5 km, 6 people cabins Bus Interparroquial

CUENCA[191]

BRT	There is no BRT system
Underground	There is no underground system
Urban Buses	Urban Bus and Microrregional 29 lines; 474 buses; 7 transport operators. Adapting to the Integrated Transport System
Other	Bus Interparroquial (regional), 70 buses, 5 transport operators

ECUADOR

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED BICYCLES	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
QUITO[192]	**Contactless smartcard in BiciQ**	---	**Roads: 8 Variable Message Panels (PMV) with risk weather, incidents and road safety tips** **Bus and BRTs: Web and social networks information (Twitter, Facebook, Youtube)** **Wifi on buses and BRT** **BiciQ: Web, and social networks information (Twitter, Facebook, Youtube)**	**BiciQ. Website and smartcard**	**Mobility Management Center:** **Central Adaptive Traffic Light System: automatic traffic lights in 600 intersections** **Transit Surveillance System (STV)** **803 Traffic Lighted intersections**	**1,072 cameras implemented out of 1,511 Video Camerasplanned** **115 Surveillance video cameras (CTTV) out of 185 video cameras planned** **309 public transport priority devices** **13 Infringement Control Systems (Fotomultas)** **28 devices for tunnel control** **10 Infringement Control System devices** **BRT Prioritization system**
CUENCA[193]	**Contacless smartcard in bus**	---	**Electronic information panels onboard**	**In planning phase**	**Traffic Center:** **126 Traffic Lighted intersections**	**126 centralized traffic lighted intersections with optic fiber out of 275 in planning phase**

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[194]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

There are 9 e-toll stations in the Panamerican highway (Autopista Panamericana). Payment forms: cash, debit card (Panapass) and electronic toll (e-toll - Telepass).

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

This technology is not available in the country.

FUTURE DEVELOPMENTS[195]

Quito has implemented 1,072 video cameras and still remains 1,511 to be installed. The city has also implemented 115 surveillance video cameras (CCTV) and 1,511 remain to be installed.

An ICM (Integrated City Management) platformis currently being developedin order to integrate all different aspects of road infrastructure, and on the longer term will also integrate private and public transport. The platform is expected to integrate information of all agencies, companies and institutions of the city that is required for a more intelligent management. It also contemplates the creation of an Integrated Operation Center.

Cuenca: The construction of the Automatic Public Bicycles system will involve the implementation of ITS applications required for the correct operation of the public transport system. The project will be executed in 5 phases with a total of 315 stations and 3,500 bicycles (10 per station).

The city has implemented 126 centralized traffic lighted intersections with optic fiber and 275 still remain to be installed.

Source: commons.wikimedia.org/wiki/Cam Ventoza

COUNTRY: EL SALVADOR

SELECTED CITIES

San Salvador, Santa Ana

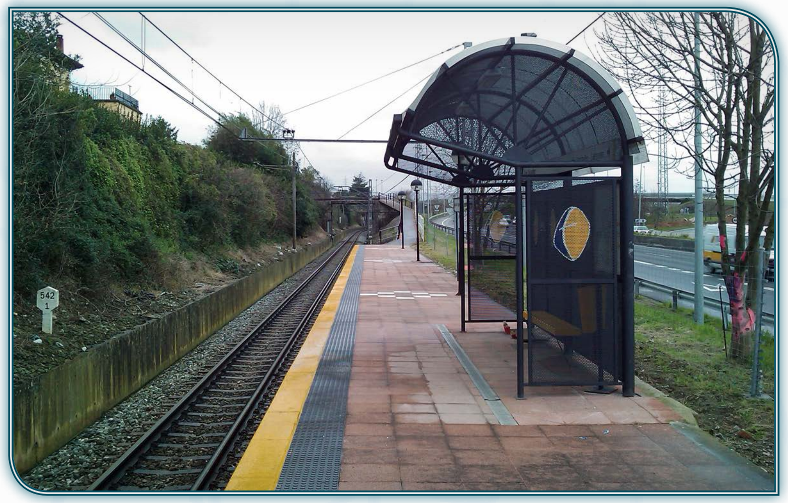
SOCIO-ECONOMIC INDICATORS[47]

Population	6,125,512 (July 2014 est.)
Income per capita	$7,500 (2013 est.)
% of public transport trips	54% San Salvador
No. of km of primary roads	Total: 6,918 km; 3,247 km paved (includes 341 km of expressways) (2010)
No. of cell phone users	8.65 million (2012)
No. of registered automobiles	795,885 (2013)[196]

DESCRIPTION OF ITS APPLICATIONS MARKET

The IDB country strategy with El Salvador 2010-2014 has transportation as one of the main development axis. Within the five year development plan, one of the objectives is to modernize the port system and mass transit system and expand/improve the country's road system, and specifically the implementation of the new mass transit system in the San Salvador Metropolitan Area[197].

The government is planning the implementation of transitfare collection systems (contactless smart-cards), automatic vehicle location systems and traveler information systems in the municipality of El Salvador.



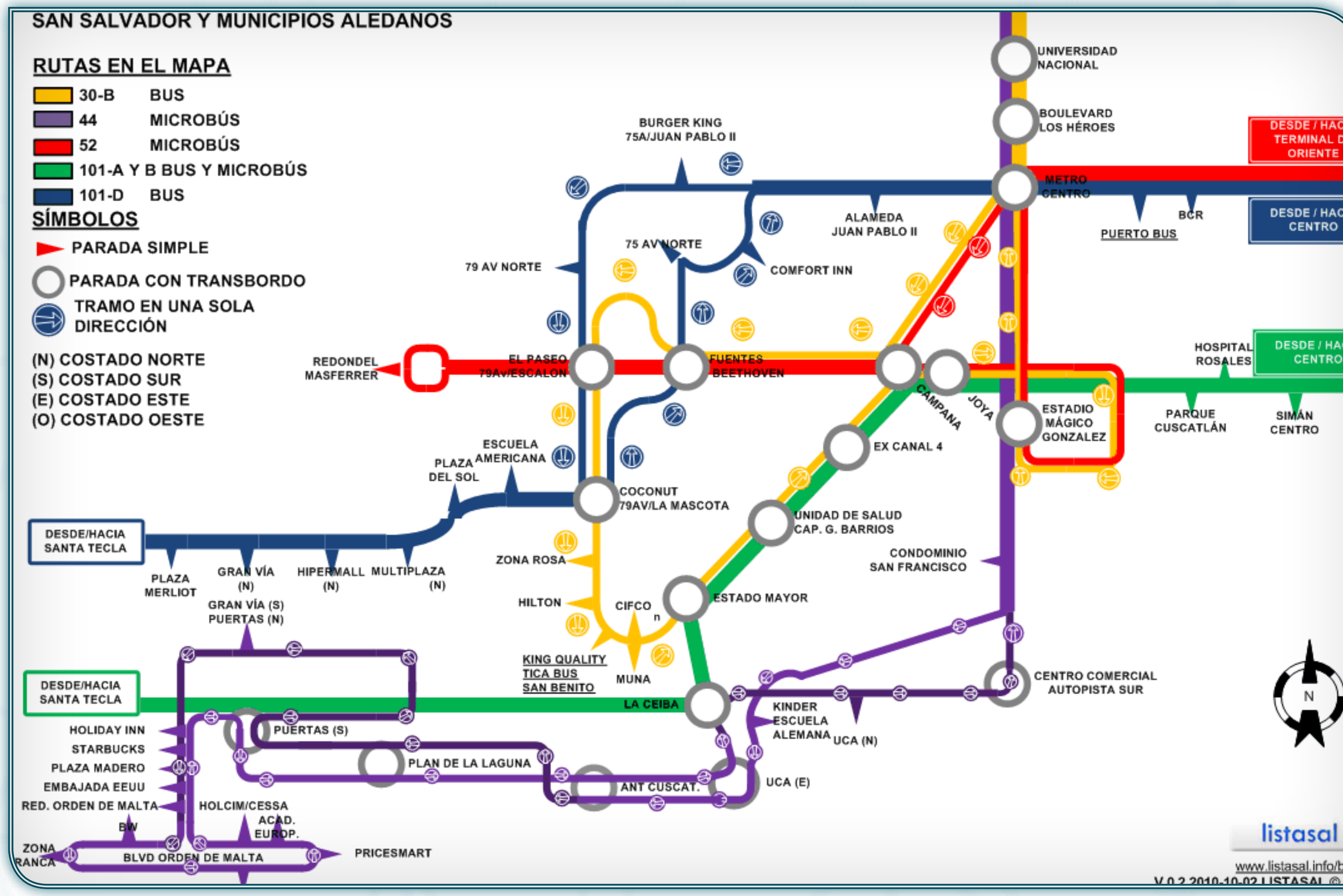
Source: commons.wikimedia.org/wiki/User:LMLM

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM

Planning, regulation and management of the transport sector in El Salvador is totallycentralized in the Vice-Ministry of Transportation (VMT) and its departments. The VMT is empowered as lead agency and coordinator of the transport policies and is responsible for implementing transport programs, functions or activities, traffic and road safety.

There is a lack of public transport regulation and fare integration and collection. At the operational level, public transport does not use established stops, causing delays and affecting the quality of service. In El Salvador operate about 1,100 routes with nearly 11,000 registered vehicles. In the Metropolitan Area of San Salvador (AMSS) operate 162 routes with a total of 4,642 vehicles (42% of the total fleet transport public in the country) distributed in equal numbers for both buses and minibuses.

SITRAMSS (Integrated Transport System of Greater San Salvador) is already under implementation, the first BRT corridor developed was Oriente-Poniente axis, from San Martin to Santa Tecla.



DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

SAN SALVADOR[198]

Transitway Modes:

BRT	**SITRAMSS (under construction): 7,8 km, 18 stations, 190 vehicles**
Underground	**---**
Urban Buses	**Metrobus Municipal, Metropolitan area of San Salvador:4.642 buses, 162 routes**
Other	**---**

SANTA ANA[199]

Transitway Modes:

BRT	**---**
Underground	**---**
Urban Buses	**Only interurban buses**
Other	**---**

EL SALVADOR

	ITS APPLICATIONS					
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
San Salvador[200]	Contactless Smart Card planned, not yet implemented	AVLC planned, not yet implemented Control Center planned, not yet implemented (based on GPS technology)	Traveler Information systems planned, not yet implemented	NO	Traffic Control Center: Traffic lights coordinated from the Control Center of the Vice Ministry of Transport	Traffic lights with video cameras 37 Traffic lights connected with National Police, from which 32 are located in traffic intersections Traffic Lights identify vehicle flow Investment: 1,5 million USD
Santa Ana[201]	NO	NO	NO	NO	---	---

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

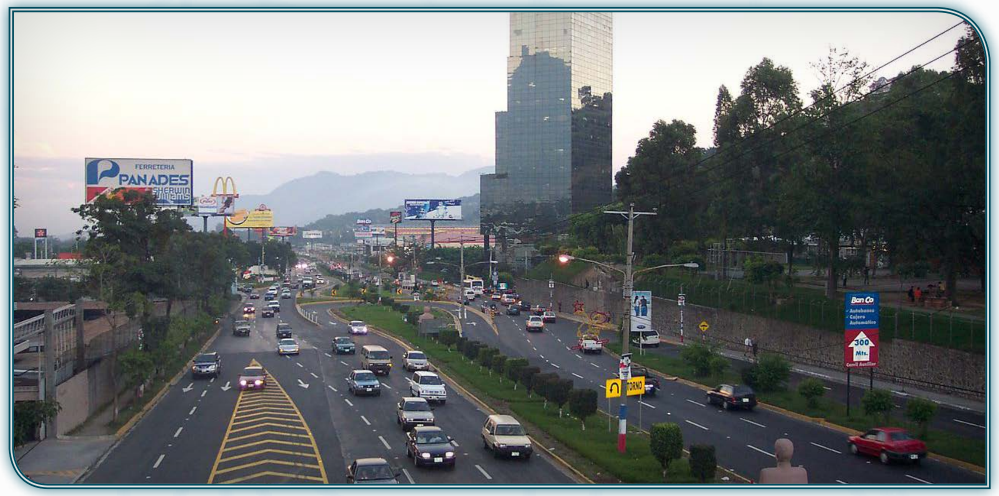
ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY...)

ELECTRONIC TOLL COLLECTION

There are no electronic toll collection systems implemented in El Salvador.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

There are not automatic vehicle identification systems implemented in El Salvador.



FUTURE DEVELOPMENTS

The government is planning the implementation of transit fare collection systems (contactless smartcards), automatic vehicle location systems and traveler information systems in the municipality of El Salvador.

COUNTRY: GUATEMALA

SELECTED CITIES

Ciudad de Guatemala, Quetzaltenango

SOCIO-ECONOMIC INDICATORS[47]

Population	15,991,987 (2014)[202]
Income per capita	$5,300 (2013 est.)
% of public transport trips	Ciudad de Guatemala 52%
No. of km of primary roads	Total: 3,706 km; 153 km paved[203]
No. of cell phone users	21,474,384 million (2014)[204]
No. of registered automobiles	2,738,925 (2014)[205]

DESCRIPTION OF ITS APPLICATIONS MARKET

The ITS applications market is under developed in Guatemala. The Annual Operations Plan (Plan Operativo Annual) from March 2014 clearly stated the need to modernize from the technological point of view to optimize the control of interurban transport.The SIGA prepaidcard has been introduced at the metropolitan level, integrating urban transport systems (Transmetro and Transurbano).

Therefore, there are potential investment opportunities in the country to implementintelligent transport systems applications for urban transport, urban and interurban traffic and commercial vehicles in cross-border areas.

source: commons.wikimedia.org/wiki/User:K21edgo

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[206]

The primary road network includes 3,706 km of paved roads, although the country counts with a total of 16,456km. According to the Guatemalan Chamber of Construction, in the year 2008 there were 6,409 km paved.

The national transport sector of Guatemala is composed of 884 Km of railway lines, from which 102 km are privately owned and the rest is unused.

The Metropolitan Development Program of the City of Guatemala (2005), in the Strategic Axis of Urban Mobility states that Guatemala Metropolitan Area (AMG) presents problems of inefficiency, insecurity and disparities in the transport system that causes congestion; likewise notes that the Municipality of Guatemala has among its objectives to make efficient and safe mobility in Guatemala City.

Guatemala has ports in Champerico, Puerto Barrios, Puerto Quetzal, Puerto San José, Santo Tomas de Castilla.

The country counts with 11 airports with paved runways, among these are Aeropuerto Internacional La Aurora, which is the biggest, located in Ciudad de Guatemala and Aeropuerto Internacional Mundo Maya, the second biggest servicing the central area of Petén.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

CIUDAD DE GUATEMALA[207]

Transitway Modes:

BRT	TRANSMETRO: 2 corridors, 3 lines, 52 stations, 81 articulated buses, and 35 feeder buses; 330,000 daily trips
Underground	NO
Urban Buses	109 routes, 4operators, 3,044 urban buses + BRT; 3,500,000 daily trips TRANSURBANO with 1,160 vehicles and pre-paid cards
Other	---

QUETZALTENANGO[208]

Transitway Modes:

BRT	NO
Underground	NO
Urban Buses	3 urban/interurban lines and microbuses, at least 5 bus companies
Other	Camionetas (Chicken buses) Minibus routes thread through all parts of the city

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Ciudad de Guatemala [209]	Contactless Smart Card: SIGA In BRT only 17% of buses are using the card In urban buses 445 buses are equipped with prepayment capabilities Interoperable with urban buses Onboard equipment: validation machines and passenger counting system	In 155 articulated buses and 445 urban buses Real-time monitoring of the vehicle by a competent authority	Website	Ciclovia Free service for the user Information terminals in pick-up stations Pick-up stations near transport modes Investment: less than 500 USD per bike	Traffic Control Center 20 CCTV real-time Cameras Automatic Vehicle Identification system 200 surveillance cameras throughout the city	20 CCTV real-time Cameras Speed control Digi Cameras installed in the main streets of the city
Quetzaltenango [210]	NO	NO	NO	NO	Municipa Traffic Police is in charge of the transit control	---

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[211]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

EMETRA, is the Metropolitan Regulatory Entity for Transport and Transit (Entidad Metropolitana Reguladora de Transporte y Tránsito) of Ciudad de Guatemala. They have implemented practices in managing and treating traffic accidents, with the introduction of new IT tools and management.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

The Motorway Palín – Escuintla, whose length is 29.63 km is using e-toll systems VIA-R (telepeaje, contactless smart cards).

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS

source: commons.wikimedia.org/wiki/File:Stabroek_Market.JPG

COUNTRY: GUYANA

SELECTED CITIES

Georgetown

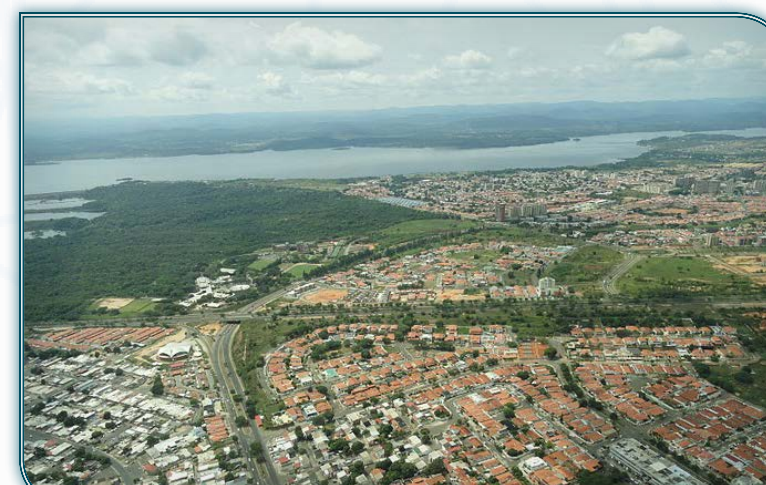
SOCIO-ECONOMIC INDICATORS[47]

Population	735,554 (July 2014 est.)
Income per capita	$8,500 (2013 est.)
% of public transport trips	---
No. of km of primary roads	Total: 7,970 km; 590 km paved
No. of cell phone users	547,000 (2012)
No. of registered automobiles	12,363 (2010)[212]

DESCRIPTION OF ITS APPLICATIONS MARKET

According to the IDB country strategy with Guyana 2012-2016[213] the Bank will support restructuring the sector to improve its efficiency with the shift from rehabilitating the road system to expand its capacity and the improvement of urban transportation in a sustainable manner. Road safety is also one of the priorities of the government; significant funds are being placed on the improvementof this aspect. Potential opportunities will arise in the implementation of public transport, urban and interurban traffic control and road safety ITS applications.

source: commons.wikimedia.org/wiki/File:Georgetown street,_Guyana



source: commons.wikimedia.org/wiki/User:Hdezeo

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[214]

The Government of Guyana has undertaken a process of rehabilitation of paved roads, but most of the unpaved roads are in poor conditions. The interior roads are generally unpaved in areas of low population density, but connect with the road towards inland communities and mining and forest centers. The Government is currently focused on improving and extending road infrastructures and improving road safety.

In Guyana there are a total of 187 km of railway network, all dedicated to ore transport. The road network of Guyana comprises 3,995 km, of which 500 km are paved. It serves a national fleet of about 52,000 vehicles.

Most of West Coast, East Bank, East Coast and Berbice areas are served by numerous private buses, and taxis serve almost everywhere along the coast, primarily Georgetown, which is serviced by a Speed Boat Association, the Demerara Harbour Bridge and many newly constructed highways.

Navigable waterways extend to 669 miles (1,077 km), including the Berbice, Demerara, and Essequibo rivers. There are ports at Georgetown, Port Kaituma, and New Amsterdam.

There is 1 international airport (Cheddi Jagan International Airport, Timehri); 1 regional airport (Ogle Airport); and about 90 airstrips, 9 of which have paved runways. Guyana, Suriname and the Falkland Islands are the only three regions in South America which drive on the left.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

GEORGETOWN[215]

Transitway Modes:

BRT	**NO**
Underground	**NO**
Urban Buses	**Local public transport based in minibus (vans)**
Other	**Boats, transbordador "chalana"**

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Georgetown[216]	NO	NO	NO	NO	---	---

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[217]

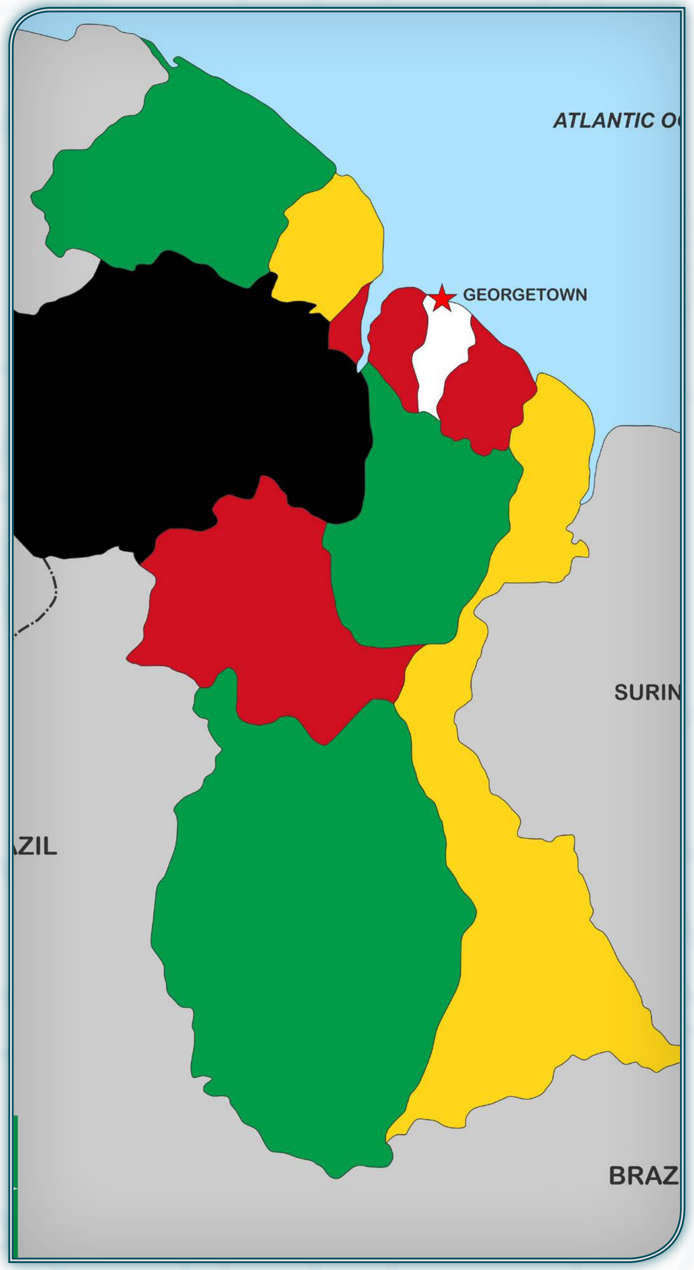
INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS



Source: commons.wikimedia.org/wiki/User:Korrigan

COUNTRY: HAITI

SELECTED CITIES:

Port au Prince, Cap Haitien

SOCIO-ECONOMIC INDICATORS[47]

Population	9,996,731 (July 2014 est.)
Income per capita	$1,300 (2013 est.)
% of public transport trips	---
No. of km of primary roads	Total: 4,266 km; 768 km paved
No. of cell phone users	6.095 million (2012)
No. of registered automobiles	198,000 (2011)[218]

DESCRIPTION OF ITS APPLICATIONS MARKET[219]

The Government of Haiti is currently focusing on priority projects identified in the Program to Support the Development of the Transport Sector in Haiti (PSDTH). One of their main objectives is to improve the quality of road infrastructure and road safety in the national transport network. The current and future actions relate to the rehabilitation and improvement of the primary, secondary and tertiary road network to consolidate a trunk road system that provides a safe and reliable connection between Haiti's main cities and improves integration and enhancement of rural areas.

The ITS applications market is under developed in Haiti. The government authorities has stated their interest in promoting sustainable balanced and equitable development of the country through integrated transport infrastructure networks and promoting multimodal transport. However, the main development priorities within the transport sector in Haiti are related to the improvement of road infrastructures, which were significantly damaged by the earthquake.

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DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM

HAITÍ

The road transport is the predominant transportation mode in Haiti. The country has 4,266 km of roads, of which 768kmare paved. Haiti has two main highways Route Nationale No. 1 links Port-au-Prince, Montrouis, Gonaïves and Cap-Haïtien. Route Nationale No. 2, links Port-au-Prince with Les Cayes via Léogâne and Petit-Goâve. There is not an active railway system in Haiti.

As far as public transport services are related, there are bus services performed according to fixed routes.

The Toussaint Louverture International Airport is located 10 km North/North East of Port-au-Prince. Other cities such as Jacmel, Jérémie, Les Cayes, Cap-Haïtien, and Port-de-Paix have airports that are accessible by smaller aircrafts.

The maritime transport has its main node in the port of Port-au-Prince, but there are other major seaports inCap-Haitien, Gonaives and Jacmel.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

PORT AU PRINCE

Transitway Modes:

BRT	**There is no BRT system**
Underground	**There is no underground system**
Urban Buses	**Tap-taps: privately owned buses**
Other	**---**

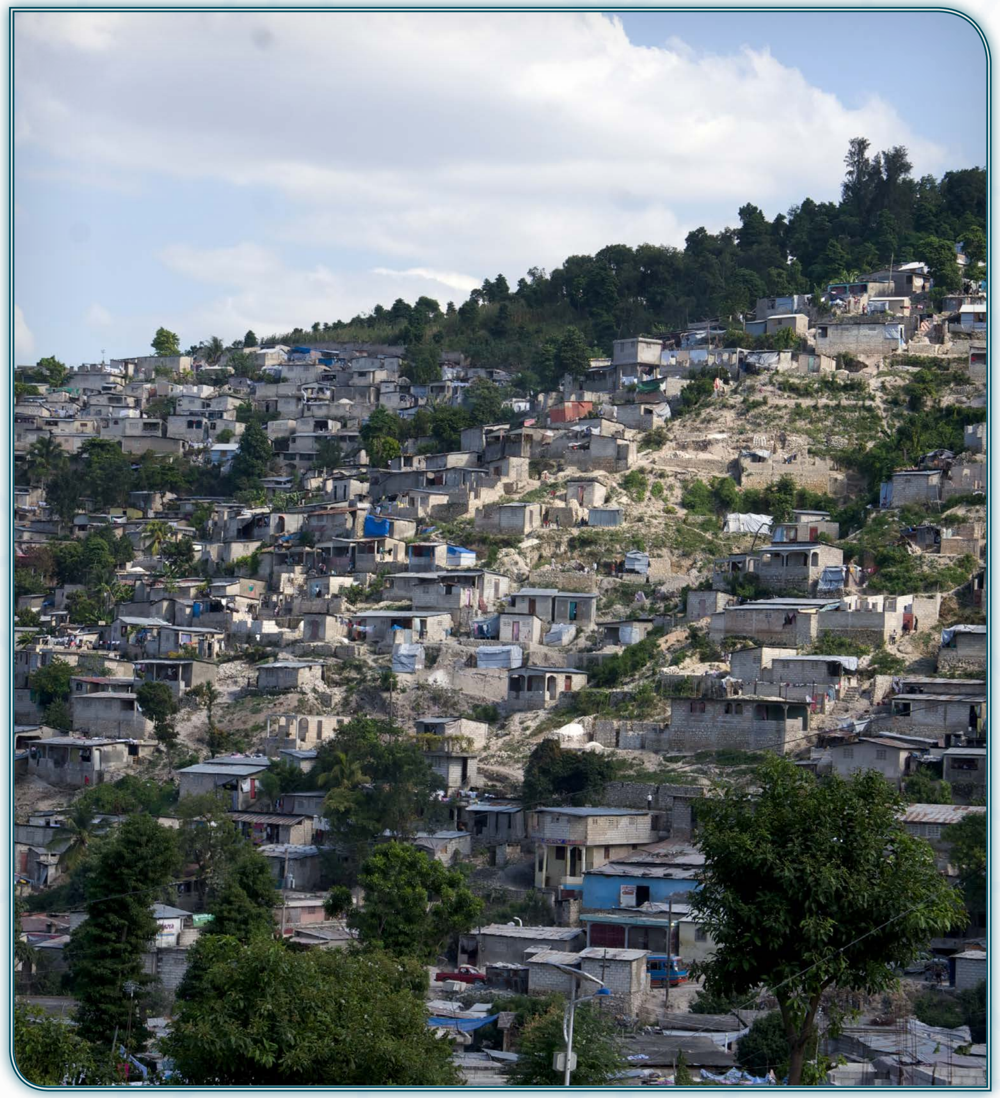
CAP HAITIEN

Transitway Modes:

BRT	**There is no BRT system**
Underground	**There is no underground system**
Urban Buses	**---**
Others	**---**

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
PORT-AU-PRINCE	**NO**	**NO**	**NO**	**NO**	---	---
CAP HAITIEN	**NO**	**NO**	**NO**	**NO**	---	---

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[220]



Source: flickr.com/photos/45005153@N07

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS

The main future projects relate to the improvement of road infrastructure and road safety in the national transport network.

COUNTRY: HONDURAS

SELECTED CITIES

Tegucigalpa

SOCIO-ECONOMIC INDICATORS[47]

Population	8,725,000 (2014)
Income per capita	$4,800 (2013 est.)
% of public transport trips	Tegucigalpa 71% (2012)
No. of km of primary roads	Total: 14,742 km; 3,367 km paved
No. of cell phone users	7.37 million (2012)
No. of registered automobiles	1,348,188 (2014)[221]

DESCRIPTION OF ITS APPLICATIONS MARKET[222]

According to the IDB country strategy with Honduras for the years 2015-2018, one of the Government's priorities is to promote production infrastructure as an engine of economic activity, concretely the road infrastructure to contribute to regional integration and reduce operating and transportation costs.

One of the objectives is to improve physical operating conditions at major border/customs posts. This may bring potential opportunities for the implementation of commercial vehicles in cross-border areas.

At local level, in Tegucigalpa within the framework of the Sustainable Urban Mobility Plan, there are plans to reorganize the public transport network, to make it more efficient and secure, offering a broader coverage. This fact may present potential opportunities of investment in the implementation of public transport and urban/interurban transit ITS applications.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM

Honduras has more than 14,742km of roads, the main highway of the country stretches from Puerto Cortés on the Caribbean, passing through San Pedro Sula, Comayagüela, Tegucigalpa, reaching Nacaome and Choluteca in the south of the country, where also crosses the Panamerican road.

The country's rail system consists of 785 km of railways, divided into two systems, the Honduras National Railroad (Ferrocarril Nacional de Honduras (FNH)), with nearly 600 km of tracks. The other system, owned by the Tela Railroad Company, is 190 km long. Both systems operate in coastal areas in the north-central and northwestern of Honduras and serve primarily for the transportation of banano.

In Honduras there is a need to move towards a Sustainable Transport system to present an alternative to the private vehicle. Currently there is an excess of public transport offer, there is not an infrastructure for non-motorized modes and public transport trips are uncomfortable and insecure. Public transport is in general not integrated, so there is an increased use of private vehicles, and therefore high levels of pollution and energy consumption.

Source: flickr.com/photos/27609180@N00

Tegucigalpa has already a Sustainable Urban Mobility Plan (SUMP (2013-2020)) with a diagnosis of the mobility in the city and a development program for the next years. The objective is to reorganize the public transpor tne twork, to make it more efficient and secure, offering a broader coverage.

The public transportation system in Tegucigalpa is not organized, with encouraged competition between the fleet owners, low quality and low efficiency of service. The regulation of public transport is very poor. The government and the Municipality of Tegucigalpa have decided to promote a meaningful reform of the public passenger transport system in the city Tegucigalpa, this includes a reorganization of services and operators (modernization of the fleet and infrastructures, of the fare collection system), and implementation of a BRT system. In late May 2011, the Congress approved the draft of a new law under a loan agreement with the Inter-American Development Bank. The BRT system will be managed exclusively by the government of the Central District of Tegucigalpa.

Honduras has 6 seaports: Puerto Cortés, Puerto Castilla, La Ceiba, Roatán and Tela, located in the north of the country in the Atlantic Ocean and in the south in the Pacific Ocean only the seaport of Bocas del Henecan or San Lorenzo.

The main airports are Ramón Villeda Morales y Toncontín.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

HONDURAS

TEGUCIGALPA[223]

Transitway Modes:

BRT	METROBÚS (TRANS 450): 14 stations; 2 lines; 10 km In planning phase: BRT: 5 corridors, 106 bus routes (trunk and feeder lines) transport network length is 1,092 km; average speed 20km/h (BRT) and 15km/h (buses)
Underground	NO
Urban Buses	103 lines Microbuses and traditional bus: 2,250 ómnibus of 54 passengers, 1,500 busitos (micro-omnibus) of 30 passengers; 83 urban and 20 interurban lines Out of the 83 urban lines, 66% operate in "rapiditos" (micro buses) 75% of the interurban routes operate in traditional bus vehicles
Other	---

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
TEGUCIGALPA[224]	Contactless smart card	AVLC Monitoring Control Center GPS system	Website, fare information, routes, schedules, frequency	NO	Traffic control Center: bus priority in intersections, urban toll, improvement of the traffic light system at intersections, flow separation, traffic light monitoring	Synchronized traffic lights system at 73 intersections, from which 54 intersections have a regulation system, capable of detecting vehicles and adjusting times. Investment: 1.8 million USD

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[225]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

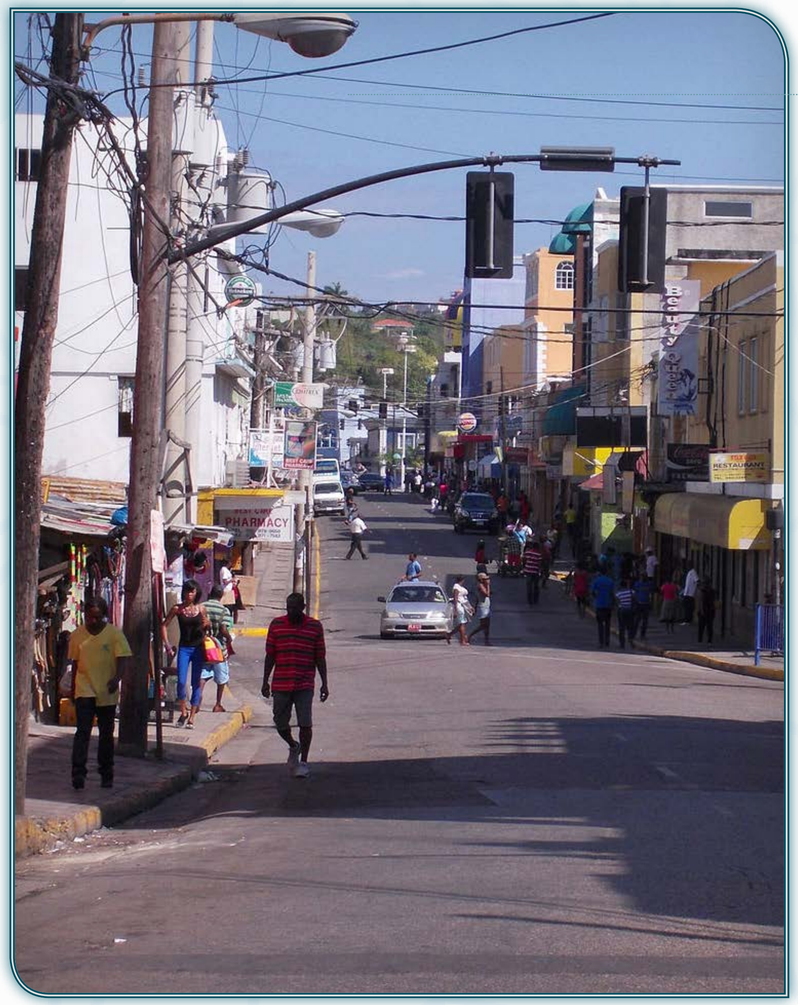
ELECTRONIC TOLL COLLECTION

Only the road CentroAmerica 5 (CA-5) in Honduras has installed 4 toll stations in the country.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS

The BRT in Tegucigalpa is in planning phase. This will require the future implementation of ITS applications such as transit fare collection systems, automatic vehicle location systems, passenger's information, and traffic control.



source: commons.wikimedia.org/wiki/User:WPPilot

COUNTRY: JAMAICA

SELECTED CITIES

Kingston, Montego Bay

SOCIO-ECONOMIC INDICATORS[47]

Population	2,930,050 (July 2014 est.)
Income per capita	$9,000 (2013 est.)
% of public transport trips	Kingston 3% (2004)[226]; Montego Bay 57%
No. of km of primary roads	Total: 22,121 km; 16,148 km paved (includes 44 km of expressways)
No. of cell phone users	2.665 million (2012)
No. of registered automobiles	502,265 (2010)

DESCRIPTION OF ITS APPLICATIONS MARKET[228]

The In 2006, the Government of Jamaica mandated thePlanning Institute of Jamaica (PIOJ) to lead the preparation of a comprehensive long-term National Development Plan (NDP) to place Jamaica in a position to achieve developed country status by 2030. Development of the Plan began in January 2007 with the creation of a various Task Forces including the Transport Task Force. This team prepared an action plan for the transport sector; the Transport Sector Plan for Vision 2030 Jamaica was completed in 2009.

The Action Plan in-pointed a set of objectives, among which objective 1.3 Improved management of traffic on the road network, clearly states the strategy to "develop driver feedback/intelligent roads", by conducting actions such as implement real time broadcast of traffic data and routing congestion alleviation, implement the IntelligentTransportation System, and establish linkage with traffic technology developers worldwide. Similar measures are compiled within the railway and public transport subsectors.

Over the medium and long term it will be necessary for Jamaica to consider a wide range of 11 measures to improve traffic flows in its road transport system, including use of more efficient traffic management techniques, junction improvements, promotion of higher vehicle occupancy, parking restrictions, intelligent transportation systems and flexible work and school hours to reduce peak traffic flows.Therefore, there is investment potential in the country in areas like public transport, road transport and urban and interurban traffic.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[229]

JAMAICA

The transport sector in Jamaica includes road, rail air and maritime transportation. Land transportation in Jamaica encompasses two components: road and railway transportation. The bulk of commuting public in Jamaica travels via land transportation.

Jamaica has one of the densest road networks in the world, with a total of 16,148km of paved roads (2011). Railway transportation forms the second tier of land transportation. Thepublic railway tracks belonging to the Jamaica Railway Corporation (JRC) span 335km across the island.

The Government undertook the development of a Public Transportation Rationalization Project, aimed at developing a comprehensive and inter-modal transportation system for the island, including major towns such as Montego Bay and May Pen; a Multi-Modal Public Transportation Policy; studies for a multi-modal transport plan for the extended Kingston Metropolitan Transport Region; and development of Rural-Urban Plans for a number of rural towns including Ocho Rios, May Pen, Santa Cruz, Montego Bay and Spanish Town. Progress was made toward expanding the public bus system, with the Jamaica Urban Transit Company (JUTC) adding 300 new buses to its fleet in 2009-2011.

Source: commons.wikimedia.org/wiki/User:Gian-

Jamaica possesses well developed maritime infrastructure with a total of 14 seaports including four cruise ship facilities.

Jamaica's air transport system comprises an international system and a domestic system: Norman Manley International Airport (NMIA), Sangster International Airport (SIA), and the recently designated Ian Flemming International Airport.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

KINGSTON[229/230]

Transitway Modes:

	BRT	NO
Transitway Modes:	Underground	---
	Urban Buses	Bus services provided by Kingston Transit, 460 buses operating and including the artic, bi-artic, buses for the handicapped and luxury coaches, 120 routes
	Other	---

MONTEGO BAY[231]

	BRT	NO
Transitway Modes:	Underground	---
	Urban Buses	Montego Bay Metro: Bus services provided by Kingston Transit, 8 buses operating, 3 routes
	Other	In 2013, about 19,034 vehicles were licensed to provide public transport services[232]

JAMAICA

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED BICYCLES	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Kingston[233]	Transit card (Smart Card) JUTC	Automatic Vehicle Locator (AVL) Vehicle tracking system, GPS in 28 buses	Transit trip planner based on Google maps	---	The Traffic Management Centers serve as the major point of connectivity between the array of field devices and the TMC. Real time information in the form of video and data is collected and analyzed at the TMC Currently all traffic signal installation in Jamaica operates on a single timing plan	---
Montego Bay[234]	Smart Cards Electronic Fare Collection Machines onboard all buses	MetroBus Management System	Traveler Information System	---	In planning phase: In 2012 Montego Bay was chosen to implement a "pilot" project for a Smart City Integrated Operation and Control Center (IOCC) in the framework of the ESCI Initiative by the Inter-American Development Bank. The project includes the installation of closed-circuit cameras The IOCC is composed of: Traffic Signal Control System	Automated Road safety enforcement cameras

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[235]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

Traffic operations in urban centers across the country is both localized and isolated.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

The National Road Safety Council (NRSC) is advocating the use of electronic surveillance systems to achieve compliance by road users.

ELECTRONIC TOLL COLLECTION[236]

The Highway 2000 Project (H2k) is one of the Government of Jamaica's landmark Millennium Projects. It will link Kingston to Montego Bay, through the Parishes of Kingston and St. Andrew, St Catherine, Clarendon, Manchester, St Elizabeth, Westmoreland and St James. The Highway will also connect Bushy Park and Ocho Rios, traversing the Parishes of St Catherine and St Ann. The total length of the highway is approximately 230 km, with an anticipated right-of-way of 100m. The project was divided in 4 phases: phases 1A and 1B have been completed, at the moment phase 2A (67.2 km) is being developed.

Tag and Multipass are available means of payment based on prepaid accounts like cell phones.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

Source: flickr.com/people/28667132@N00

FUTURE DEVELOPMENTS[237]

In 2012 Montego Bay was chosen to implement a "pilot" project for a Smart City Integrated Operation and Control Center (IOCC) in the framework of the ESCI Initiative by the Inter-American Development Bank. The project includes the installation of closed-circuit cameras The IOCC is to be composed of:

- **a.** Traffic Signal Control System;
- **b.** Route Taxi and Metro Bus Management System;
- **c.** Parking Information System;
- **d.** Traveler Information System;
- **e.** Automated Traffic Enforcement System;
- **f.** Crime-Prevention System;
- **g.** Disaster-Prevention System.

The Highway 2000 Project (H2k) is still being developed; phase 2 of the project is under construction at the moment.

COUNTRY: MEXICO

SELECTED CITIES

México City, Guadalajara, Monterrey, Campeche, La Paz, Xalapa

SOCIO-ECONOMIC INDICATORS[47/238]

Population	123,799,000 (2014)
Income per capita	$15,600 (2013 est.)
% of public transport trips	51% (2011)
No. of km of primary roads	137,544 km paved (includes 7,176 km of expressways)
No. of cell phone users	105,005,729 (2013)
No. of registered automobiles	34,869,611 (2013)

DESCRIPTION OF ITS APPLICATIONS MARKET

The Strategic National Development Plan (PND)[239] and Infrastructure and Communication Program, both published in 2013, include the use of intelligent transport systems (ITS) as a strategy for improving and updating the infrastructure of the different modes of transport. In particular, they contain the following challenges and opportunities:

- National Development Plan 2013-2018 - Strategy 4.9.1: Expand, modernize and maintain the infrastructure of the different modes of transport, and improve their connectivity through strategic considerations in terms of efficiency. Action Line: Ensure increased road safety by improving physical conditions and using ITS systems.

- Infrastructure and Communication Program 2013-2018 - Strategy 3.5: Promote investment in transport and logistics infrastructure, in order to reduce companies' operational costs: Promote the use of intelligent transport systems for improving security and speed up the movement of cargo and passen-

gers. Encourage the development and implementation of ITS systems to freight and passengers transport, in order to provide better movements planning, strengthen road safety, reduce accidents, improve traffic and increase commercial speed in passengers and cargo movement, especially in cross-border transactions.

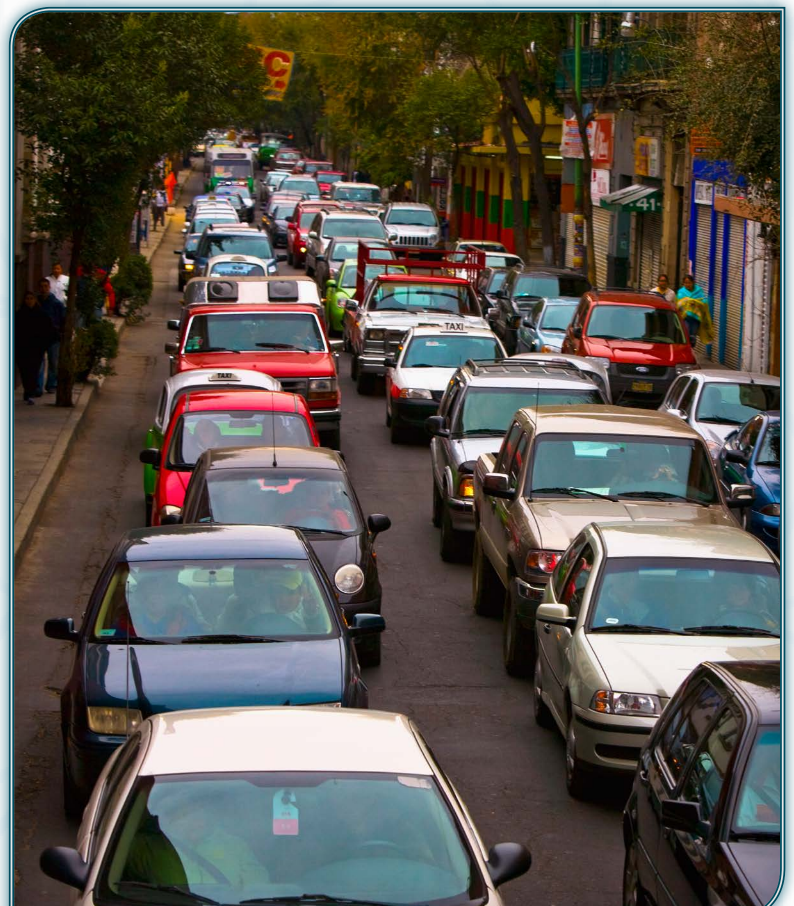
These challenges implies a great boost for the ITS market in Mexico, as a result of the large investments in infrastructure planned throughout the current presidential term. These investments, as set out in the National Infrastructure Plan (Programa de Inversiones en Infraestructura de Transporte y Comunicaciones[240]), published in 2014, include 386,255 million Mexican Pesos (MDP) in Road infrastructure, 98,098 MDP in railway and mass transport; 62,381 MDP in Ports and 35,036 MDP in airports.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM

The road infrastructure mobilizes most of the cargo (55% of total) and passengers (98% of total). To meet this demand, the road network has 377,660 km long, divided among federal network (49,652 km), state feeder roads (83,982 km), the rural network (169,429 km) and improved ways (74,596 km).

Railway infrastructure consists of 26,727 km of railroads, 20,722 km of which are part of the trunk roads and its branches, mostly concessions, 4,450 km are secondary railroads and 1,555 km are particular.

The National Port System in Mexico is composed of 117 ports and terminals. Federal Government is



in charge of 71 of those ports, which are operating under a concession model to 25 Port Authority (API – Administración Portuaria Integral). Of this 25 API, 16 belong to SCT, 2 belong to FONATUR, 6 are state and 1 is private. Of all ports and terminals, there are four strategic ports that move 96% of the containerized cargo (Altamira, Veracruz, Manzanillo and Lazaro Cardenas). In terms of passenger transport, the number of movements in cruises has decreased in the last years to 4.8 million people in 2012 compared with 6.7 million in 2010.

The National Aeronautical System consists of 76 airports, 1,388 airfields and heliports 408. Notably, 17 airports account for 88% of 86.4 million passengers per year, which is the total passenger arrival and departure airports, and 98% of the 747 thousand tons of cargo.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

MEXICO

MÉXICO CITY[241]

BRT	METROBUS: 5 lines and Line 6 under construction; 170 stations; 105 km; 104 buses (27 bi-articulated, 320 articulated, 54 buses of 11 m)
Underground	METRO PUBLIC TRANSPORT SYSTEM - STCM (Sistema de Transporte Colectivo Metro): 12 lines (Line 12 operates only partially); 195 stations; 226,448 km
Urban Buses	PASSENGER TRANSPORT NETWORK - RTP (Red de Transporte de Pasajeros): 94 lines; about 3,000 km and 1,550 buses PRIVATE OPERATORS (Road Corridors): 8 lines, about 200 km and 780 vehicles MICROBUS: individual concessioners with more than 200 lines and 20,000 vehicles
Other	LIGHT RAIL - STE (Servicios de Transportes Eléctricos): 1 line; 18 stations; 18 km. TROLLEYBUS: 8 lines; 204 km; 290 trolleybuses SUBURBAN TRAIN: 1 line; 7 stations, 27 km

GUADALAJARA[242]

BRT	MACROBUS: 1 line; 27 stations; 45 articulated buses (Line 2 under definition)
Underground	LIGHT RAIL - SITEUR (Servicios de Tren Eléctrico Urbano): 2 lines; 29 stations; 24 km; 48 vehicles (Only Line 2 is partially underground, Line 3 under construction)
Urban Buses	PRE-TREN, line that feeds LIGHT RAIL: 1 line; 35 stations; 26.5 km; 26 vehicles About 10 private operators and 200 lines and branch lines
Other	TROLLEYBUS: 2 lines

MONTERREY[243]

BRT	ECOVIA: 1 line; 41 stations; 80 buses; 30 km Lines 2 and 3 under definition
Underground	LIGHT RAIL - METRORREY: 2 lines (line 3 under construction); 31 stations; 32 km. (Only some sections are underground; Mainly aerial)
Urban Buses	Line 3 under construction TRANSMETRO: 10 lines that feed METRORREY, with about 100 buses METROBUS: 22 lines that feed METRORREY, with about 450 vehicles About 270 lines and branch lines
Other	---

CAMPECHE[244]

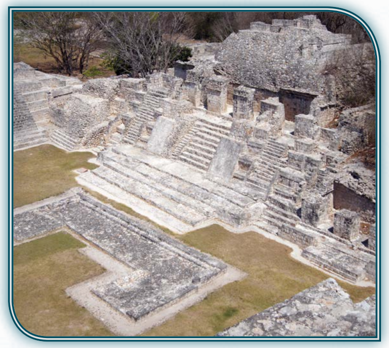
BRT	There is no BRT system
Underground	There is no Underground system
Urban Buses	355 vehicles
Other	---

LA PAZ[245]

BRT	There is no BRT system
Underground	There is no Underground system
Urban Buses	332 vehicles; 72 routes
Other	---

XALAPA[246]

BRT	There is no BRT system
Underground	There is no Underground system
Urban Buses	1,200 vehicles; 104 routes
Other	---



Source: commons.wikimedia.org/wiki/User:Jonik

Source: flickr.com/photos/99299995@N02/

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
MEXICO CITY[247]	Integrated Contactless Smart Card in METROBUS, METRO - SCTM, LIGHT RAIL - STE, and ECOBICI	AVLC in BRT (some lines) GPS monitoring in some main urban lines	235 Multimedia Information panel (TFT) in 151 stops and terminals Panels in buses. Apps with transit info based in open data.	ECOBICI Initial invest: 75 MDP for 90 stations and 1,200 bicycles Nowadays: 275 stations in 21 km2 and 3,600 bicycles	Center: flow traffic conditions management in real time 200 cameras Old version of an adaptive traffic control system without use of real-time sensor data to automatically adjust traffic lights	Speed cameras
GUADALAJARA[248]	Contactless Smart Card in BRT and LIGHT RAIL	AVLC in BRTand feed lines MACROBUS. GPS monitoring in some main urban lines (like 13 and 380)	Electronic screen to inform travelers in BRT stations. Web and APPs transit information FREE WIFI in BRT and Underground	Mi Bici Initial data: 65 MDP, 86 stations and 976 bicycles with localization functions (300 more, in 2015)	Traffic Control Center Cameras	Red light cameras Speed cameras
MONTERREY[249]	Integrated Contactless Smart Card in BRT and urban buses Contactless Smart Card in LIGHT RAIL.	AVLC in BRT	Electronic screen to inform travelers in BRT stations and vehicles	Mejor en Bici Free bicycle scheme with a single station	SINTRAM: Centralized, adaptive and real time system of traffic lights control in Monterrey Metropolitan Area Operational in 700 traffic lighted intersections out of 1,300 intersections 20 transit monitoring cameras; 20 VMS	NO
CAMPECHE[250]	NO, only cash	---	---	---	Non adaptive, manual controlled traffic lights	NO
LA PAZ[251]	NO, only cash Proposed in PIMUS (2014) within urban buses network restructuring	Proposed in PIMUS (2014) within urban buses network restructuring	---	Proposed in PIMUS a bike network (2014)	Non adaptive, manual controlled traffic lights. Improvements proposed in PIMUS (2014)	NO

XALAPA[252]	NO, only cash	AVLC in 40 buses (private operator)	NO	NO Not expected in the short term in new PIMUS (2015), although it was planned in "Movilidad 360" (2013)	Old centralized traffic lights system without adaptive and real time skills . Planned in "Movilidad 360" (2013), but not projected neither implemented yet. PIMUS* (2015) expected the adequacy of two avenues, including traffic light synchronization and exclusive lanes for public transport	NO

*PIMUS: Sustainable Urban Mobility Integral Plan (Plan Integral de Movilidad Urbana Sustentable) MDP: Million Mexican Pesos

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

Last public-private association's contracts to build and modernize Mexican highways have included ITS applications to ensure traffic management in these roads. ITS applications included in these contracts are, in most of the cases, following:

- Variable Message Signs.
- Closed Circuit Television, in toll plazas, junctions or dangerous areas.
- Weight in Motion systems, to collect weight data of commercial vehicles.
- Data Collection Stations, to collect data of vehicles using roadway.
- Weather Stations, to collect data of weather conditions.
- SOS Phones, for roadway users to ask for help.
- Fiber Optics based communications.
- Highway Traffic Management Center, to manage these ITS applications.

Communication protocols are based in NTCIP, according to standards published by The Secretariat of Communications and Transport (SCT)[253].

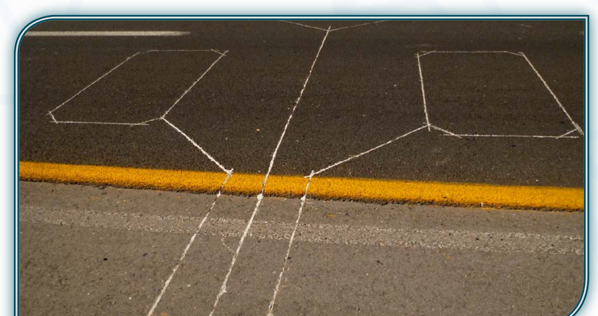
In 2014, there are about 3,600 km of intelligent highways with different levels of ITS equipment, taking into consideration finished projects, projects under implementation and recently awarded ones.

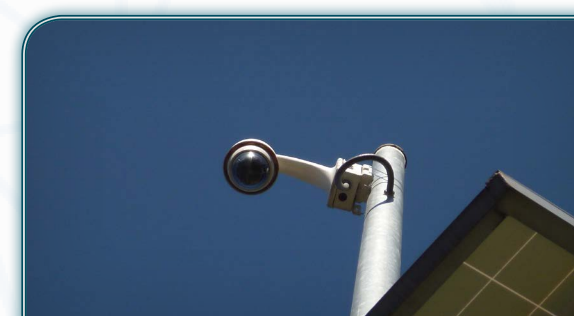
On the other hand, there is not any National nor Regional Traffic Management Center. SCT is the institution in charge of the development and management of the Federal Road Network, and the contractor of private highways operators.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

Tunnel safety: new roads with tunnels Durango – Mazatlan (61 tunnels) and Nuevo Necaxa – Tihuatlan (7 tunnels) have implemented advanced ITS applications to increase safety. VMS, CCTV, SOS phones, loudspeaker system, weather stations, etc.

Speed control: not implemented as a part of a national plan. Some regions or cities in the country like Mexico City, Guadalajara o Cancun have implemented speed control systems within the urban network or in perimeter roads.





ELECTRONIC TOLL COLLECTION[254]

ETC systems are a reality in Mexico since 20 years ago. Until November 2014 Mexico had different means to pay without stop in toll highways: IAVE used in the toll Federal network operated by CAPUFE, Viapass, Televía, etc. But in November 2014 Mexico will complete a new interoperable ETC system in the more than 5,300 km of toll roads throughout the country. A single TAG will be used to travel through Federal highways managed by CAPUFE (3,800 km of road network with 131 toll plazas, 470 electronic toll lanes and two control centers), and any other toll road in the country.

The new ETC systems use vehicles detection and classification systems, license plate recognition cameras and multiprotocol antennas to guarantee the communication with three available protocols in the homologated TAGs.

Source: *flickr.com/photos/cogdog/*

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)[255]

FAST (commercial transport) and SENTRI (private transport) programs, based in RFID card identification, in Mexico – USA border, managed by USA. More information in:

http://www.cbp.gov/travel/trusted-traveler-programs/fast
http://www.cbp.gov/travel/trusted-traveler-programs/sentri/sentri-overview

In south border with Guatemala there are not similar programs implemented to facilitate border crossings at present.

FUTURE DEVELOPMENTS[256]

TRANSIT FARE COLLECTION - AVL - TRAVELER INFORMATION SYSTEMS

Cities as Acapulco, Puebla, Pachuca, Mérida, Monterrey or Tijuana have tendered or will tender projects to deploy AVL, transit fare collection and traveler information systems in a new BRT lines or in an Integral Transport Systems (SIT), as in the case of Mérida.

SHARED MOBILITY SYSTEMS

- **Mexico DF:** extension to 171 new stations and 2600 bicycles more.
- **La Paz:** Proposed in the plan "PIMUS" (2014), although not concreting if it will be an ITS solution.
- **Xalapa:** Planned in "Movilidad 360" (2013), although the initial proposal not includes intelligent systems, only a free bicycle rental service of 100 bicycles and 23 station points.

URBAN TRAFFIC MANAGEMENT

- Mexico DF – Centauro Project: Updating of traffic light and Adaptive Traffic Control System. Implementation of software and devices in more than 3000 intersections of the city, managed from a control center.
- Plans PIMUS (Integral Plan of Sustainable Urban Mobility) and "Movilidad 360" of La Paz and Xalapa, respectively suggest improvements in the Urban Traffic Management through ITS solutions.
- In Campeche the council has requested 35 million of Mexican pesos to the Public Works Direction for the implementation of intelligent traffic lights, not yet approved at present.

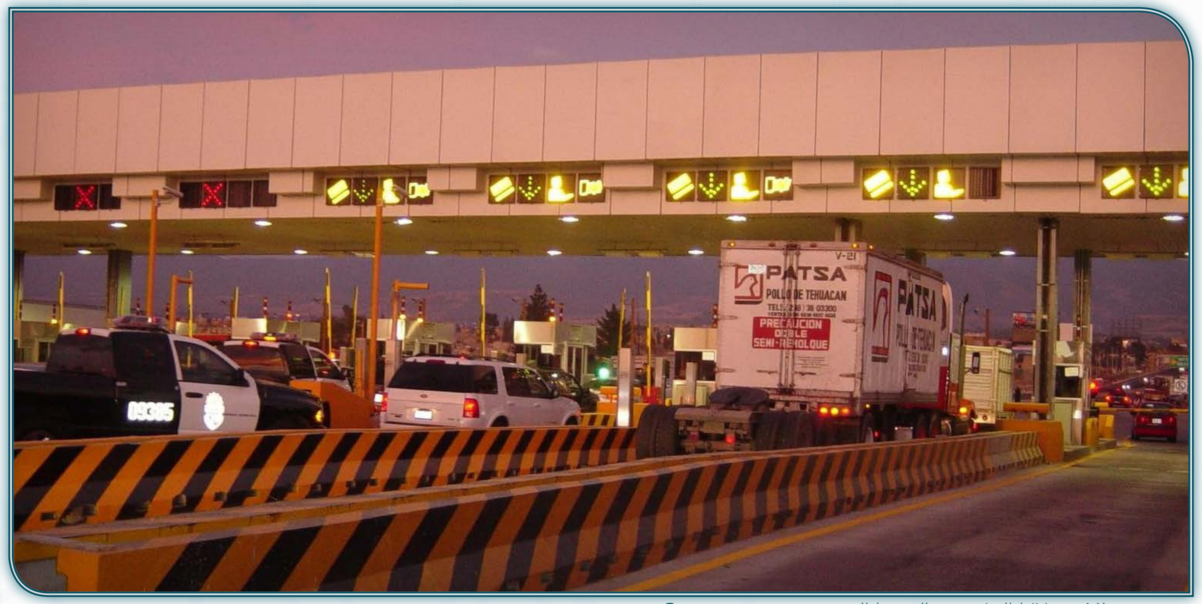
ENFORCEMENT IN URBAN ENVIRONMENT

- **Mexico DF:** The Ministry of Public Security of Mexico City (SSP) has proposed a program to install electronic enforcement devices in 250 spots, to detect speed infringement, red lights violators, dedicated lane invaders, etc.

INTERURBAN TRAFFIC MANAGEMENT – ROAD SAFETY IN INTERURBAN ENVIRONMENT

The SCT Program for the period 2013-2018 includes, among others, action lines for highways and freeways, and improve road safety with Intelligent Transport Systems; in accordance with the equipment of the last freeways inaugurated as Durango-Mazatlán or Mexico Tuxpan.

During that period, the Administration will put into operation 46 new highways, in addition to the already existing ones, among these include Oaxaca-Istmo, Jala-Compostela-Las Varas, Atizapán-Atlacomulco, Tuxpan-Tampico y Cardel-Poza Rica. All of them will include ITS systems.



Source: commons.wikimedia.org/wiki/User:Mbarousse

ELECRONIC TOLL COLLECTION

Achieve interoperability of the new electronic toll system in the country: all toll roads will accept the same electronic payment means, regardless of the tag operator behind (Nov 2014).

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

United States and Mexico have signed a collaboration agreement to upgrade border crossings between the two countries, including in many of them ITS applications for inspection task at customs. Highlight the following future projects:

- Modernization of the vehicular access to the north in the Chaparral Garita which will increase to 34 lanes with an investment of 500 million dollars and is expected to be completed in 2017.
- In 2015 is scheduled to start a new checkpoint in Mexicali with investment of 150 million dollars and planned to be completed in 2017.

Modernization of Otay-Tijuana border crossing. It is the expansion of the Otay Mesa border crossing where it is expected over $ 700 million investment.

Source: commons.wikimedia.org/wiki/User:Splette

COUNTRY: NICARAGUA

SELECTED CITIES

Managua

SOCIO-ECONOMIC INDICATORS[47]

Population	5,848,641 (2014)
Income per capita	$4,500 (2013)
% of public transport trips	Managua 47%
No. of km of primary roads	Total: 23,897 km; 3,282 km paved
No. of cell phone users	5,346 million (2012)
No. of registered automobiles	4550,000 (2014)[257]

DESCRIPTION OF ITS APPLICATIONS MARKET

The IDB country strategy with Nicaragua for the period 2012-2017 for the transport sector focuses mainly in the extension, rehabilitation and construction of the road network. The Government⊠s priority within the transport sector is the improvement of the road network with a view on increasing the efficiency of road transport and promoting the economic activity.

The Public Transport Director Plan envisioned the improvement of the public transport service and supported the implementation of a BRT system. The ITS market opportunities in Nicaragua are linked to the implementation of ITS applications in the urban transport and urban/interurban traffic management areas, since the city is also planning the modernization of the traffic lighting system of the city of Managua.

Source: flickr.com/photos/9815285@N02

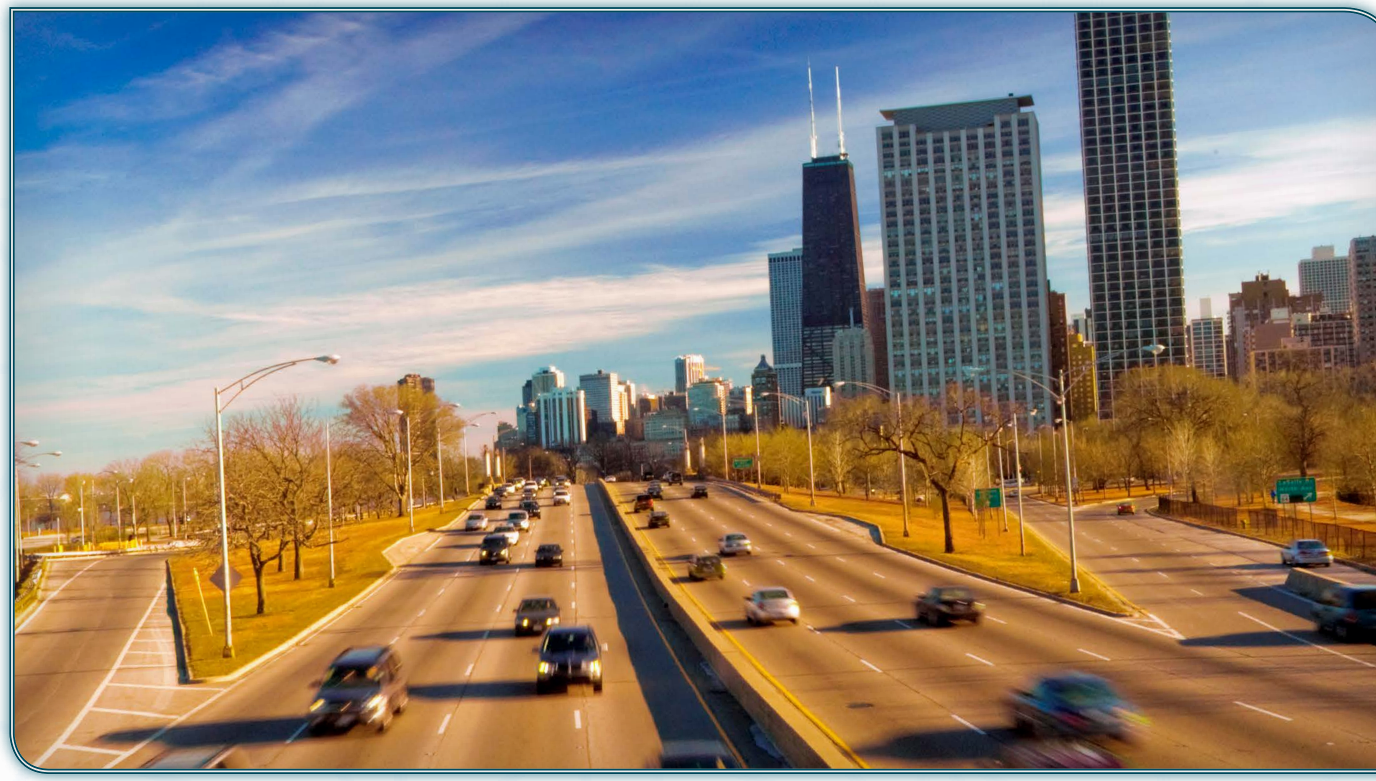
DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[258]

The road network of Nicaragua has a length of more than 23.897 km, from which more than 10% are paved roads (2011). During the rainy season only 68% of the total road network is in fair condition, meaning that some communities are isolated during this period.

For maritime traffic, Nicaragua has an international seaport, Puerto Corinto, which currently lacks the adequate facilities for international freight operations, having to rely on the ports of neighboring countries such as Costa Rica and Honduras.

The International Cooperation Agency of Japan (JICA) developed the National Transport Plan of Nicaragua, which aims at the modernization of the public transport system of the main cities.

The country has 19 airports and one international airport in Managua: Augusto Cesar Sandino International Airport.



DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

MANAGUA[259]

Transitway Modes:

BRT	In planning 2008. BRT with 22 km, 25 stops, 3 terminal stations, 156 buses, 5 routes, 210.000 passengers per day
Underground	There is no underground system
Urban Buses	39 lines; 27 cooperative companies; 840,000 passengers per day
Other	---

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
MANAGUA[260]	Smart Card	---	---	There is no Shared Bicycles system	In planning process to be implemented	---

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[261]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

This technology is not available in the country

FUTURE DEVELOPMENTS[262]

The City Council Commission of the Municipality of Managua approved in 2013 a project to modernize the traffic light system of the capital, to be reviewed at the next town meeting.

The project includes the installation of LED cameras in 32 of the 140 intersections of Managua and the goal is to modernize the vehicle system consisting of 280,000 vehicles traveling throughout Managua.

COUNTRY: PANAMA

SELECTED CITIES

Ciudad de Panama

SOCIO-ECONOMIC INDICATORS[47]

Population	3,787,511 (2015)
Income per capita	$ 16,993 (2015)
% of public transport trips	Panama: 46.57%
No. of km of primary roads	Total: 15,555 km; 6,351 km paved
No. of cell phone users	7.28 million (2015)
No. of registered automobiles	934,233 (2015)

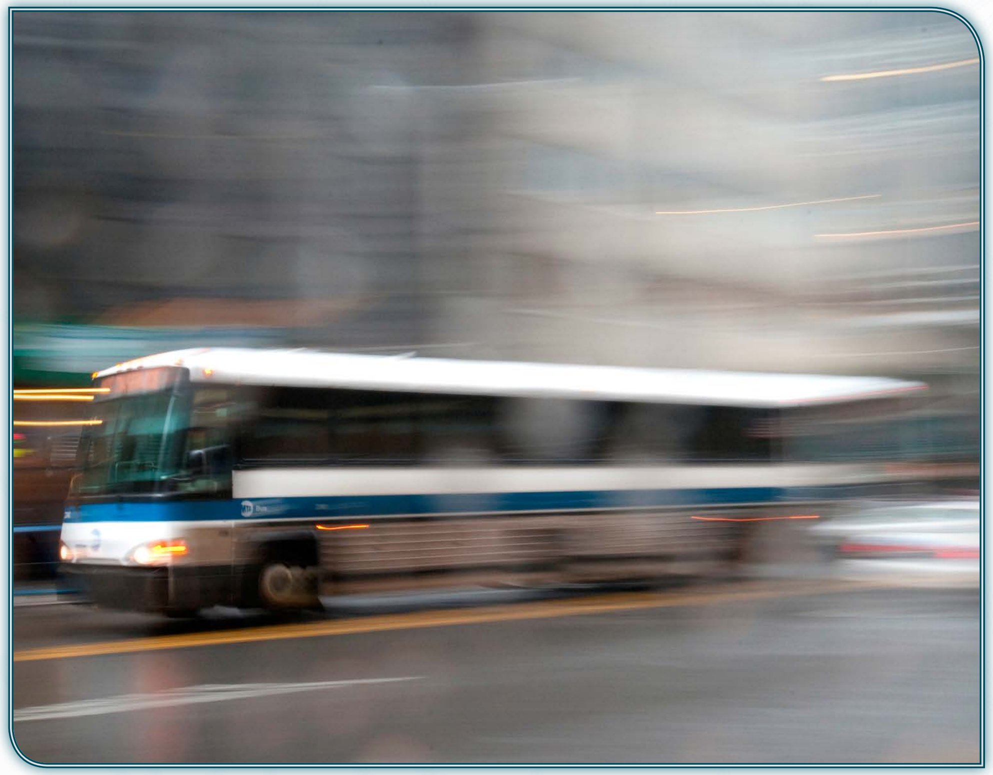
Sources: National Statistics Institute (Instituto Nacional de Estadística y Censo (INEC)), Integrated Sustainable Mobility Plan (Plan Integrado de Movilidad Urbana Sostenible (PIMUS)), National Authority of Public Services (Autoridad Nacional de Servicios Públicos (ASEP)), RUV-Transit and Land Transport Authority (Autoridad de Tránsito y Transporte Terrestre (ATTT)), Transit and Road Safety Directorate (Dirección de Tránsito y Seguridad Vial).

DESCRIPTION OF ITS APPLICATIONS MARKET

Panama is moving forward in the implementation of Intelligent Transport Systems in various subsectors within the transport field. The ITS applications market is developing in Panama. The Public Transport Authority of Panama (Autoridad del Tránsito y Transporte Terrestre (ATTT)) is highly compromised with the modernization of transport in the city of Panama. In the Metropolitan Area the process has started with the implementation of the Metrobus system, Metro Line 1 and components such as the electronic payment, the transport control and monitoring center and the User Information System. The policy aims at transforming the traditional bus system into an efficient and reliable massive passenger system. However, it is still far from the idea of a BRT system, which requires the construction or rehabilitation of infrastructure, specially designed stops for the system. In Panama, this has not been possible mainly due to road infrastructure of the city.

Currently, the Metrobus system operates in mixed traffic lanes, except in certain cases as in Ave España, Ave Peru, AveCentral and Cinta Costera, where some sections of the road have been designated with one lane priority for public transport (Metrobus and other operators).

ITS applications such as smart cards, AVLC, or advanced traffic light systems are being implemented. Therefore, there are potential investment opportunities in the country in the urban transport and also in the e-toll areas, linked to the extension of the South Corridor.



DESCRIPTION OF THE NATIONALTRANSPORTATION SYSTEM

Panama has aroad network with an extension of 15,555 km (2015), of which 70% are paved.

The transport authority of the City of Panama is the Transit and Land Transport Authority (Autoridad del Tránsito y Transporte Terrestre (ATTT)). Panama has made a commitment to improve public transport, as a vehicle for improving the quality of life for all its citizens and expects to invest more than 10 billion USD until 2035 to implement the "Ruta Maestra". The Metro Line 1 of Panama, linking the great Albrook Bus Station to Los Andes, opened on April 5, 2014, becoming the first metro system in Central America, in operation since April 2014. The Metro Line 2 of Panama is in procurement process, and the tender is to be launched in February 2015.

Until 2010, the main transportation mode in Panama City was the local buses, called "Diablos Rojos". They still operate from the East, West and North of the city. Although in a less extent, they still compete with the Metrobus System's main operator in the city center. The Metrobus system is the new mass transit system, based in a BRT system, located in the city of Panama.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

CIUDAD DE PANAMÁ

Transitway Modes:

BRT	**Metro Bus, the transport operator is Mibus, composed of 2,800 bus operators, 150 routes, 1,236 buses, 730,000 trips daily**
Underground	**Metro de Panama, 1 line, 13 stations, 13.7 km of length; Investment: 1,300 million USD There will be also a "Ruta Maestra", a metropolitan metro network composed of 3 metro lines, 1 tramway and 1 regional railway line Metro Line 2 is in procurement process, tender to be published in February 2015**
Urban Buses	**Urban bases called "Diablos rojos" are being replaced by the Metrobus system**
Other	**Taxis**

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Ciudad de Panama	Contactless Smart Card METROBUS (MIFARE Plus) 1,000 charging points	AVLC Metrobus Public Transport Control Center	Real time information public panels in stops Applications for cellulars and web page	NO Only lanes for recreation purposes on weekends	ATTT/TELVENT Centralized Traffic Lights System: 180 traffic lighted intersections TELVENT/MOP/FCC Monitoring and Control Traffic Center (CCTV) in 30 traffic lighted intersections, 70 surveillance video cameras and 128 sensors to feed 35 user's information panels	ATTT/TELVENT 5 Video Cameras for road traffic safety in critical intersections

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

As part of the road realignment taking place in the capital city, the Transit and Land Transport Authority (Autoridad del Tránsito y Transporte Terrestre (ATTT)) installed digital information and signal panels. A total of 128 sensors, 70 surveillance video cameras have been placed at different locations in coordination with the Ministry of Public Works (Ministerio de Obras Públicas (MOP)). The variable message signs are incorporated into monitoring cameras that are controlled by the offices of the ATTT using text and images.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

An e-toll system was implemented in the North and South corridors of Panama in December 2014, through the use of a Panapass system (e-payment) on pre and post payment modalities. For the use of both corridors, ENA has initially maintained 5 exclusive e-payment cabins and 2 cabins for card payment.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS

- Extension of the North Corridor. Operations starting in March 2015.
- Extension of Metro Line 1, San Isidro station: operation starting in December 2015.
- Metro Line 2 in procurement process, tender to be publicized in February 2015.
- Connection of North Corridor in Ave. España (section Brisas del Golf) in planning process.
- Extension of the South Corridor, which is in planning process, will present potential implementation opportunities for ITS applications deployment.
- Viaduct Ave. Cincuentenario (Costa del Este) in construction process.
- 3rd Bridge over the Panama Channel in planning process.
- Metro Line 3 in planning process.

Source: commons.wikimedia.org/wiki/User:Felipe_Antonio

COUNTRY: PARAGUAY

SELECTED CITIES

Asunción

SOCIO-ECONOMIC INDICATORS[47]

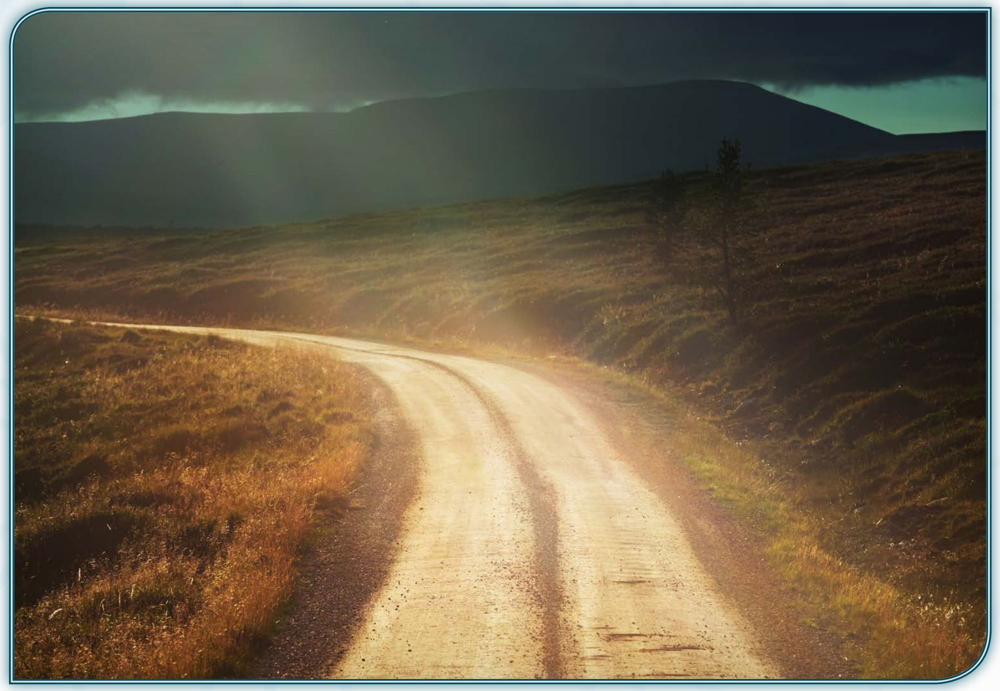
Population	6,703,860 (2014)
Income per capita	$6,800 (2013)
% of public transport trips	Asunción 50%
No. of km of primary roads	Total: 32,059 km; 4,860 km paved
No. of cell phone users	6,79 million (2012)
No. of registered automobiles	1,227,469 (2014)[352]

DESCRIPTION OF ITS APPLICATIONS MARKET[264]

The ITS applications market is not well developed in Paraguay. The government is currently designing the National Master Plan of Transport Infrastructures and Services, which will contain the transport priorities for the next 20 years. Also, according to the Country Strategy with the IDB (April 2014) for the period 2014-2018, the Government establishes Transport and Connectivity as one of the main priorities.This includes the improvement of transport infrastructures and road safety.

The future implementation of the interurban railway line (Tren de Cercanías Asunción-Ypacaraí). Integrated Public Transport System, (Metrobus) will bring along the implementation of ITS applications, such as transit fare collection systems, automatic vehicle location systems, traffic lights control applications, shared mobility applications in Asunción.

Furthermore, the strong road rehabilitation process that is carrying out the government will also favor the implementation of electronic toll systems and cross-border automatic vehicle location systems in the near future. Therefore, it may be observed an investment potential in this field in the country in all areas, e-toll, urban transport, urban and interurban traffic as well as commercial vehicles in cross-border areas.



DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[265]

Paraguay has a road network of 32,059 km, of which 90% are unpaved roads.

With regards to land transport, the country only has only 3 km of railroad tracks; it is the Latin American country with the smaller railway network.

Thus, the main mode of land transport is urban and interurban buses, covering many of the relationships between the different cities. The long distance and international bus system has its origin / destination in the Asuncion bus terminal that connects all the departments of Paraguay and several cities of South America Argentina, Brazil, Bolivia, Chile, Uruguay and Peru.

The country's main airport, Aeropuerto Internacional Silvio Pettirossi, is located in the metropolitan area of Asuncion and communicates with various American cities. There are other airports such as Guarani International Airport.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

ASUNCIÓN[266]

Transitway Modes:

BRT	**Metrobús[267] PYA'E PORÂ – ASUNCIÓN. In planning stage the 1st phase of the project: 1 corridors, 4 trunk lines, 16 feeder lines, 18 km, 26 stations**
Underground	**There is no underground system.There is an interurban railway line between Asunción and Ypacaraí and to be connected with Metrobus (in planning stage)**
Urban Buses	**200 lines, 55 legal companies, 2,555 buses, 1,000,000 passengers per day**
Other	**Shared Bicycles. In planning phase: 100 bicycles.** **In planning phase. Urban/interurban railway (Tren de Cercanías) Asunción- Ypacaraí. 44 km of double lane, 5 stations, 6 stops, 50,000 passengers per day**

PARAGUAY

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
ASUNCION[268]	In planning phase	Control Center in planning phase with BRT construction	In planning phase with exclusive bus lane Ruta Transchaco	---	Traffic Light Con-trol Centerhas been constructed, will enter in operation soon	In planning phase: 40 security cameras 50synchronized led traffic light crossings 24 speed controllers

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[269]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CON-TROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

There are 10 speed radars and modern equipment managed by the transit agents (Patrulla Caminera).

ELECTRONIC TOLL COLLECTION

Paraguay has modernized the existing toll stations in the country (Ypacarai, Coronel Oviedo, Bridge Haven, Ambush and 25 Decem-ber)by installing automatic barriers, traffic lights passing cameras, surveillance cameras and electronic coils. However, there are no e-toll stations in the country.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

There is also Automated Collection EquipmentasTraffic Fees Collection Systems.

Electronic Filing of Cross-borderTransport Exchange, through the customs website and before leaving the country. The SOFIA System is a computerized customs clearance system that interactsdirectly withits users: Customs Brokers, Transport Companies, Custodians, Customs Officers and Agencies related to foreign trade.

FUTURE DEVELOPMENTS[270]

Asunción: The construction of the BRT system will involve the implementation of ITS appli-cations required for the correct operation of the public transport system (Control Center).

The construction of the Interurban Rail (Tren de Cercanías) Asunción-Ypacaraí system will involve the implementation of ITS applications required for the correct operation of the public transport system.The creation of a Traffic Light Control Center has planned to install 78 syn-chronized led traffic lights, 40 security cameras (CCTV) and 24 speed controllers as well as intelligent traffic lights at 150 intersections.

The creation of a dedicated bus lane for omnibus in Ruta Transchaco implies besides placing 33 passenger shelters in the section of the project, the implementation of information road signs, the installation of 10 traffic lights (suitable for the proper synchronization of the green wave) and deployment of 35 traffic cameras.

COUNTRY: PERÚ

SELECTED CITIES

Lima, Cuzco, Huancayo, Trujillo

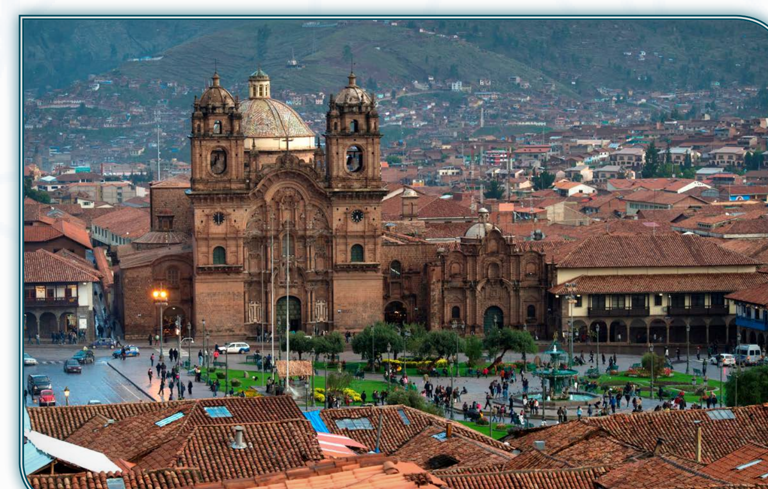
SOCIO-ECONOMIC INDICATORS[47/271]

Population	30,147,935 (July 2014 est.)
Income per capita	$11,100 (2013 est.)
% of public transport trips	53% (2011)
No. of km of primary roads	Total: 25,387 km; 20,597 km paved (2014)
No. of cell phone users	29.4 million (2012)
No. of registered automobiles	2,999,223 (2012)

DESCRIPTION OF ITS APPLICATIONS MARKET

According to the Ministry of Transport and Communications (MTC) "Achievements Report from Aug 2011 to Jul 2014", from 2011 to 2016, the whole investment in Transport and Communications sector, through Construction and Public-Private Partnerships, will reach 22 billion USD.

Source: flickr.com/photos/desdegus/



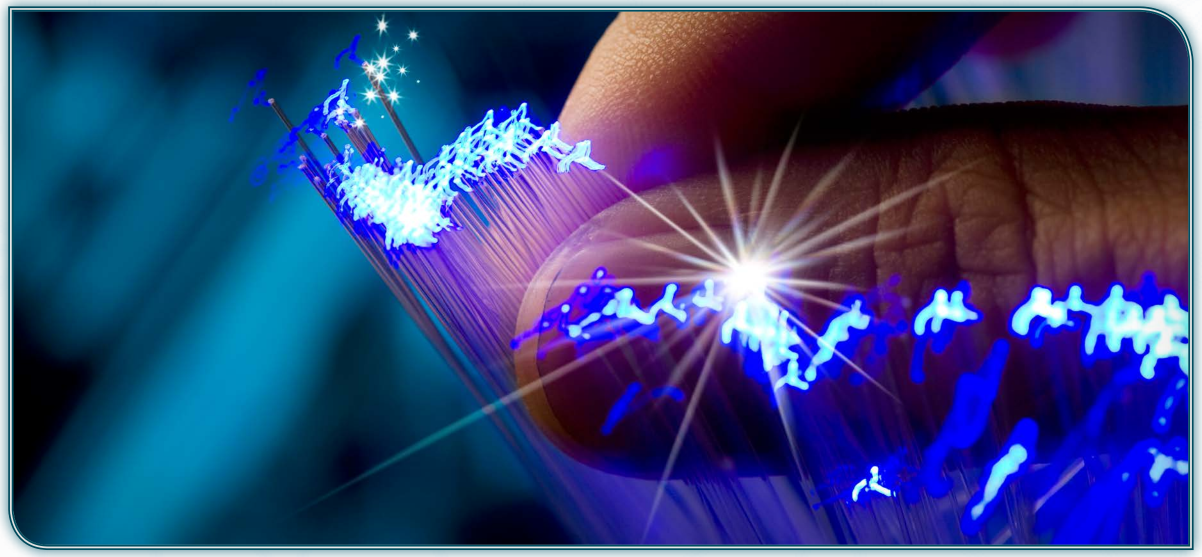
PERÚ

Until 2013, the MTC has prioritized investments in infrastructure and services under the multimodal approach of logistics corridors articulated within the Plan for Development of Transport Logistics Services. By 2014, three flagship projects are mentioned:

1) The paving to 100% of Longitudinal de la Sierra Road, linking Desaguadero (on the border with Bolivia) with Vado Grande (on the border with Ecuador).

2) Fiber Optics backbone concession, awarded in December 2013, which involves the laying of 13,500 km of fiber throughout the country, thus allowing all provincial capitals to access broadband.

3) Line 2 of the Lima Metro, whose concession has been awarded in March 2014 and which will benefit more than one million passengers a day.



By 2013, the MTC prepared the "Intelligent Transportation Systems (ITS) National Architecture and Master Plan". In report #6, "ITS Master Plan", there are 6 identified needs directly related with ITS systems, as follows:

1. Define an organizational structure for the ITS systems deployment regulation.
2. Define a regulatory framework for the ITS systems deployment.
3. Improve transport intermodality.
4. Enable systems interoperability.
5. Enable integration of control centers operation.
6. Increase access to telecommunications infrastructure to integrate ITS systems implemented in the road network.

These 6 identified needs and other 7 more general result in 21 ITS strategic projects grouped in 5 fields of action, establishing a time horizon for its development of 10 years (2014-2024).

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[272]

In 2014, national road network is 27,140 km long, of which 1,734 km are still on project phase. The total road network was 140,672 km long in 2012, being divided in national (17.5%), departmental (17.2%) and local (65.3%).

It is an extensive road network, not all paved, that connect all departmental capitals and most of provincial capitals. Goods are transported in thousands of trucks that arrive even in areas and towns quite isolated from the territory. Most of the roads are in charge of PROVIAS, decentralized agency of the Ministry, which is responsible for maintaining and expanding routes. Some roads have been under concession to private companies for their construction or improvement and maintenance according to public contracts signed with the State.

The Peruvian rail network is quite limited in terms of infrastructure, since it has only 1,907 km of extension. It is planned to expand it considerably in the coming years due to private investment initiatives. The Peruvian railway network consists of 5 main railways:

- Central Railway: under concession to the company "Ferrovías Central Andina", is the main means of transport of mineral products from the center of the country, and has the highest station in the world.
- Railway Huancayo-Huancavelica: Extension of the former one, currently in process of modernization.
- The Southern Railway: under concession to the trans-Andean railroad company.
- Railway Toquepala-Ilo: Of mining use, it belongs to the mining company Southern Peru.
- Railway Tacna - Arica: is an international railway, with about 70 km that connects the city of Tacna with the Chilean port of Arica, and belongs to the Regional Government of Tacna.

The total number of existing and active seaports in the country is 24, of which 19 are maritime, river 4 and 1 lake. Peruvian ports are managed by the National Ports Company (Empresa Nacional de Puertos S.A. (ENAPU-PERU)), decentralized entity of the Ministry of Transport and Communications. Major seaports are Callao, Maratani and Paita.

The main and most important airport of Peru is the Jorge Chavez international airport in Callao. It is considered one of the most important airports in South America, for passengers, cargo and mail, and because of its strategic location for international connections. There are 191 airports, 59 of them with paved runways, and 5 heliports.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

PERÚ

LIMA[273]

BRT	METROPOLITANO: 1 trunk line of 24 km and 22 feeder routes; 46 stations and 300 vehicles in trunk line; 222 vehicles in feeder routes; 650,000 passengers daily
Underground	METRO OF LIMA: 1 line; 26 stations; 34 km long approx 24 trains in service. 330,000 passengers daily Line 2 under construction
Urban Buses	Currently there are approximately 35,000 vehicles with more than 100 lines; 34 km of dedicated bus lanes It is planned to reduce to 14,000 vehicles and the development of: · complementary network of corridors (5 trunk lines and their feeder routes, planned and nowadays 2 trunk lines in-service) · integration network of corridors (2 trunk lines and their feeder routes, planned) and several approach routes

TRUJILLO[274]

Public transport gets 10% of daily trips, bicycle 1%, taxi and collectives 61%, mototaxi 6% and private vehicles 21%.

BRT	---
Underground	---
Urban Buses	MICROBUS: 1,214 vehicles; 35 routes; RURAL VAN (COMBI): 1,611 vehicles; 49 routes
Other	---

HUANCAYO[275]

BRT	---
Underground	---
Urban Buses	MICROBUSES: 500 vehicles and 18 routes; RURAL VAN (COMBI): 1,832 vehicles and 45 routes; AUTOS COLECTIVOS: 1,636 vehicles and 34 routes; Public transport represents 7% of vehicles fleet
Other	URBAN TRAIN called Metro Wanka in project but stopped in January 2014

Source: commons.wikimedia.org/wiki/User:ReservoirHill

CUZCO[276]

BRT	---
Underground	---
Urban Buses	RURAL VAN (COMBI), MICROBUS and OMNIBUS: 940 vehicles approximately; 30 routes
Other	---

PERÚ

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC(*)	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
LIMA[230]	Two Contactless Smart Cards. One for BRT and their feeder routes and other for Metro of Lima Recently tendered a ticketing system for 14,000 buses. Nowadays there is no integration between them.	AVLC in BRT 300 buses for trunk line and 222 buses for feeder routes. Recently tendered an AVLC system in 14,000 urban buses for complementary network of corridors integration network of corridors and approach routes	Website Electronic display panels in stations and inside the vehicles with audio announcements Mobile apps Type of information: routes schedules and arrival information in real time.	Free bicycle scheme without ITS technology in San Borja district with 6 stations and 200 bikes.	At least 1,189 traffic lights, of which 866 are isolated (679 are over 20 years old) and 323 are centralized. There are 469 CCTV cameras, of which 122 are dome cameras	It only has 10 portable speed control devices that must be operated manually by the police. Currently automated enforcement deployment is being under study
TRUJILLO[231]	In planning process. Between September,27th and October, 4th of 2014 a contactless smart card was tested in a pilot fare collection program in 8 buses	In process. Buses fleet is to be renewed to include this system	Planned within theSustainable Urban Mobility Plans, "Mobility Pact"	Planned within the "Mobility Pact".	600 intelligent traffic lights that use sensors for priority in 111 congested intersections[366] Traffic Control Center, 52 CCTV cameras at 22 intersections. Functions: mainly counting vehicles and traffic lights regulation	NO
HUANCAYO[232]	NO, only cash	NO	NO	NO	NO	NO
CUZCO[233]	NO, only cash	NO	NO	NO	NO	NO

(*) According to the Supreme Decree 017-2009-MTC (Transport Administration National Regulation) and the Directive no. 007-2009-MTC/15, interurban passenger transportation vehicles should have a wireless monitoring and control system to transmit to the authority the vehicle on route information on a permanent basis. This information is transferred to a control centre managed by SUTRAN (Superintendence of people, cargo and goods transport – "Superintendencia de Transporte Terrestre de Personas, Carga y Mercancías"), a public company attached to the Ministry of Transport and Communications (MTC).

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[278]

INTERURBAN TRAFFIC MANAGEMENT (TRAFFIC SIGNAL, DETECTORS, VMS, ...)

All concessions have SOS posts deployed.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

ELECTRONIC TOLL COLLECTION

COVIPERU S.A., Concesionaria Vial of Peru, Concession which operates since September 2005 the Pan American Highway South from bridge Pucusana to Ica, offers the means of payment Telepass/EasyWay: At Chilca plaza, pre and post payment RFID passive tags are allowed, in addition to cash and vouchers prepaid. Tags payment is done by matching the tag with the license plate number.

In the non-concessional network, the intention is to implement automated tolls. There is a pilot plan at Mocce plaza, under an agreement with the Public Company Korea Expressway Corporation, of South Korea.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

A nation-wide automatic vehicle identification system called SIIV (Sistema Integral de Identificación Vehicular) is under implementation since 2010. By 2014 about 70% of the vehicles are already equipped with an RFID device linked to the plate number. However no ITS border crossings application based on this device has been developed yet.

FUTURE DEVELOPMENTS[279]

There are some ITS future developments, as follows:

Fiber Optics network.-

- Provision of 700 MHz band for mobile Internet next generation (4G-LTE) is intended in short.

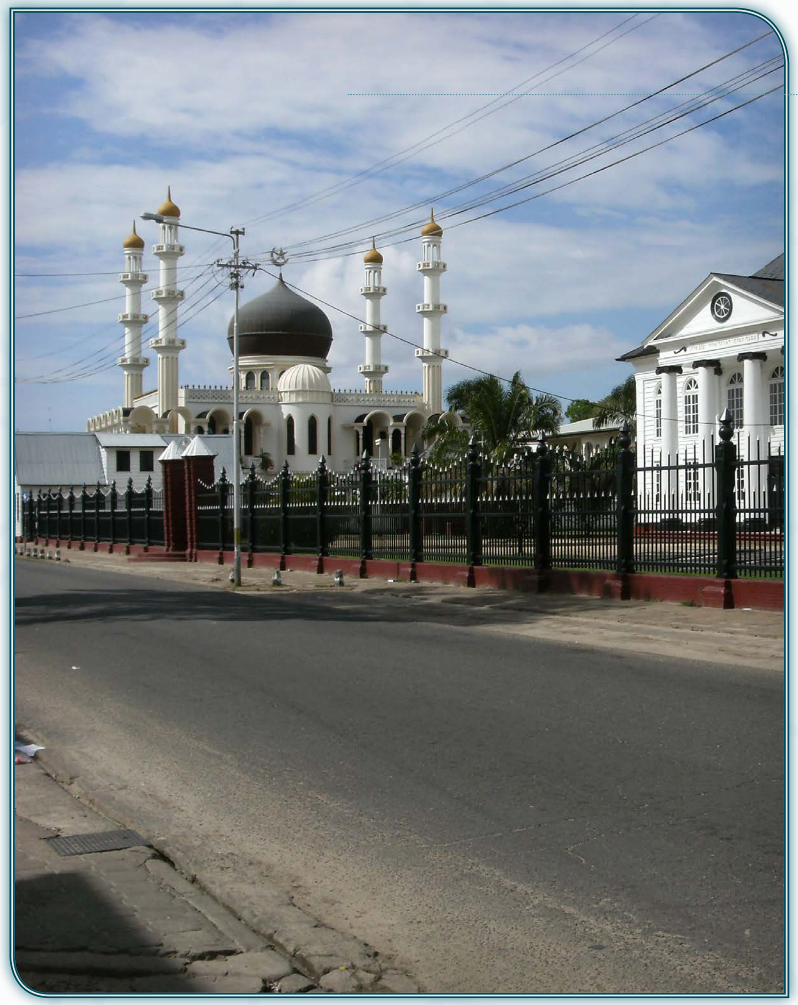
Transit Fare Collection – AVL – Traveler Information Systems.

- Lima
  Integration of the current two fare collection systems (Metro of Lima and BRT) in Lima is intended. Also a Ticketing and AVLC System for 14,000 urban buses that will operate in the new complementary network of corridors, integration network of corridors and approach routes.
- Trujillo
  Within the framework Sustainable Urban Mobility Plans, "Mobility Pact", a fleet of micro-buses will be renewed with an AVL with security and monitoring systems, control center and fare collection with contactless smart cards.

ITS Master Plan Development.- In a ten years period (2014-2024), up to 21 ITS strategic projects will be developed, as follows:

ACTION LINE	ITS STRATEGIC PROJECT
Competitiveness	Development of ITS systems dissemination platform (2014 – 2016)
	User information systems development manual (2016 – 2019)
	Plan for Public Transport Improvement (2016 – 2019)
Institutional development	Set up of the new national body for ITS systems deployment (2014 – 2016)
	Support to implementation and follow up of the Master Plan (2014-2016)
	Establishment of a public-private work group (2014 – 2016)
	Development of inter-institutional agreements (2016 – 2019)
Systems interoperability	ITS systems telecommunications Master Plan (2014 – 2016)
	ITS systems protocols and standards approval Program (2014 – 2016)
	Electronic toll systems National Interoperability Plan (2014 – 2016)
	Fare Collection systems National interoperability Plan (2014 – 2016)

ACTION LINE	ITS STRATEGIC PROJECT
Operation & Management	National road network control centers Plan (2016 – 2019)
	Processes automation at border crossings (2019 – 2024)
	Registration, monitoring and control of dangerous goods transport Processes automation (2019 – 2024)
	Control centers coordination Manual (2019 – 2024)
	Review and improvement of national vehicles and drivers electronic register (2014 – 2016)
	Electronic center for traffic penalties processing (2016 – 2019)
Infrastructure	Manual for ITS systems deployment in road projects (2016 – 2019)
	Manual for ITS systems deployment in urban mobility management (2016 – 2019)
	Weigh-in-motion deployment (2019 – 2024)
	Park and ride set up (2019 – 2024)



Source: commons.wikimedia.org/wiki/User:Mark_Ahsmann

COUNTRY: SURINAME

SELECTED CITIES

Paramaribo

SOCIO-ECONOMIC INDICATORS[47]

Population	573,311 (July 2014 est.)
Income per capita	$12,900 (2013 est.)
% of public transport trips	N/A
No. of km of primary roads	Total: 4,500km; 1,300km paved[280]
No. of cell phone users	977,000 (2012)
No. of registered automobiles	134,335 (2013)[281]

DESCRIPTION OF ITS APPLICATIONS MARKET[3282]

The IDB country strategy with Suriname focuses on the rehabilitation of important deteriorated sections of the primary road network; and feasibility studies to enhance regional integration.

According to the Trade Policy Review reported by Suriname in April 2013, the road transport will be organized on the basis of policy for passenger and freight transport. Legal provisions for road transportation which are adapted to the basic principles ofsafety, effectiveness and efficiency are to be adjusted or replaced. The reorganization of PublicTransport is also one of the main objectives, concretely adjusting the licensing policy and the organizationof the taxi sector.

The ITS applications market is not developed in Suriname. As shown in the information below, ITS applications have not been introduced in the country in most of the areas selected in the study. The reorganization of public transport may bring potential opportunities for the deployment of intelligent transport systems in the city of Paramaribo, but no concrete measures are planned at the moment.

Source: de.wikipedia.org/wiki/Benutzer:Oz

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[355/283]

SURINAME

The Suriname is heavily dependent on roads for internal and intra-regional transportation, with riverand air travel playing a supporting role to service areas difficult to access overland. The road network comprises 4,500 km, of which 1,300 km are mainly inter-regional, primary paved roads.

The physical state of the road network is uneven with important sections deteriorating, thus reflecting the need fo ra more structured approach to routine road maintenance and its financing.

The main roads are the East-West Corridor between Albina and Nieuw Nickerie and the North-South Corridor between Paramaribo and Brokopondo. Suriname's road network connects with Guyana and French Guyana by ferries across the Corantijne River in the west and the Marowijne River in the east.

In Suriname, the buses are private. The drivers, however, follow collectively determined routes. The buses are somewhere between private taxis and public transportation and leave the bus station only when they are totally full, meaning there have not specific schedules.

Paramaribo is served by the Johan Adolf Pengel International Airport and Zorg en Hoop Airport for local flights.

Rivers and canals are an important means of transport. The lower courses of the larger rivers are accessible to oceangoing vessels.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

SURINAME

PARAMARIBO[284]

Transitway Modes:

BRT	NO
Underground	NO
Urban Buses	Buses are a mix of public minibuses and private taxis, called "wild buses": minibuses where small time entre-preneurs (bus operators) service regular routes. Along the route there are bus stops but they are not placed everywhere
Other	Taxis leave from the same areas as the minibuses Boats

ITS APPLICATIONS						
CITIES	TRANSIT FARE CO-LLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRON-MENT
Paramaribo[285]	NO	NO	NO	NO	NO	NO. In 2010, several traffic cameras were installed along Suriname's roadways in an attempt to thwart speeding traffic. It is unclear, however, whether the cameras are operational

SURINAME

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

There are not many traffic signals, most intersections are not signaled.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY,...)

N/A.

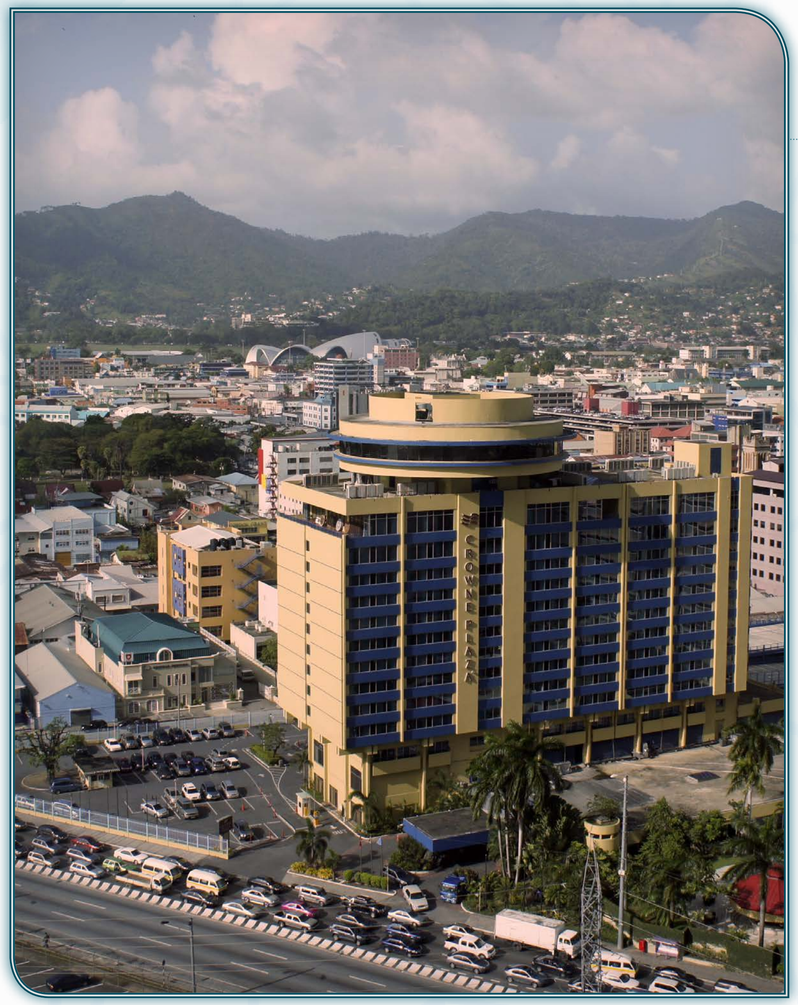
ELECTRONIC TOLL COLLECTION

There are no toll roads in Suriname.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

FUTURE DEVELOPMENTS

Most upcoming projects are related to road extension and rehabilitation.



Source: commons.wikimedia.org/wiki/User:Mariordo

COUNTRY: TRINIDAD Y TOBAGO

SELECTED CITIES

Port of Spain

SOCIO-ECONOMIC INDICATORS[47]

Population	1,223,916 (July 2014 est.)
Income per capita	$20,300 (2013 est.)
% of public transport trips	N/A
No. of km of primary roads	Total: 8,320 km; 4,252 km paved
No. of cell phone users	1.884 million (2012)
No. of registered automobiles	321,191 (2010)

DESCRIPTION OF ITS APPLICATIONS MARKET[286]

The 2011-2015 IDB Country Strategy with the Republic of Trinidad and Tobago established transport as one of the key priority areas. The government's reform agenda aimed at implementing a comprehensive road maintenance and rehabilitation system to improve the quality, sustainability and safety of the roads.

The Ministry of Works and Infrastructure (MOWI) is developing a Highways Information System, to assist in the planning, design, construction, management and preservation of the highway network. The project would entail the development and implementation of all the various modules a System Management including Intelligent Transportation Systems.

At the same time, the Traffic Management Program will address the need for modern, reliable traffic management infrastructure through the installation of pavement markers, road markings, traffic signs and signals. These initiatives represent future investment opportunities for the implementation of intelligent transport systems in the country.

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM

Source: flickr.com/people/10039026@N03

Trinidad and Tobago has an extensive network of highways and roads connecting most points of the islands, with a total of 8,320 km, all of them are paved. Trinidad Island also has a small highway network, which consists of two 4-lane freeways: Churchill Roosevelt Highway, runs from Port of Spain to Arima, and extends for 45 km, and Sir Solomon Hochoy Highway, runs from San Juan to San Fernando and extends for 50 km.

The Highways Division of the Ministry of Works and Infrastructure is currently responsible for 2,050 km of the 9,592 km (or 21%) of roads throughout Trinidad. For Tobago, road infrastructure works are carried out by the Tobago House of Assembly's (THA's) Division of Infrastructure and Public Utilities (DIPU).

Trinidad and Tobago has a wide-ranging system of public transport, including a state owned bus service, taxis and maxi-taxis (mini buses and vans). State owned buses are run by the Public Transport Service Corporation (PTSC) and are clearly marked with the company's name and logo.

In Port of Spain all maxi-taxis and buses heading out of the city are centrally housed in the transportation hub known as City Gate. Cars, taxis and privately owned minibuses, called maxi taxis, are the most popular form of transport on the islands. The Port Authority of Trinidad and Tobago (PATT) manage a daily ferry service providing transport for passengers, vehicles and cargo between Port of Spain and Scarborough.

The island of Trinidad, Port of Spain is served by the Piarco International Airport.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

TRINIDAD Y TOBAGO

PORT OF SPAIN[287]

Transitway Modes:

BRT	No, but there is a Priority Bus Route (which is dedicated to public and private bus and minibus traffic and runs along the former Trinidad Government Railway line)
Underground	No
Urban Buses	The Public Transport Service Corporation is a public bus transport company appointed by the government; 8 city routes
Other	---

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELLR INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Port of Spain[288]	---	---	Website	NO	National Traffic Management Center (NTMC): Centralized Traffic Signal System · Central Corridor Traffic Management System · Closed Circuit Television Subsystem (CCTV) · Variable Message Sign Subsystem (VMS) · Vehicle Detection Subsystem (VDS) · Communications Subsystem The Traffic Signal System provides centrally coordinated signal timings Modernizing the signal equipment at 11 intersections allowed integration with the wireless communications infrastructure, and provided the centralized control of the field equipment Investment: 42 million USD	Monitoring and control of 10 CCTV cameras, two variable message signs, and 17 vehicle detectors SPEED detectors, cable-barriers and traffic-light enforcement

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[289]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

The Ministry of Works and Transport in Port of Spain, Trinidad has deployed a National Traffic Management System. The system includes roadside traffic equipment such as traffic signals, variable message signs, traffic detectors and CCTV cameras, and a wireless communications system, as well as designing and constructing the National Traffic Management Center (NTMC) for monitoring and operating the new equipment. The NTMC serves as the central hub for traffic operations in Trinidad. Located in the ministry's headquarters, the high-profile center is a state-of-the-art facility allowing operations staff to monitor the highway into Port of Spain.

The NTMS is the control-center for other systems which manage traffic on the East-West Corridor and conduct traffic surveillance.

Port of Spain Highways are equipped with CCTV cameras, road signage, lane markings, cat eyes and other safety features.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...

The Traffic Management Program will address the need for modern, reliable traffic management infrastructure through the installation of pavement markers, road markings, traffic signs and signals. During the first phase, thirty (30) heavily trafficked routes have been identified for improvement and designs are currently being undertaken with construction scheduled for the first quarter of the new fiscal year.

ELECTRONIC TOLL COLLECTION

N/A.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

N/A.

FUTURE DEVELOPMENTS

To ease the current traffic jams that result in two to three hour commutes during rush hours, a number of projects are in various stages of implementation. The upgrading of the Churchill-Roosevelt highway to a grade separated expressway is one of the future projects.

The Government of the Republic of Trinidad and Tobago, through the Ministry of Works and Infrastructure (MOWI), is developing a Highways Information System, to assist in the planning, design, construction, management and preservation of the highway network. The project would entail the development and implementation of all the various modules a System Management including Intelligent Transportation Systems.

Source: commons.wikimedia.org/wiki/User:Marceloracosta

COUNTRY: URUGUAY

SELECTED CITIES

Montevideo

SOCIO-ECONOMIC INDICATORS[47]

Population	3,332,972 (2014)
Income per capita	$16,600 (2013)
% of public transport trips	Montevideo: 55%
No. of km of primary roads	Total: 77,732 km; 7,743 km paved
No. of cell phone users	5 million (2012)
No. of registered automobiles	1,604,464 (2011)[290]

DESCRIPTION OF ITS APPLICATIONS MARKET[291]

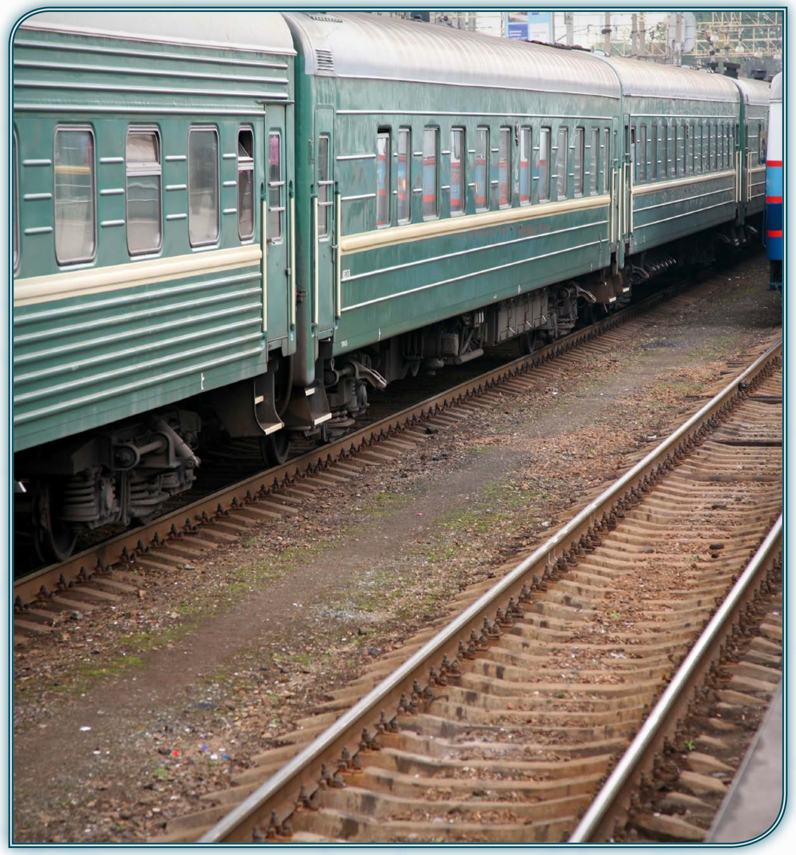
The ITS applications market is under developed in Uruguay. However, in the city of Montevideo, the development of an Integrated Transport System (Metropolitan Transportation System, STM) has led to some ITS applications implementation within the Mobility Control Center (Centro de Control de la Movilidad), such as CCTV, signal synchronization, Variable Message Signs (VMS) with information, GPS in buses, electronic smart cards for public transport, etc.

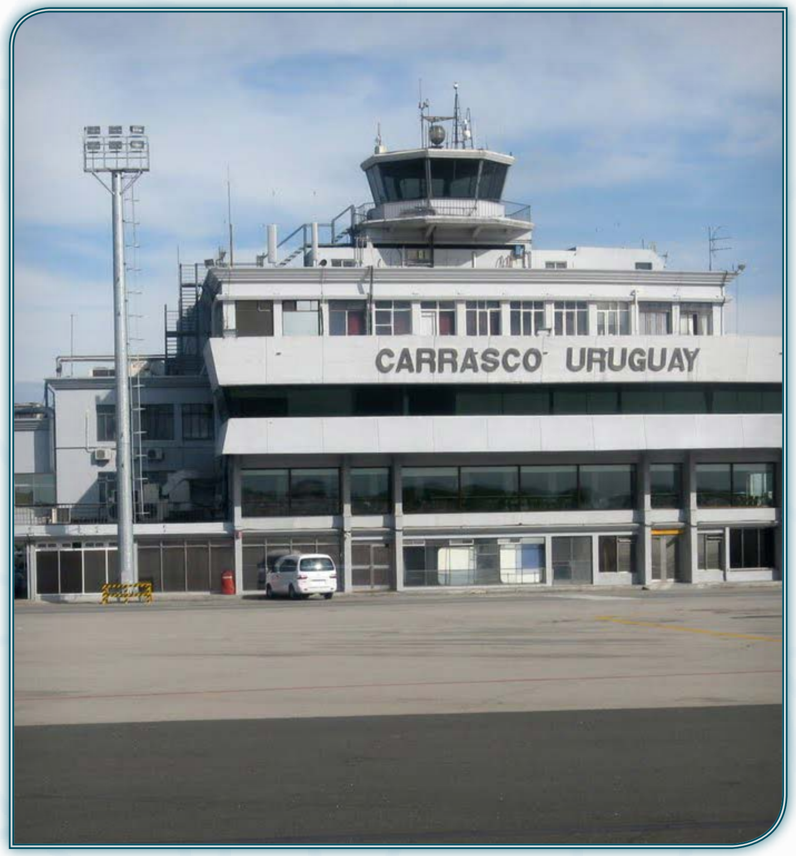
The Municipality of Montevideo has also drafted an Urban Mobility Plan. The main component of the project is the development of the Metropolitan Transport System, which seeks to improve and rationalize the current public transport services provision under quality, productivity, profitability, and coverage criteria.The strategy includes the provision of a modern infrastructure, new technologies and operations and management schemes. The initial phases have also previewed the implementationof ITS collection systems through the use of touchless pre-paid smartcards.The construction of the BRT system will not only require the implementation of ITS applications linked to the fare collection, but also operation management, user information and traffic control systems.

URUGUAY

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[292]

The main transport network in Uruguay is the road network. It has a length of 77,732 km and it is managed by the National Road Directorate DNV (Dirección Nacional de Vialidad (DNV)). The main feature is that most roads converge in the capital Montevideo. Only 10% of the network is paved. 1,600 km of the national routes are tolled roads managed by the private concessionaire CVU (Corporación Vial del Uruguay S.A.) own by National Development Corporation (Corporación Nacional para el Desarrollo (CND)) a publicly owned entity.





The railroad network comprises more than 3,000 km of which only 1,650 km are currently in operation. The tracks are medium or standard gauge (1,435 mm).The State Rail Administration (Administración de Ferrocarriles del Estado (AFE)) is the rail track manager and operator of passenger services. Since 2011 the Rail Logistic Society (Sociedad Logística Ferroviaria (SLF)), participated by AFE and CND (Corporación Nacional para el Desarrollo), operates the freight transport services.

Uruguay ranks lower in terms of transport infrastructure and relatively well in terms of logistics, which includes regulations and other aspects that affect the cost of moving goods towards markets. Performance is good especially in terms of customs, timeliness and logistics competence. Furthermore, Uruguay has made improvements in logistics, increasing its overall performance index (LPI) by almost 0.5 between 2007 and 2012; the biggest improvement within Latin America.

Uruguay has two main airports, Aeropuerto Internacional de Carrasco located in Canelones, within the Metropolitan Area of Montevideo, and Aeropuerto Internacional de Laguna del Sauce, in Maldonado.

URUGUAY

MONTEVIDEO[293]

Transitway Modes:

BRT	Sistema de Transporte Metropolitano (STM): 1/6 projected corridors; 17 Stations; 6 km; 9,000,000
Underground	There is no underground system
Urban Buses	Feeder lines STM (Sistema de Transporte Metropolitano); 145 lines; 4,250 stops; 1,528 buses; 429 control points; 110 destinations; 5 private companies (Coetc, Comesa, Cutcsa, Raincoop, Ucot); 7 transfer points; 294 million passengers per year
Other	Administración de Ferrocarriles de Pasajeros (AFE): 3 lines and 6 stations in Montevideo Movete: Shared Bicycle system; 8 stations; 80 bicycles; control and management web center

CITIES	ITS APPLICATIONS					
	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRONMENT
Montevideo[294]	Smartcard "Tarjeta STM" in Sistema de Transporte Metropolitano (STM) and Movete	Mobility Management Center of Montevideo (Centro de Gestión de la Movilidad de Montevideo (CGM)): GPS Control System in STM	10/120 variable message signs. Information of incidents and traffic conditions and public transport. STM Montevideo App Web, social networks and apps of Movete	Movete. 80 bicycles; 8 stations	Mobility Management Center of Montevideo (Centro de Gestión de la Movilidad de Montevideo (CGM))	Intelligent Traffic Lights System planned in 400 intersections 150 CCTV cameras planned

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[295]

URUGUAY

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

The country has created the National Road Safety Unit (Unidad Nacional de Seguridad Vial (UNASEV)).The 2014 Action Plan of UANSEV has among its objectives to promote the implementation of transit control technology (speed, etc)[296].

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

There are 2 speed control radars in Ruta InterBalnearia.

ELECTRONIC TOLL COLLECTION

Electronic toll collection is available in all tolled roads managed by CVU (13 tolls).

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

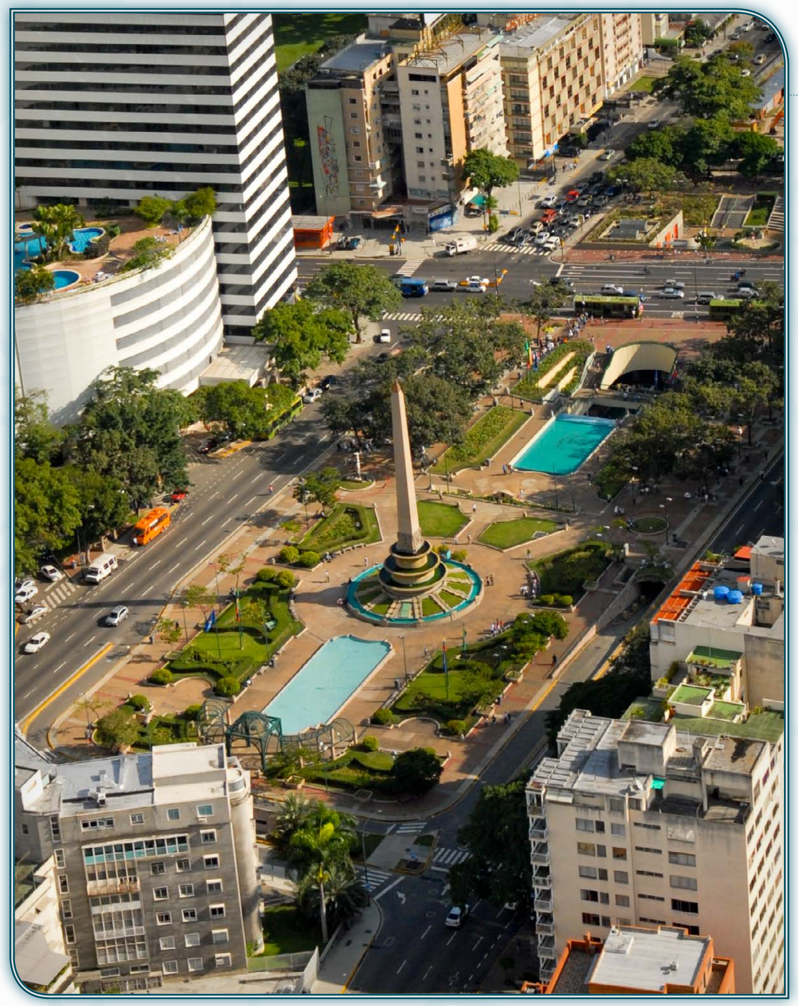
FUTURE DEVELOPMENTS[297]

Montevideo: Municipality of Montevideo (IMM) plans to provide the Mobility Management Center with a traffic lights synchronized system of 400 intersections and 120 Variable Message Signs at key points and 150 CCTV cameras with LED technology to manage and control traffic in the city.

The Mobility Plan of Montevideo also proposes to install speed cameras for traffic control, and increased coverage of signalized intersections.

As for public transport, this plan proposes the introduction of a public bicycles system to encourage the use of sustainable transport modes in the city.

In addition, the construction of the BRT system and the Integrated Transport System (STM) will involve the Implementation of ITS applications required for the correct operation of the public transport system, fare collection, operation management, user information systems, etc.



Source: *flickr.com/photos/manurey/*

COUNTRY: VENEZUELA

SELECTED CITIES

Caracas

SOCIO-ECONOMIC INDICATORS[47]

Population	**28,868,486 (2014)**
Income per capita	**$13,600 (2013)**
% of public transport trips	**Caracas 57%**
No. of km of primary roads flickr.com/photos/manurey/	**Total:96,155 km; 32,308 kmpaved**
No. of cell phone users	**30,52 million (2012)**
No. of registered automobiles	**4.051,705 (2007)**

DESCRIPTION OF ITS APPLICATIONS MARKET

The Government of Venezuela has designed a Programme of Massive Surface Transport System (Programa de Sistemas Masivos de Transporte Superficial) to restructure urban and interurban public transport and improve its quality. Linked to this programme, the government (National Foundation Fund for Urban Transport / Fundación Fondo Nacional de Transporte Urbano – FONTUR) also designed a National Plan for the Maintenance and Recovering of the Public Transport Fleet (Plan Nacional de Mantenimiento y Recuperación de Flota de Transporte Público) within the framework of the tenth goal of the Master Transport Plan 2013-2019, which refers to "Managing a feasible model for acquiring and improving the transport fleet. One of the goals envisioned in the plan is to monitor and control the geographic location of the fleet, preventive maintenance and fleet utilization through the Fleet Control Center[299].

Additionally within the Master Transport Plan, FONTUR designed the Integral Toll Rehabilitation Plan (Plan Integral de Rehabilitación de Peajes) with the objective to modernize toll stations and improve freight collection systems. Currently, only freight transport is subject to pay tolls. FONTUR is managing 21 toll stations, and their objective is to improve the electronic toll collection systems for freight transport.Mechanisms to control weight and height for commercial vehicles transporting goods will be implemented in the current 21 toll stations.

As a result, potential development is foreseen in the country in the areas of urban and interurban transport with the implementation of the BRT system and also in transit control and e-toll.


Source: commons.wikimedia.org/wiki/Wellbore

DESCRIPTION OF THE NATIONAL TRANSPORTATION SYSTEM[300]

Venezuela has a road network of around 96,155 km in length, from which around a third of the roads are paved. The country has a limited national railway system, which has no active rail connections to other countries. Railway expansion projects are currently on hold. Several major cities have metro systems; the Caracas Metro has been operating since 1983. The Maracaibo Metro and Valencia Metro were opened more recently.

The country has recently designed transport promotion plans and programs to improve the quality of urban and interurban public transport.

Venezuela is connected to the world primarily via air through the Simón Bolívar International Airport in Maiquetía, near Caracas and La Chinita International Airport near Maracaibo and sea with major sea ports at La Guaira, Maracaibo and Puerto Cabello. The Orinoco River is navigable up to 400 km inland, and connects the major industrial city of Ciudad Guayana to the Atlantic Ocean.

DESCRIPTION OF THE URBAN TRANSPORTATION SYSTEM IN THE SELECTED CITIES: Main and emerging cities

CARACAS[301]

Transitway Modes:

BRT	BUSCARACAS
Underground	Sistema Metro de Caracas[303]. 4 lines. Currently, the C.A. Metro de Caracas executes a set of lines expansion projects, as in the case of Line 5 and the System Caracas - Guarenas – Guatire (30 km, 7 stations. The company is also carrying out the renovation and refurbishment of Line 1 Line 1 - Propatria-Palo Verde: 20.36 km, 22 stations, 1,200,000 passengers per day Line 2 - Las Adjuntas / Zoológico / El Silencio: 17.81 km, 13 stations, 250,000 passengers per day Line 3 - Plaza Venezuela / El Valle: 4.38 km, 4 stations, 120,000 passengers per day Line 3 (Section 2-Phase 1) - El Valle-La Rinconada 5.97 km, 3 more stations under construction Line 4 Capuchinos-Zona Rental: 5.5 km, 4 stations, 40,000 passengers per day Metro Los Teques (Fase 1): 9.5 km, 20,000 passengers per day

Urban Buses	Metrobus – feeder service for Metro, 57 lines and 220 buses Urban buses – 457 lines: 1,220 buses and more than 10,000 microbuses
Other	Metrocable de Caracas – includes cablecars integrated as feeder lines within the Metro system in order to provide accessibility to neighbourhoods located uphill. There are two lines in service (Metrocable de San Agustín – 2.1 km and 5 stations; and Metrocable de Mariche-Palo Verde – 4.84 km and 2 stations). Future plans include 2 more Metrocable lines; Max 20,000 passengers per day Transmetropoli. Metropolitan Transport System. 24 lines; 138 stations Ferrocarril Caracas-Cúa; 41.4 kmskm; 3 stations; 100,000 passengers per day Cabletren Bolivorianounder construction (expected to be finished in 2014) 2.1 Km, 5 stations

VENEZUELA

ITS APPLICATIONS						
CITIES	TRANSIT FARE COLLECTION	AVLC	TRAVELER INFORMATION SYSTEMS	SHARED MOBILITY SYSTEMS	URBAN TRAFFIC MANAGEMENT	ENFORCEMENT IN URBAN ENVIRON-MENT
CARACAS[304]	---	CCO Metro Caracas Intelligent Fleet Management System de Transmetrópoli	Transport and Transit Metropolitan Information System (Sistema Metropolitano de Información sobre Transporte, Tránsito y Vialidad) of the metropolitan area of Caracas (INMETRA) Audio information in Metro Web and social networks in Metro Transmetropoli Metro Electronic panels on buses Transmetropoli y BusCaracas	There is no Shared Bicycles system	Metropolitan Intelligent Traffic Lights Network	Metropolitan Intelligent Traffic Lights Network has 228 intelligent traffic lights equipped with GPS system, 34 Traffic Controllers, 60 Synchronized GPS Kits ("Onda verde") 5km of High Occupancy Vehicle (HOV) reversible traffic lane

DESCRIPTION OF IDENTIFIED ITS APPLICATIONS IN THE COUNTRY[305]

INTERURBAN TRAFFIC MANAGEMENT (e.g. TRAFFIC SIGNAL, DETECTORS, VMS)

N/A.

ROAD SAFETY IN INTERURBAN ENVIRONMENT (SPEED CONTROL, WEATHER INFORMATION, TUNNEL SAFETY, ...)

There are 36 speed radars in expressways.

ELECTRONIC TOLL COLLECTION

Tolls administration is currently being transferred to the regional governments, but at the moment there are not any e-toll applications implemented in the country.

AUTOMATIC VEHICLE IDENTIFICATION (BORDER CROSSING)

Sistema Aduanero Automatizado (SIDUNEA World)/ Automatic Border System is an software tool used by the Border Administration / Administración Aduaneray Tributaria, to register, exchange and process information, as a tool to control goods/freight subject to international traffic.

FUTURE DEVELOPMENTS[307]

In 2008 tolls were removed claiming that many did not meet the minimum distance allowed between them. The system did not provide and alternative road free of charge and the revenue did not meet the objective of maintaining the roads in proper condition.

In 2014 the Government announced the reactivation of tolls through a Comprehensive Rehabilitation Plan, clarifying that only freight transport would be charged, since these were the main cause of asphalt deterioration. Mechanisms to control weight and height for commercial vehicles transporting goods will be installed.

Caracas: The construction of the BRT and the new metro line systems involve the implementation of ITS applications required for the correct operation of the public transport system.

6

CONCLUSIONS

Conclusions

More than 480 million people live in cities in Latin America and the Caribbean. Nowadays, 80% of the LAC region population is living in urban areas and expected to rise in a 9% by 2050, what makes LAC the most urbanized region in the world.

The motorization rate is increasing rapidly in major cities, such as Santiago de Chile or Mexico DF, although in the region is still clearly below the average of OECD countries. This growing reliance on private transport is intensifying some transport problems in the whole LAC region, and despite the differences and logical particularities of each country, they share similar transport concerns: increased congestion, pollution and environmental deterioration, insufficient road safety, lack of infrastructure and low levels of competitiveness and productivity.

Intelligent Transport Systems provide efficient solutions to improve mobility, road safety and environmental problems, with a low investment; therefore, they are a very interesting tool, particularly in large cities and metropolitan areas with increasing demand.

With the aim of compiling and sharing the knowledge of successful ITS experiences and fostering best practices on ITS deployment, this report focuses on the 10 key ITS applications that better respond to transport sector needs and priorities in the LAC region, and then presents a country-by-country analysis of these ITS applications. The 10 key ITS applications are:

AREA	ITS APPLICATION	
TRANSIT	1	Transit Fare Collection
	2	Automatic Vehicle Location and control systems- AVLC
	3	Traveler Information Systems in Transit Area
	4	Shared Mobility Systems
URBAN TRAFFIC	5	Urban Traffic Management (traffic signal, detectors, VMS, ...)
	6	Enforcement in urban environment (speed control, red-light cameras, left turn cameras, ...)
INTERURBAN ROADS	7	Interurban Traffic Management (traffic signal, detectors, VMS, ...)
	8	Road Safety in interurban environment (speed control, weather information, tunnel safety, ...)
ROAD PRICING	9	Electronic Toll Collection
COMMERCIAL VEHICLES	10	Automatic Vehicle Identification (Border Crossing)

The main conclusions to be drawn from the analysis of all the information compiled, either from ITS application or from country-by-country, are divided into five different sections:

- ITS marketplace in the LAC region.
- ITS systems presence in the LAC region.
- ITS systems state-of-the-practice in the LAC region.
- Findings from the international benchmarking exercise.
- Opportunities and barriers for the ITS systems development in the LAC region.

6.1 ITS market in the LAC region

ITS are already present through many different applications in LAC countries, however there is still a lot to be developed in existing infrastructures and vehicles. New infrastructure and Public Transport development projects are frequently equipped with sophisticated ITS equipment, showing a general acceptance of the positive cost-benefit balance of these technologies, particularly when they are introduced in the engineering process from the first steps.

From the analysis made in the LAC region, the following conclusions may be drawn:

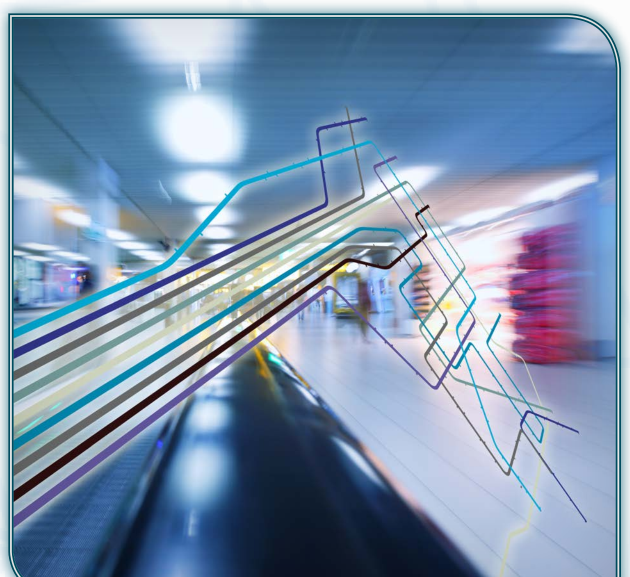
- With regard to the existence of any plan or national strategy for ITS deployment, Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Panama, Paraguay and Peru, among others, receive significant boosts from their local, regional or national public institutions, such as the following:

  The **Argentinean** government is currently investing in road infrastructure projects with some ITS components, with the goals of reducing response times in emergencies, improving dynamic and travel costs of users, transport logistics and cargo, as well as reducing road accidents. Three Ministries will develop various financing research instruments and involvement of local ITS stakeholders.

  Given the upcoming hosting of the Olympics in 2016, **Brazilian** cities will have to invest heavily in the modernization and expansion of its transportation system. The country plans to invest in the construction of new metro lines, light rail train lines, and Bus Rapid Transit systems. At the same time, Brazil is seeking to increase private road concessions and implement Public Private Partnerships (PPP's) to generate new funds for investment in roads, rails, ports and airports.

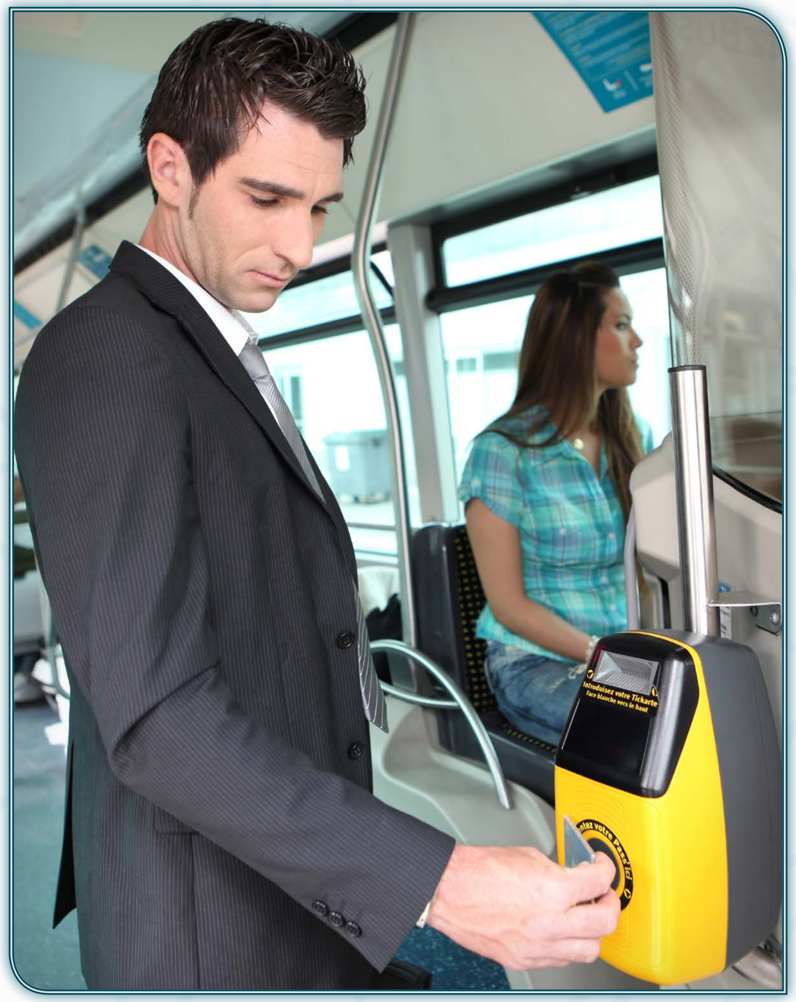
  The National Transport Policy was introduced in **Chile** in late 2013, based on 13 action lines that establish a strong commitment for a massive incorporation of technologies applied to mobility with special emphasis on transit management, information to users and security vehicles.

  In **Colombia**, the National Planning Department (Departamento Nacional de Planeación (DNP)) leads an initiative that aims to boost the transport sector by implementing technology. Because of this effort, Colombia has developed the first version of the National ITS Architecture and the Master Action Plan. The ITS architecture in Colombia intends to integrate all transport modes and pretends to create a public body to lead and coordinate the ITS Development Programme in the country and / or adopt standards and protocols, laws, rules and regulations to support the ITS legal framework, prepare institutional arrangements / agreements and identifying financing sources: public funding, private funding and performance indicators.



The Public Transport Council (Consejo de Transporte Público), the **Costa Rican** public transport authority is specially engaged in the promotion and modernization of the countries' public transport system by introducing ITS technologies, such as fare integration through smart cards or information integration.

In **Mexico**, the Strategic National Development Plan (PND) and Infrastructure and Communication Programme, both published in 2013, include the use of intelligent transport systems (ITS) as a strategy for improving and updating the infrastructure of the different modes of transport.



In **Panama**, the Public Transport Authority of Panama (ATTT) is highly compromised with the modernization of transport in the city of Panama,for example with the creation of the BRT system, and the new metro line of Panama City, where ITS applications (such as smart cards, AVLC, advanced traffic light systems, etc) are being implemented.

By 2013, the **Peruvian** Ministry of Transport and Communications (MTC) prepared the "Intelligent Transportation Systems (ITS) National Architecture and Master Plan" and identified 21 ITS strategic projects grouped in five fields of action, establishing a 10 years horizon for its development (2014-2024).

Obviously, the existence of a policy or national strategy on ITS systems determines higher levels of deployment, as it can also be seen in the following sections.

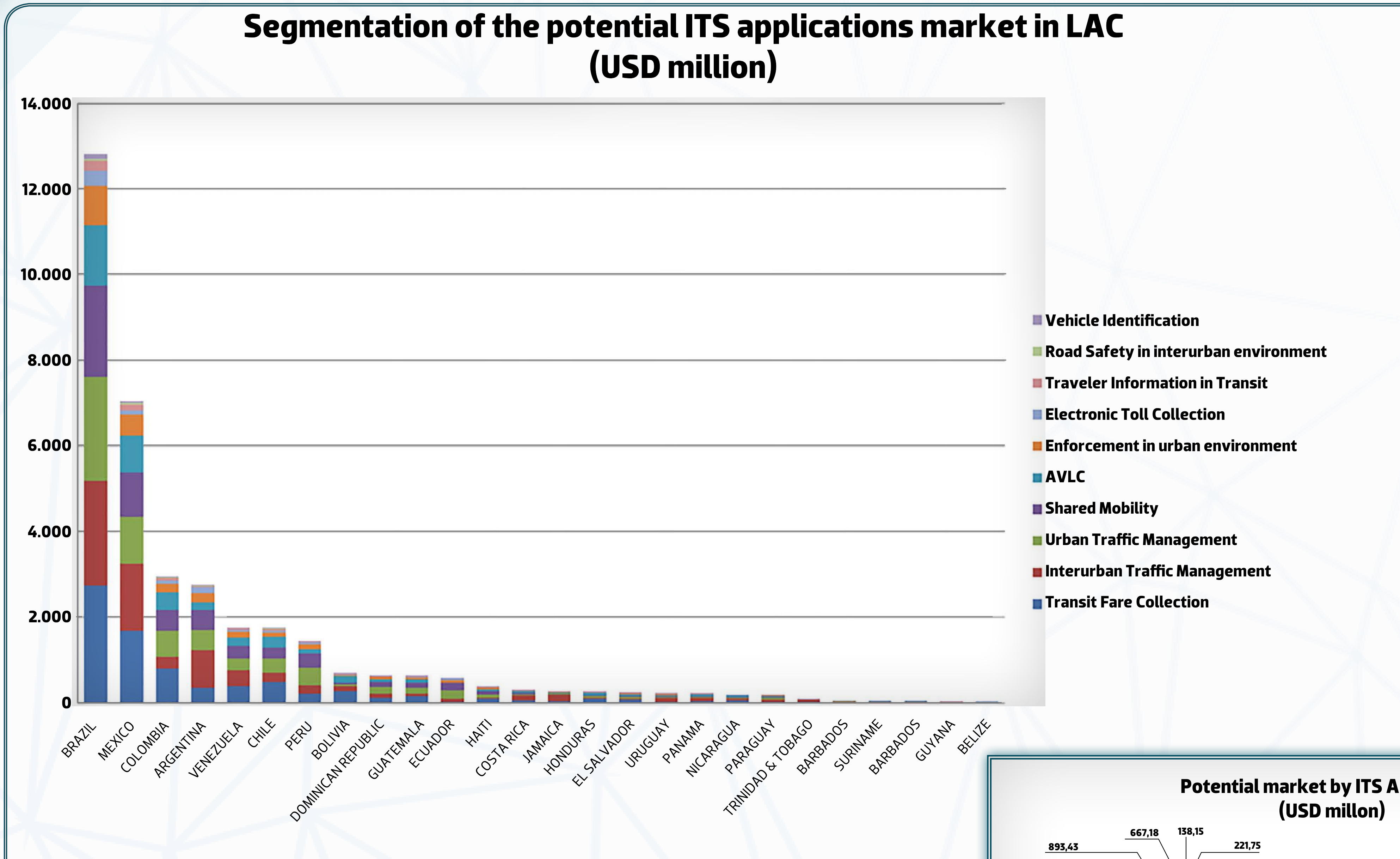
In general, administrations and public-private agencies should know, to a greater or lesser degree, the total amount of necessary investments and reinvestments in ITS systems in their areas of responsibility. Such figures should be spread in time, according to the progress of the different civil works or to the funds availability, but these records are not usually available to the public. However, some interesting figures can give us an idea of the ITS market size, although finding conclusive data on this topic has been rather difficult. Here are some records from three different countries:

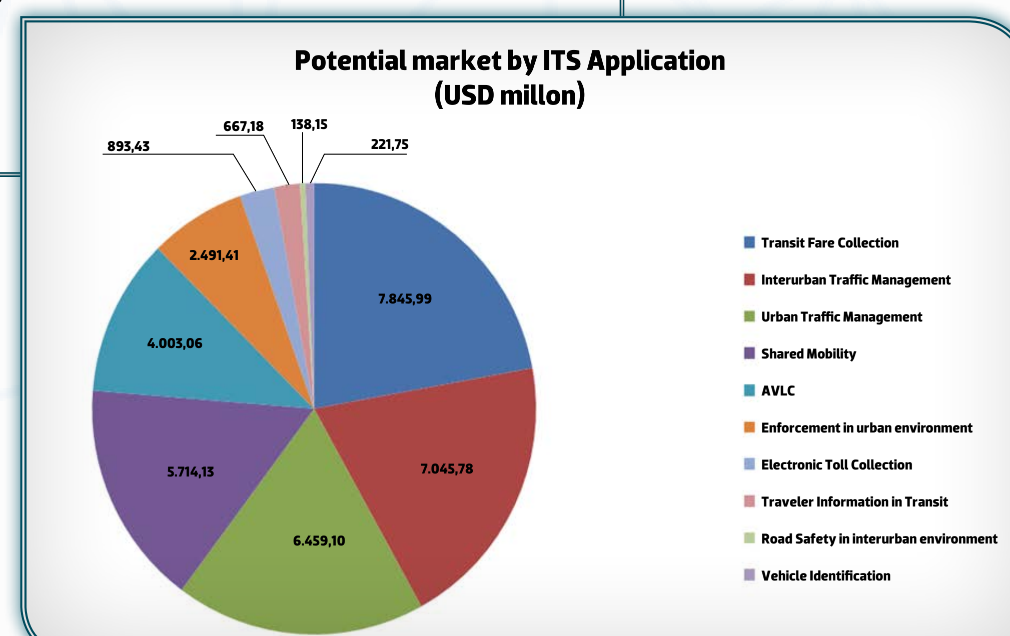
Concerning market size in **Chile**, a multimillion-dollar infrastructure plan was announced to modernize the whole country by mid-2014. This plan considers investments on connectivity infrastructures, water reservoirs and ports for about 18,800 million USD, and investments through concessions (mainly roads) for about 9,900 million USD.

In **Mexico**, as set out in the National Infrastructure Plan (Programa de Inversiones en Infraestructura de Transporte y Comunicaciones), published in 2014, include 386,255 MDP in Road infrastructure, 989,098 MDP in railway and mass transport; 62,381 MDP in Ports and 35,036 MDP in airports.

In **Peru**, according to the Ministry of Transport and Communications (Ministerio de Transporte y Comunicaciones (MTC)) "Achievements Report from Aug 2011 to Jul 2014", from 2011 to 2016, the whole investment in Transport and Communications sector, through Construction and Public-Private Partnerships, will reach 22 billion USD.

A first approach to the market size for the ten ITS applications in LAC countries has been done, resulting in a global estimation of over 35 billion USD. As it is shown in the graph, the most populated countries take the lead when considering ITS opportunities.





The presence of large cities with growing motorization rates and safety problems bring the need of new investments in ITS, taking advantage of technological systems to help to promote Public Transport and optimize the use of available infrastructure with improved mobility and safety standards.

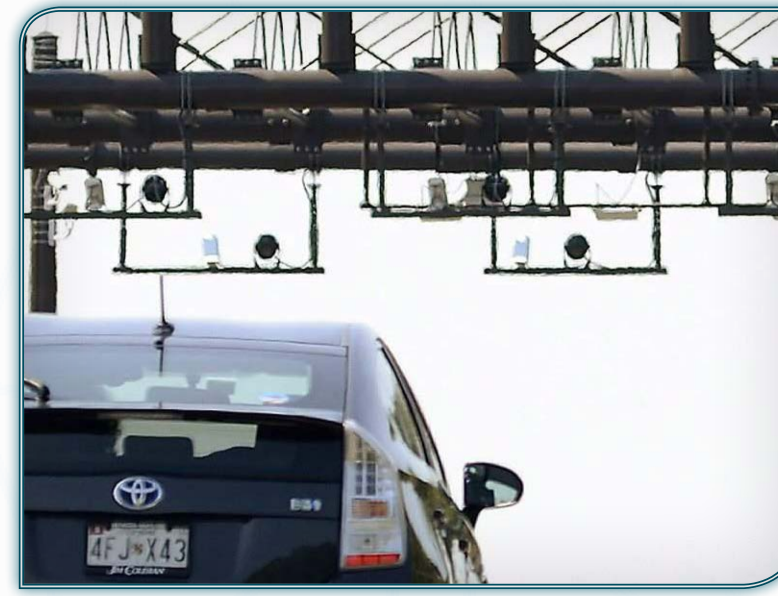
6.2 ITS applications presence in the LAC region

To a greater or lesser extent, and according to the information collected, almost all countries in the LAC region have ITS applications on an urban or interurban basis, with a few exceptions:

- The countries where at least 8 of the 10 analyzed ITS applications have been found are Brazil, Colombia, Argentina, Mexico and Chile.
  Brazil, Colombia, Argentina, Mexico and Chile deserve special mentions for being the ones where more ITS applications were found in main and emerging cities. With regard to interurban applications, only Chile and Mexico have deployed the four types of ITS applications considered; Brazil and Argentina and Mexico have all interurban applications except Automatic Vehicle Identification used in border crossings.

- Incomes per capita of these countries are above the average, and they are the most populated countries in the LAC region, along with Peru and Venezuela.
  As explained in the previous section, all these countries have national strategies or plans for ITS deployment.

In a mid-range are Uruguay, Venezuela, Panama and Guatemala, and, to a lesser extent, Bolivia, Peru and Honduras.
Uruguay, Venezuela, Panama and Guatemala have more major cities with ITS systems deployment, primarily their main cities, as well as up to three interurban ITS applications. In total 6-7 types of applications.
Bolivia and Honduras are examples of wide range of ITS applications on a small scale. It should be noted that all interurban applications considered are already deployed in Bolivia, and almost all urban ones in Honduras (except shared mobility).



Source: sites.google.com/site/skriptaits/

The last country included in this group is Peru, with its main city having deployed at least four ITS applications (except shared mobility and soon enforcement in urban environment in El Callao) and two interurban ones (traffic management and electronic toll collection). It is also interesting to point out that 21 ITS strategic projects have been identified in the "Intelligent Transportation Systems (ITS) National Architecture and Master Plan", establishing a 10 years horizon for its development (2014-2024).

- In a low range there are nine countries, ranked from most to least ITS applications deployed: Ecuador, Costa Rica, Barbados, Dominican Republic, Jamaica, Trinidad and Tobago, Paraguay, El Salvador and Nicaragua.

This heterogeneous group cannot be ranked from similar figures on population or incomes per capita, for example, and they range from five to two ITS applications deployed. No country in this group has Automatic Vehicle Identification at border crossings, and shared mobility in the urban environment is difficult to find (except in Ecuador).

Ecuador is an interesting case in this group, because of the good range of ITS applications deployment in the cities, but not similar in the interurban area (only Electronic Toll Collection). The city of Quito is living an accelerated process of restructuring and innovation in all intervention areas, initiating a process of implementation of ITS solutions to address the needs of public and private transport systems.

- Haiti, Suriname, Belize, Guyana and Bahamas are at the bottom, where no relevant ITS applications have been found.

This is also a heterogeneous group, involving the richest (Bahamas) and the poorest (Haiti) countries in the LAC region. In general terms, Caribbean islands have a lower development level in the implementation of ITS applications. Only Belize has a national road safety strategy, with speed limit enforcement.

In general terms with a few exceptions, factors such as the size, geographic and demographic characteristics, socio-economic configuration, financial resources and the public transport system status determine the development level of Intelligent Transport Systems in a country. Smaller countries have clear constraints given the nature of their configuration (i.e., reduced km of highways and smaller traffic volumes, therefore, less need of electronic tolling systems, reduced institutional support, etc). The number of applications implemented relates to the size, institutional capacity, political will, financial and organizational capabilities, and also depends on the size of cities selected for the study in each country.

An overview of the ITS applications currently deployed in the LAC region can be found on the following pages (ITS presence in the LAC region). Also in section 7 Annex 1: Maps, there is other graphical information concerning presence of ITS applications in the LAC region.

6.3 ITS presence in the LAC region

✓ ITS application available ✗ ITS application not available ➲ ITS application under deployment

INTERURBAN							URBAN					
Interurban Traffic Management	Road Safety in Interurban Environment	Electronic Toll Collection	Automatic Vehicle Identification (Border crossing)	COUNTRY	City	Type of City	Transit Fare Collection	Automatic Vehicle Location and Control Systems-AVLC	Traveler Information Systems in Transit Area	Shared Mobility	Urban Traffic Management	Enforcement in Urban Environment
✓	✓	✓	✗	ARGENTINA	Buenos Aires	Main	✓	✓	✓	✓	✓	✓
					Rosario	Main	✓	✓	✓	✓	✓	✓
					Añelo	Emerging	✗	✗	✗	✗	✗	✗
					Las Heras	Emerging	✓	✓	✓	✗	✓	✓
					Mar del Plata	Emerging	✓	✗	✗	✗	✓	✓
					Paraná	Emerging	✓	✓	✗	✗	✓	✓
					Salta	Emerging	✓	✓	✓	✗	✓	✓
✗	✗	✗	✗	BAHAMAS	Nassau	Main	✗	✗	✗	✗	✗	✗
✓	✓	✗	✗	BARBADOS	Bridgetown	Main	✗	✓	✗	✗	✓	✓
✗	✓	✗	✗	BELIZE	Belmopan	Main	✗	✗	✗	✗	✗	✗
✓	✓	✓	✓	BOLIVIA	La Paz	Main	✓	✓	✓	✗	✓	✓
					Cochabamba	Emerging	✗	✗	✗	✗	✓	✓
✓	✓	✓	✗	BRAZIL	Brazilia	Main	✓	✓	✓	✓	✓	✓
					Sao Paulo	Main	✓	✓	✓	✓	✓	✓
					Rio de Janeiro	Main	✓	✓	✓	✓	✓	✓
					Curitiba	Main	✓	✓	✓	✗	✓	✓
					Florianópolis	Emerging	✓	✗	✓	✗	✗	✗
					Goiânia	Emerging	✓	✓	✓	➲	✓	✓
					Joao Pessoa	Emerging	✗	✗	✗	✗	✓	✓
					Palmas	Emerging	✗	✗	✗	✗	✗	✓
					Vitoria	Emerging	✓	✓	✓	✗	✓	✓

☑ ITS application available ☒ ITS application not available ➲ ITS application under deployment

INTERURBAN							URBAN					
Interurban Traffic Management	Road Safety in Interurban Environment	Electronic Toll Collection	Automatic Vehicle Identification (Border crossing)	COUNTRY	City	Type of City	Transit Fare Collection	Automatic Vehicle Location and Control Systems-AVLC	Traveler Information Systems in Transit Area	Shared Mobility	Urban Traffic Management	Enforcement in Urban Environment
☑	☑	☑	☒	CHILE	Santiago	Main	☑	☑	☑	☑	☑	☑
					Valdivia	Emerging	☒	☒	☒	☒	☒	☒
☒	☑	☑	☒	COLOMBIA	Bogotá	Main	☑	☑	☑	☑	☑	☑
					Medellin	Main	☑	☑	☑	☑	☑	☑
					Cali	Main	☑	☑	☑	☒	☑	☑
					Barranquilla	Emerging	☑	☑	☑	☒	☑	☑
					Bucaramanga	Emerging	☑	☑	☑	☒	☑	☑
					Cartagena	Emerging	☑	☑	☑	☒	☑	☑
					Pereira	Emerging	☑	☑	☑	☒	☑	☑
☑	☑	☑	☒	COSTA RICA	San José	Main	☒	☑	☒	☒	☑	☑
☒	☒	☑	☒	DOMINICAN REPUBLIC	Santo Domingo	Main	☑	☒	☑	☒	☑	☑
					Santiago de los Caballeros	Emerging	☒	☒	☒	☒	☒	☒
☒	☒	☑	☒	ECUADOR	Quito	Main	☒	☒	☑	☑	☑	☑
					Cuenca	Emerging	☑	☒	☑	➲	☑	☑
☒	☒	☒	☒	EL SALVADOR	San Salvador	Main	➲	➲	➲	☒	☑	☑
					Santa Ana	Emerging	☒	☒	☒	☒	☒	☒
☒	☒	☑	☒	GUATEMALA	Ciudad de Guatemala	Main	☑	☑	☒	☑	☑	☑
					Quetzalte-nango	Emerging	☒	☒	☒	☒	☒	☒
☒	☒	☒	☒	GUYANA	Georgetown	Main	☒	☒	☒	☒	☒	☒
☒	☒	☒	☒	HAITI	Port au Prince	Main	☒	☒	☒	☒	☒	☒
					Cap Haitien	Emerging	☒	☒	☒	☒	☒	☒

☑ ITS application available ☒ ITS application not available ➲ ITS application under deployment

INTERURBAN							URBAN					
Interurban Traffic Management	Road Safety in Interurban Environment	Electronic Toll Collection	Automatic Vehicle Identification (Border crossing)	COUNTRY	City	Type of City	Transit Fare Collection	Automatic Vehicle Location and Control Systems-AVLC	Traveler Information Systems in Transit Area	Shared Mobility	Urban Traffic Management	Enforcement in Urban Environment
☒	☒	☑	☒	HONDURAS	Tegucigalpa	Main	☑	☑	☑	☒	☑	☑
☒	☒	➲	☒	JAMAICA	Kingston	Main	☑	☑	☒	☒	☑	☒
					Montego Bay	Emerging	☑	☑	☑	☒	➲	☑
☑	☑	☑	☑	MEXICO	Ciudad de México	Main	☑	☑	☑	☑	☑	☑
					Guadalajara	Main	☑	☑	☑	☑	☑	☑
					Monterrey	Main	☑	☑	☑	☑	☑	☒
					Campeche	Emerging	☒	☒	☒	☒	☒	☒
					La Paz	Emerging	☒	☒	☒	☒	☒	☒
					Xalapa	Emerging	☒	☑	☒	☒	☒	☒
☒	☒	☒	☒	NICARAGUA	Managua	Main	☑	☒	☒	☒	➲	☒
☑	☒	☑	☒	PANAMA	Ciudad de Panama	Main	☑	☑	☑	☒	☑	☑
☒	☑	☑	☑	PARAGUAY	Asunción	Main	☒	➲	☒	☒	☒	☒
☑	☒	☑	☒	PERU	Lima	Main	☑	☑	☑	☒	☑	☒
					Cuzco	Emerging	☒	☒	☒	☒	☒	☒
					Huancayo	Emerging	☒	☒	☒	☒	☒	☒
					Trujillo	Emerging	➲	➲	☒	☒	☑	☒
☒	☒	☒	☒	SURINAME	Paramaribo	Main	☒	☒	☒	☒	☒	☒
☑	➲	☒	☒	TRINIDAD AND TOBAGO	Port of Spain	Main	☒	☒	☒	☒	☑	☑
☑	☑	☑	☒	URUGUAY	Montevideo	Main	☑	☑	☑	☑	☑	☑
☒	☑	☒	☑	VENEZUELA	Caracas	Main	☒	☑	☑	☒	☑	☑

6.3 ITS systems state-of-the-practice in the LAC region

According to the data collected in this study, it is observed that ITS applications have started to find their way in the LAC region, mainly in the urban environment, as a response to the transportation needs due to the rapid population and vehicle fleet growth in the cities that lead to congestion problems, environmental issues, etc.

Therefore, it seems logical that **Urban Traffic Management** is easily found in every large city, commonly in the form of centralized traffic light systems, since they allow improving mobility, adapting their cycles to traffic conditions. According to the information collected, 41 main and emerging cities have such application, and 2 more are already under construction. Bahamas, Belize, Guyana, Haiti, Paraguay or Suriname have little or no experience with urban centralized traffic systems.

The level of sophistication of this application may vary a lot from one city to another; there are cities with isolated local traffic lights, and other cities with a centralized management center assisted with CCTV cameras and dynamic signs, such as Rio de Janeiro, Santiago de Chile or the city of Panama among others.

Enforcement systems, are also commonly found as a key tool to rise safety standards though a higher respect to traffic rules. Moreover, it is a self-financing application through user fines, catching the attention of urban mobility administrators. In particular, 39 main and emerging cities have such an application deployed, and the same previous countries together with Nicaragua have little or no experience on this field.

However, without any doubt, those technologies related to **Public Transport** are booming in the LAC region. To combat mass transport deficiencies (over demand, old vehicles, rates not adjusted, etc.) many cities are reorganizing and renewing the fleet of vehicles. In this context, incorporation of ITS applications such as **Fare Collection Systems, AVL systems** or **Passenger Information Systems** are considered. Among these technologies, the first to be installed are Fare Collection Systems, aiming a better control of the money collected and the demand, and shorter boarding times through smartcards; then, together with the necessary renewal of the fleet, vehicles are also frequently equipped with Automatic Vehicle Location Systems and Passenger Information Systems, (mainly through mobile apps, at stations, on board or on the Internet).

In particular, 27 cities have the three systems mentioned, and it is worth mentioning that all cities selected from Colombia are included in this group, as well as all main and some emerging cities from Argentina, Brazil and Mexico, and the capitals from Bolivia, Chile, Panama, Peru and Uruguay. On the contrary, there are no experiences in this field in Bahamas, Belize, Costa Rica, Guyana, Haiti, Suriname and Trinidad and Tobago.

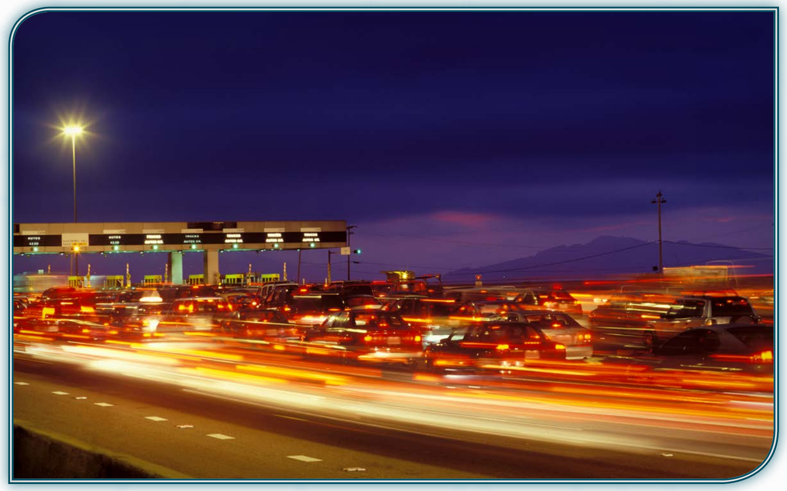
The rise of the BRTs in the region, explained in part by the successful reference in the city of Curitiba (Brazil), has gone hand in hand with the implementation of these three systems, extending their use also to other modes of transport. That is when a user satisfaction approach appears.

With the underlying idea of achieving a more sustainable urban transport and minimize pollution, up to 14 Latin American cities include **Shared Mobility** programs, but only a few ones incorporate current ITS technologies for their management. Such is the case of Rosario in Argentina, Bogotá in Colombia, Quito in Ecuador and Guadalajara in Mexico.

The analysis of the state-of-the-practice at cities' level, reflects that most Latin American capital cities have a high development level, taking into consideration that most of them have deployed or are in the middle of a planning or construction process of integrated transport systems, and thus have implemented or are implementing Transit Fare Collection Systems, Automatic Vehicle Location and Fleet Management systems, Traveler Information Systems, Urban Traffic Control and Management Centers, etc. It could be as a result of a more latent need for technological systems to solve major congestion problems, environmental issues, and mass transit demand.

At national level, the ITS application most frequently found was **Electronic Toll Collection**, with experiences in 15 of the 26 countries in the LAC region, mainly for two reasons: first, the cost-benefit relation due to the efficiency of this application, and second, that investments are in hand of private companies. In the next years, some nationwide interoperable electronic toll collection systems and some free flow tolling projects will be a reality, with some advanced deployments as the one in Santiago de Chile with several free flow interoperable systems coexisting in a single city.

It should be noted in this point that there are several solutions adopted. For example, Santiago de Chile uses TAGs based on European standards (CEN 5.8 GHz), Colombia uses active TAGs (CEN 5.8 GHz) and passive TAGs (ISO 18000-6C) that are not interoperable. Only Brazil and Mexico have recently regulated interoperability at a national scale. In fact, according to the information collected, ETC systems interoperability is the pending subject in the LAC region.

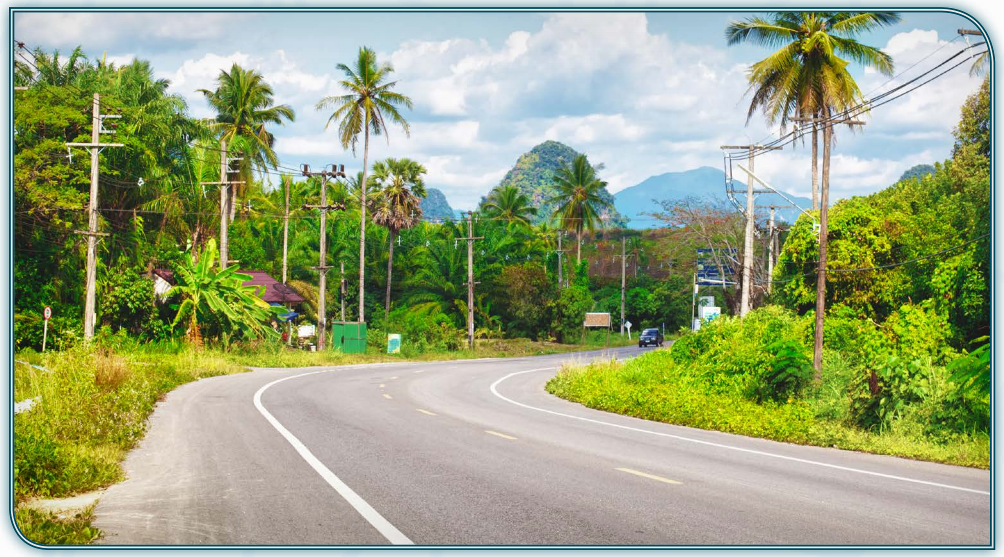


In the field of **Interurban Traffic Management**, existing ITS applications for traffic and safety management have still a long way ahead, since they are only present in some private concessions. However, there is a rising awareness by the Administrations in some countries to include, in the tender documents of new infrastructures, service requirements that force ITS systems investments.

Finally, **Border Crossing** applications based on **Automatic Vehicle** Identificationhave the lowest deployment levels, only present in 4 of the 26 countries: Bolivia, Mexico, Paraguay and Venezuela.

6.4. Findings from the international benchmarking exercise

Throughout the document, unquestionable benefits of ITS systems applied to traffic and transport have been shown, both for companies/institutions that deploy them and daily users. Improvements in road safety and people mobility, productivity, environmental and congestion reduction are clearly irrefutable; but it is also important to see some benefits from other points of view, as a conclusion from the international benchmarking exercise shown in this report.



Today, offering a comfortable and secure road network is as important as providing a high-quality user service. A service based on control and information systems that enable practical features to make more comfortable transit and travels for users. A service that, at the same time, allows managers to collect relevant data related to the use of the infrastructure or the modes of transport; an appropriate data mining process of these data will provide infrastructure managers a powerful tool for a better planning. This will reduce the need to undertake costly investments in adding capacity to the existing road network or transportation system, thus achieving a more efficient public resources management.

A good example of this would be real time and on-route traffic information dissemination, to warn users of incidents and recommend alternative routes to take. Thus, in case of an incident or emergency, underused roads could serve as alternative routes, mitigating the effects of the incident and resulting in a balanced use of the road network. In the same way, transit users also need to be able to react easily and in time in case that the bus they are about to get may be delayed, or there is a problem in their transfer to another transportation mode. Indeed, it is in such situations when the public administration's efforts are most appreciated by users or taxpayers.

The ten ITS applications shown in this document are probably the most important ones in terms of needs or demand, and certainly closer to the LAC region countries specific needs. However, they are not by far the only ITS applications. Some of them are very interrelated, as is the case of the three first "Transit" applications in an urban environment, usually implemented at the same time, or gradually in case of budget constraints (Transit Fare Collection, Automatic Vehicle Location and Control Systems and Traveler Information Systems in Transit Area). These applications highlight the importance of Public Transport in Latin-American big cities, with a rapidly increasing demand of mobility.

As it has also been shown in the document, many countries in the LAC region already have a first-hand knowledge of the benefits achieved, according to the ITS applications deployment and their operation and maintenance experience, either at local, regional or even national level. That is the case of Argentina, Brazil, Chile, Colombia, Mexico or Panama, among others. Based on the previous experiences, approximate deployment investment amounts are also included, although the final cost of any project will vary depending on the desired objectives or features.

As a result of the analysed experiences, it is relevant to include in this section some key issues in the implementation of the ITS applications considered in this report, in order to efficiently guide new deployments.

With regard to **Transit applications in an urban environment**, it should be noted that, especially in new deployments, **Interoperability** among all transport modes and operators should be planned from the beginning, with a unique fare media, a clearing center and a common set of technical and functional rules and specifications. In addition, to be cost efficient, **Integration** with other –existing or not– systems should be projected (mainly Automatic Vehicle Location and Control Systems and Traveler Information Systems in Transit Area), sharing the same data model. It is also important to consider an **open data** approach in the case of Traveler Information Systems, or sharing data with external public parties; therefore, an efficient coordination between all parts involved may favor

the provision of good information to travelers, that should be deployed when **timeliness, accuracy, and reliability of data** are guaranteed in order to avoid users' complaints.

Concerning **Shared Mobility**, some key points are advised according to "The Bike-share Planning Guide", in order to accomplish new deployments of such applications. Issues like **Station Density** (10-16 stations for every square kilometre, providing an average spacing of approximately 300 meters between stations) or from 10 to 30 bikes for every 1,000 **residents** within the coverage area (that should have a minimum of 10 square kilometres).

Regarding Urban and Interurban Traffic Management, the main key issue is to guarantee multi agency co-operation and coordination between urban and interurban agencies and also with public transport centers and any other departments with relevant data that may affect the urban mobility. In addition, data interoperability and information sharing across departments is also essential, as well as standardisation of components of ITS services in order to fully exploit the benefits of the ITS systems to be deployed.

The main challenge of **Urban Enforcement** is to reduce crashes caused by speeding, red light running and other traffic infractions. An important prerequisite for an efficient automated enforcement system is the availability of a **centralized register of vehicles and their owners** at a national level, in order to have an effective tool for prosecuting offenders for the law enforcement officials. And concerning implementation, **Traffic Safety criteria** must be used to determine where automated traffic enforcement will be used. These criteria include, among others, high-risk, high frequency, high-collision and high pedestrian volume locations.

Concerning **Road Safety** applications, mainly in tunnels, the reliability of collection and processing data has to be guaranteed in any case through Regulations. Two key issues should be taken into account:

- To ensure the availability of critical equipment (ventilation, fire detection, emergency lighting, etc.) with a minimum of functionality in case of a fault or breakdown. For continuous energy supplying and safety, a redundant power and communications network is needed.
- To detect when a fault occurs in the operating equipment and facilitate a quick response. (Detectors and alarm systems control).

Electronic Toll Collection (ETC) Systems should be **technologically solid, reliable and secure**, ensuring that internal fraud is prevented and detected.There are three important issues concerning ETC systems deployment:

- A **legal context** should be developed to regulate omissions and monitoring or even infringements sanctioning, especially in case of free-flow tolling.
- **Standardization** of tags and equipment related to these systems will simplify their deployment.
- It is strongly recommended the system **interoperability**: a single means of payment in all enabled facilities for small payments associated with the mobility of vehicles (mainly tolls, but also open for car-park fees).

When it comes to **Automatic Vehicle Identification (Border Crossings)**, the most relevant issues to consider in the process of implementing such applications, according to the results of some international experiences (mainly USA), are the following:

- Roadside exchange data is crucial, in order to get the best time results; the information to be filled on line and real-time roadside checks are the application key.
- All the relevant state agencies and motor carrier industry should be involved in the Program since the beginning. Regarding international border crossings, a bi-national stakeholder forum should be established, to help reduce complicated institutional issues while applying technology systems at international borders.
- Data privacy should be protected by implementing user authorization levels for sensitive information, as all competitive companies are registered in a database.
- At international tolled border crossings, the use of an interoperable transponder to assure maximum benefits to both the private and public sector would be desirable.

To conclude, in order to undertake the investment, once the cost-benefit analysis is passed, it is important to remark some issues, such as the following:

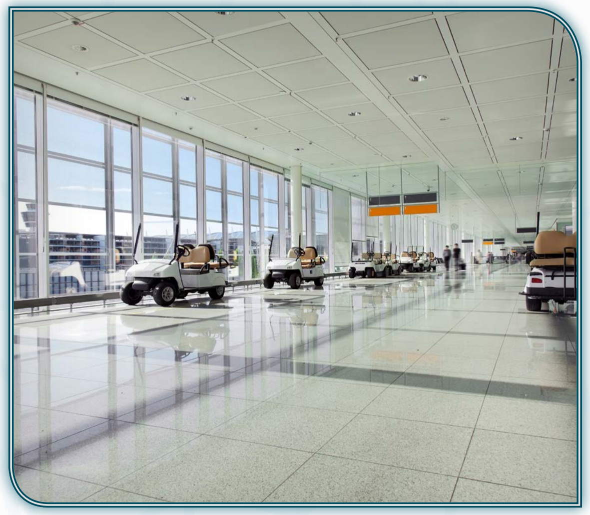
- Intelligent transport systems have a certain life cycle in each field, which is often determined by the equipment life cycle and the obsolescence of the technology. As a result, the costs of improvements and reinvestments should also be considered, in addition to operation and maintenance costs.
- Significant savings can be obtained if it is clear, from the beginning, the objective of interoperability, especially in electronic tolls and public transport ticketing.
- In case of large ITS investments it is a good practice to keep multiple suppliers forcing them to integrate their equipment, in order to avoid technological binds to a single provider.

6.5 Opportunities and barriers for the ITS systems development in the LAC region

Finally, some conclusions may be drawn about the potential opportunities and barriers for ITS systems development in the LAC region. The opportunities that may help ITS systems development in the region are:

- The expected increase in transport demand can encourage ITS systems deployment, due to its usefulness and efficiency in mobility improvement.
- The ITS technologies are mature, and they have proved to be a cost effective solution with very positive effects in terms of safety and mobility.
- The possibility of creating a domestic ITS market specialized and adapted to the particularities of the LAC region, thus allowing qualified employment and generating specific areas of research and innovation.
- ITS systems deployment helps to achieve the institutional objectives and improve continuously the public offer, through better knowledge of users demand, thus contributing to a service provision and the satisfaction of the user/contributor, as well as to the efficient improvement of public resources.
- The extensive international experiences in ITS systems development and/or deployment foster best practices and lessons-learned knowledge.

Transport as a whole will be favored if ITS systems definition and planning is carried out at the same time that construction planning, i.e., the lack of infrastructure is a chance for a better development of ITS systems, but when developing new infrastructure a specific budget for ITS systems in each project should also be considered.



Source: commons.wikimedia.org/wiki/User:ProtoplasmaKid

- The existence of an institutional entity is essential, to coordinate and promote all ITS systems development initiatives, at national, regional or local level, with clear goals in the institutional, market, technical/operational, legal and financial areas; strategic or master plans or even specific rules are also desirable.
  There are clear opportunities for improvement in the exchange of information among institutions and in the interoperability among ITS systems already deployed, mostly in electronic toll collection and public transport ticketing systems.
  Experiences in projects developments under public-private partnerships models are an opportunity of ITS systems expansion, but they need to be oriented and encouraged from an institutional approach to achieve satisfactory results.
- There are international agencies through which funds can be channelled, in order to finance ITS systems development or deployment. For the projects financial evaluation, operation and maintenance benefits derived from the ITS systems deployment should also be considered.

Among the barriers that may hinder ITS systems development in the LAC region are the following ones:

- In some countries, the lack of familiarity, knowledge and understanding of ITS systems by users and public and private agents, about its benefits, utilities and operation.
- The absence of an ITS systems domestic technology or industry.
- The lack of an institutional body that leads and coordinates investments in ITS systems, ensuring a good strategy and the successful achievement of the objectives at all levels. The absence of a national ITS plan or development strategy.
- Difficulties in generating cooperation and coordination among the different actors (public and private).

- The scarcity of financial resources for ITS systems public investment. Public-private partnership models or ITS projects held by private entities may distort the public goals if they are not properly oriented.
- The lack of infrastructure and communications at certain sections of the road network can also be seen as an opportunity.

6.6 Closing remarks

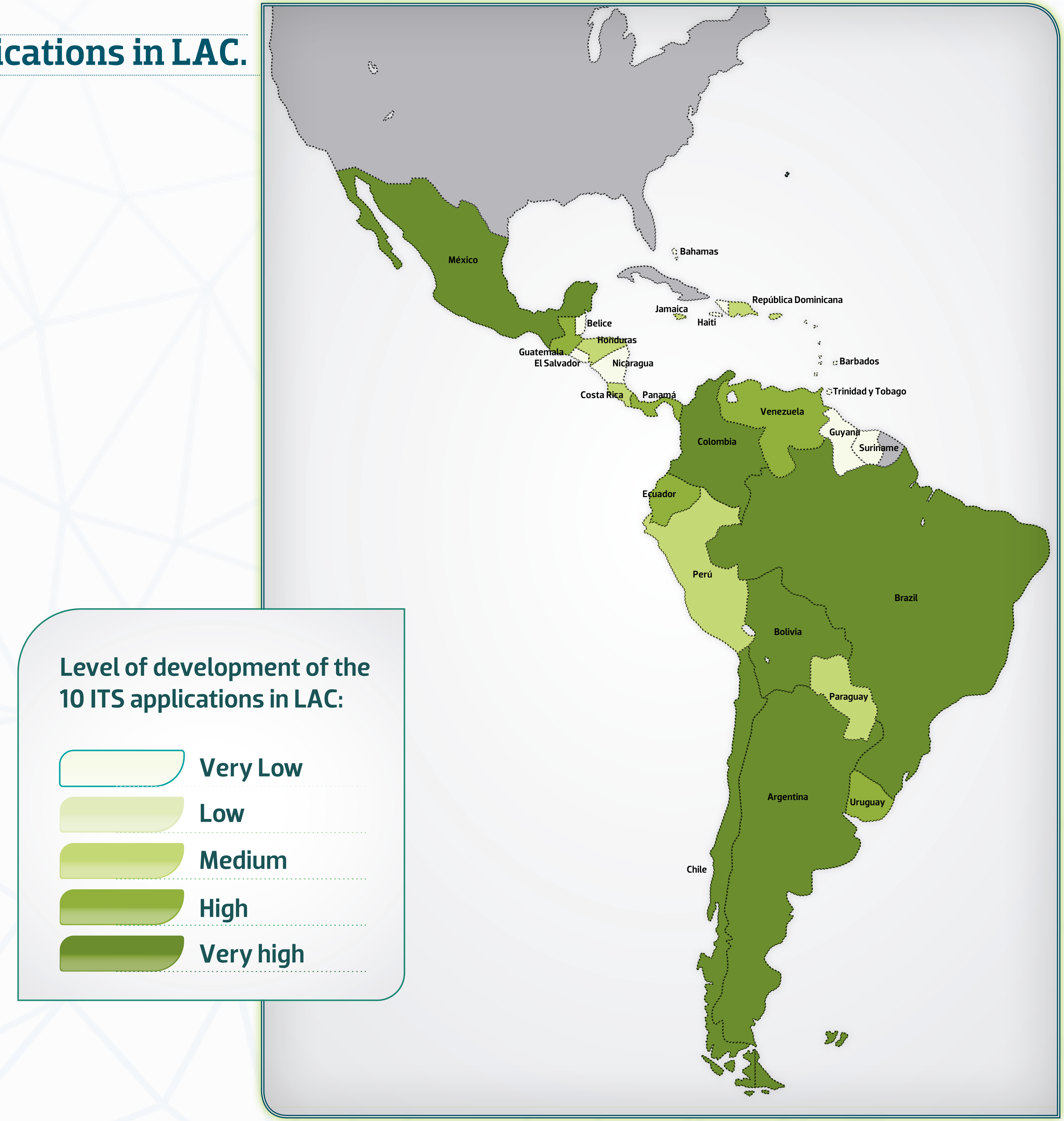
To conclude, the following points should be highlighted:

- ITS applications have started to find their way in the LAC region, mainly in the urban environment, as a response to the transportation needs due to the rapid population and vehicle fleet growth in the cities that lead to congestion problems, environmental issues, etc. Less populated countries such as some Caribbean islands have a low development rate in ITS systems.
- The existence of a policy or national strategy on ITS systems clearly determines higher presence of advanced technological systems, just as in the case of Argentina, Brazil, Chile, Colombia, Mexico, Panama and Peru.
- Technologies related to Public Transport are clearly booming in the LAC region, particularly Fare Collection Systems, AVLC systems or Passenger Information Systems. According to the information collected, interoperable fare collection systems involving all transport modes and operators is the pending subject related to Public Transport in the LAC region.
- Electronic Toll Collection systems are being widely deployed. ETC interoperability is an important issue in the LAC region: recently Brazil and Mexico have regulated nationwide interoperable technologies based on passive TAGs (ISO 18000-6C). In the next years, some national electronic toll collection interoperability and some free flow tolling projects will be a reality.
- Regarding countries and cities starting from scratch, significant savings can be obtained if the objective of interoperability is clear from the beginning, especially in Electronic Toll Collection and Fare Collection Systems.
- Another opportunity for improvement is the exchange of information among institutions. For example, Chile will collect and process information in order to make it available to external entities that can generate cost-effective products and services (open access data).
- There are international agencies through which funds can be channeled, in order to finance ITS systems development or deployment. For the projects financial evaluation, operation and maintenance benefits derived from the ITS systems deployment should also be considered.
- Intelligent transport systems have a certain life cycle in each field, which is often determined by the equipment life cycle and the obsolescence of the technology. As a result, the costs of improvements and reinvestments should also be considered, in addition to operation and maintenance costs.
- The existence of an institutional entity is essential, to coordinate and promote all ITS systems development initiatives, at national, regional or local level, with clear goals in the institutional, market, technical/operational, legal and financial areas; strategic or master plans or even specific rules are also desirable. Experiences in projects developments under public-private partnerships models are a clear opportunity of ITS systems expansion, but they need to be oriented and encouraged from an institutional approach to achieve satisfactory results.

7

ANNEX 1: MAPS

1. Presence of the 10 ITS applications in LAC.



2. National Presence of the 6 ITS applications implemented in LAC.

Level of development of the 6 ITS applications in LAC:

1. Transit Fare Collection
2. Automatic Vehicle Location and control systems.
3. Traveler Information Systems in Transit Area.
4. Shared Bicycles.
5. Urban Traffic Management.
6. Enforcement in urban environment.

Low

Medium

High

ANNEX 1

3. National Presence of the 4 ITS applications implemented at national level in LAC.

Level of development of ITS applications in LAC:

7. Interurban Traffic Management.
8. Road Safety in interurban environment.
9. Electronic Toll Collection.
10. Automatic Vehicle Indentification – Border Crossing.

- Very Low
- Low
- Medium
- High
- Very high

4. Presence of the 6 ITS applications implemented at city level in LAC.

Level of development of ITS applications in LAC:

1. Transit Fare Collection.
2. Automatic Vehicle Location and control systems.
3. Traveler Information System in Transit Area.
4. Shared Bycicles.
5. Urban Traffic Management
6. Enforcement in urban environment

- Low
- Medium
- High

5. Presence of the Transit Fare Collection Systems at city level in LAC.

Implementation of Transit Fare Collection Systems in LAC:

- No
- Planning or under Construction
- Yes

6. Presence of the Automatic Vehicle Location Systems implemented in LAC.

Level of development of the 6 ITS applications in LAC:

1. Transit Fare Collection
2. Automatic Vehicle Location and control systems.
3. Traveler Information Systems in Transit Area.
4. Shared Bicycles.
5. Urban Traffic Management.
6. Enforcement in urban environment.

Low

Medium

High

7. Presence of the Traveler Information Systems implemented in LAC.

Implementation of Traveler Information Systems in Transit Area in LAC:

- No
- Planning or under Construction
- Yes

8. Presence of the Bicycle Sharing Systems implemented in LAC.

Implementation of Shared Bicycles Systems in LAC:

- No
- Planning or under Construction
- Yes

9. Presence of the Urban Traffic Management Systems implemented in LAC.

Implementation of Urban Traffic Management Systems in LAC:

- No
- Planning or under Construction
- Yes

10. Presence of the Enforcement Systems in urban environemnts implemented in LAC.

Implementation of Enforcement in urban environment systems in LAC:

- No
- Planning or under Construction
- Yes

11. Presence of the Interurban Traffic Management Systems implemented in LAC.

Implementation of Interurban Traffic Management Systems in LAC:

Yes

No

12. Presence of the Road Safety Systems in interurban environments implemented in LAC.

Implementation of Road Safety In interurban Enviroment Systems in LAC:

Yes

No

13. Presence of the Electronic Toll Collection Systems implemented in LAC.

Implementation of Electronic Toll Collection Systems in LAC:

- Yes
- No

14. Presence of Automatic Vehicle Identification Systems (Border-crossing) implemented in LAC.

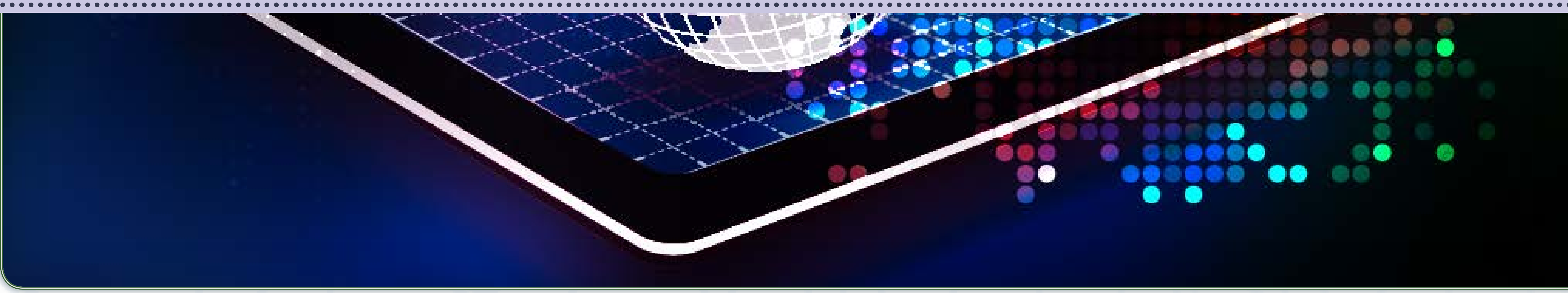
Implementation of Interurban Traffic Management Systems in LAC:

Yes

No

8

ANNEX 2: RESOURCES FOR ITS PRACTITIONERS



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Email: ur@itsisrael.org

ITS Japan
http://www.its-jp.org/english/

ITS Korea
http://itskorea.kr/
Contact details:#604, Daerung Technotown 15, Simin-Daero 401, Dongan-gu, Anyang-si, Gyunggi-do, Korea, 431-062. Tel.: +82-31-478-0400
Email: its@itskorea.kr

ITS Malt
http://itsmalta.eu/
Contact details: c/o Support & Supply Management (SSM) Group Ltd. Alexander Borg MCIPS (Stam) MIM MCILT UK Director / Managing Consultant Class Court A/1, Danny Cremona Street
HAMRUN HMR 1514 Malta Europe. Tel.: +35 6 21231015.
Email: info@itsmalta.eu

ITS México
http://www.itsmexico.org.mx
Contact Details: Cascada 410 Mexico 09450, D.F. +52 55 5243 6144

ITS Bavaria
http://www.its-munich.de/
Contact details: c/o MVV GmbH Postfach 260 154 D-80058 München. Tel.: +49 0 89 210 332 – 00
Email: info@its-bavaria.de

ITS Netherlands
http://www.connekt.nl/
Contact details: Postbus 48 2600 AA Delft. Tel.: +31 0031 1525 16565
Email: info@connekt.nl

ITS Network of National Associations
http://www.itsnetwork.org

ITS Norway
http://www.tekna.no
Contact details: Postboks 2312 Solli, 0201 Oslo, Besøksadresse: Dronning Mauds gate 15, Oslo. Tel.: +47 22 94 75 00
Email: post@itsnorge.no

ITS Poland
http://www.itspolska.pl/
Contact details: ul. Trębacka 4 lok.111, 00-074 Warszawa
Tel.: +48 22 630 99 09 NIP 113-269-31-30
REGON 141112913, KRS 0000285964
Email:: sekretariat@itspolska.pl

ITS Portugal
http://www.its-portugal.eu/
Contact details: Av. República, 6 – 7° Esq 1050 191 Lisboa, Portugal. Tel.: +351 213 104 166
Email: itsportugal@its-portugal.com

ITS Romania
http://www.its-romania.ro/
Contact details: 38 Dinicu Golescu Blvd. (Ministry of Transports), Grivita Wing, 6th Floor, Room 48, 010873 Bucharest. Tel.: +40 21 316 96 00
Email: secretariat@its-romania.ro

ITS Saudi Arabia
http://www.itsarab.org/
Contact details: 53 Morris Avenue Coventry CV2 5GT United Kingdom. Tel.: +44 203 287 1449
Email: mail@its-arab.org.

ITS Singapore

http://www.itssingapore.org.sg

Contact details: #02-236, Block 2 18 Nanyang Drive Innovation Center Singapore 637723. Tel.: +65 67942591

Email secretary@itssingapore.org.sg asst-secretary@its-singapore.org.sg

ITS Slovakia

http://www.its-sk.com

ITS Slovenia

http://www.sits.si

Contact details: Stegne 7, SI-1521 Ljubljana, Slovenia. Tel.: +386 1 511 3000

Email: info@sits.si

ITS South Africa

http://www.itssa.org/

Contact details: PO Box 84744, Greenside Gauteng 2034 South Africa. Tel.:+27 11 442 7191

Email: info@itssa.org

ITS Spain

http://www.itsspain.com/itsspain/

Contact details:/ Serrano 216, 1D – 28016 Madrid. Tel.: +34 91 353 13 43

Email: itsspain@itsspain.com

ITS Sweden

http://its-sweden.se/

Contact details: Borganäsvägen 42 784 33 Borlänge Phone: +46 243 61800

Email: info@its-sweden.se

ITS Switzerland

http://www.its-ch.ch/

Contact details: Schweizerischer Verband der Strassen- und Verkehrsfachleute Sihlquai 255 CH-8005 Zürich. Tel.: +41 44 269 40 20

Email: info@its-ch.ch

ITS Taiwan

http://www.its-taiwan.org.tw

Contact details: 10F.-1, No. 95, Sec. 3, Roosevelt Rd., Taipei 10646, Taiwan, R.O.C. Tel.: +886 2 2364 3100.

Email: its@its-taiwan.org.tw

ITS Thailand

http://its-thailand.org

Contact details:

112 Moo 9 Phaholyothin Road,Klong 1,Klong Luang Pathumthani 12120 Thailand. Tel.: +66 (0) 86-787-2940

Email: info@its-thailand.org

ITS UK

http://www.its-uk.org.uk/

Contact details: Suite 312 Tower Bridge Business Center 46-48 East Smithfield London E1W 1AW.

Tel.: +44 0 20 7709 3003

Email: mailbox@its-uk.org.uk

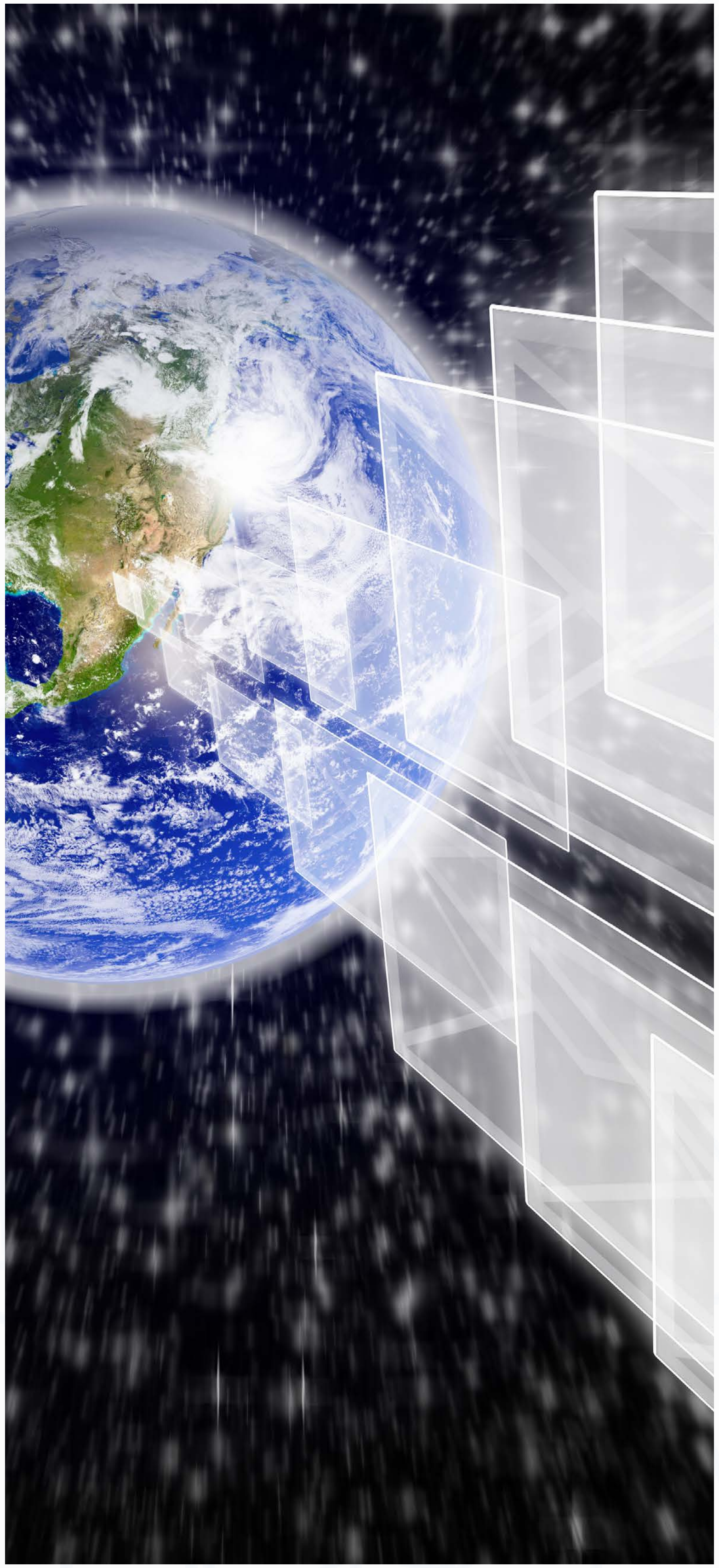
TTS Italy

http://www.ttsitalia.it/

Contact details: Via Flaminia 388 – 00196 Rome.

Tel.: +39 06 3227737

Email: ttsitalia@ttsitalia.it



8.3 Links to key publications, guidelines and content related to ITS applications

- **Asociación Latino-americana de Sistemas Integrados y BRT:** http://www.sibrtonline.org/
- **European Bus System of the Future:** http://www.ebsf.eu/
- **European Transport safety Council:** http://etsc.eu/
- **Instituto de Seguridad Vial y Educación Vial (Argentina)** http://www.isev.com.ar/
- **Instituto Mexicano del Transporte:** http://imt.mx/micrositios/seguridad-y-operacion-del-transporte/quienes-somos
- **International Road Federation:** http://irfnet.org/
- **Intertraffic world magazine:** http://www.intertrafficworld.com/
- **ITS International:** http://www.itsinternational.com
- **Revista Vial (Argentina):** http://revistavial.com/
- **Road safety European commission:** http://ec.europa.eu/transport/road-safety/index-es.htm
- **Toll trans:** http://viewer.zmags.com/publication/27eefa29#/27eefa29/1
- **Traffic Technology International:** http://www.traffictechnologytoday.com/
- **Tunnelbuilder:** http://www.tunnelbuilder.es/
- **UITP Advancing Public Transport:** http://www.uitp.org/
- **World Road Association:** http://www.piarc.org/es/
- **Worldhighways:** http://www.worldhighways.com/

8.4 Calendar of most relevant ITS events in 2015

NAME OF EVENT	LOCATION	DATE	RELEVANT INFORMATION	WEB LINK
VENITS 2015: 1st International Workshop on Vehicular Networking and Intelligent Transportation systems	**Las Vegas, Nevada, USA**	**9 Jan, 2015**	**1st International Workshop on Vehicular Networking and Intelligent Transportation systems (VENITS'15), co-located with 13th IEEE Consumer Communications and Networking Conference (CCNC 2015)**	http://www.grc.upv.es/VENITS/2015/
Congress ANDINATRAFFIC	**Bogotá, Colombia**	**16-17 March, 2015**	**7th edition of ANDINATRAFFIC, will be held in Bogotá, in March 2015. The main topics of the event will be: Integration of ITS systems in high level ITS platforms, definition of ITS Services and Service oriented architectures, ITS technology lifecycles and update mechanisms for existing ITS projects of all kinds. ANDINATRAFFIC 2015 will comprise 2 days of international trade fair and ITS showcase with direct participation of 17 countries, international academic program and international workshops (march 16th and 17th), and one day of specific workshops on current interest issues (march 18th)**	http://www.andinatraffic.com/project/andina/andina/index.cfm
Intertraffic China	**Shanghai, China**	**31 March - 2 April, 2015**	**Intertraffic China**	http://www.intertraffic.com/intertraffic-china/Pages/default.aspx
XV Spanish Congress on Intelligent Transport Systems	**Madrid, Spain**	**14-16 April, 2015**	**(Congreso Español sobre Sistemas Inteligentes de Transporte)**	http://www.itsspain.com/itsspain/index.php/evento/110

NAME OF EVENT	LOCATION	DATE	RELEVANT INFORMATION	WEB LINK
Traffex 2015	Birmingham, UK	21-23 April, 2015	Traffex and Parkex returns to Hall 5 at the NEC Birmingham on the 21 - 23 April, 2015, and is is set to be the most important event for the international traffic management, road safety, parking, highway maintenance and transport infrastructure industries	http://2013.traffex.com/content
14th ITS Asia-Pacific Forum 2015	Nanjing, China	27-29 April, 2015	The 14th ITS Asia Pacific Forum is to be hosted by ITS China and ITS Asia Pacific	http://www.itsnz.org/events.html
Intertraffic Istanbul	Istanbul, Turkey	27-29 May, 2015	The seventh edition of Intertraffic Istanbul once again proved its position as the leading traffic technology event for Eurasia and the Middle East. The show attracted 5,286 professionals infrastructure, ITS/traffic management, safety and parking from 79 countries around the globe. More than 200 exhibitors from over 30 countries presented their products and services	http://www.intertraffic.com/intertraffic-tr/Pages/default.aspx
ITS America annual meeting and exposition	Pennsylvania, USA David L. Lawrence Convention Center	01 – 03 June 2015	Co-hosted with ITS Pennsylvania, the 2015 ITS America Annual Meeting and Exposition will feature keynote speeches and panel discussions with the intelligent transportation industry's premier thought leaders and rising stars. Attendees will have the opportunity to experience the latest in transportation innovations through interactive technology demonstrations, a bustling exhibit hall, technical tours and networking events	http://www.itsa.org/

NAME OF EVENT	LOCATION	DATE	RELEVANT INFORMATION	WEB LINK
61st UITP world congress and exhibition	Milan, Italy	8-10 June, 2015	The biennial UITP World Congress and Exhibition offers participants a unique opportunity to discover the very latest public transport market developments and learn from industry leaders. The networking opportunities amongst like-minded professionals and the business opportunities available are unrivalled	http://www.uitp.org/61st-uitp-world-congress-and-exhibition
2015 IEEE 18th International Conference on Intelligent Transportation Systems - (ITSC 2015)	Las Palmas de Gran Canaria Canary Islands, Spain	15-18 Sept. 2015	The 18th IEEE Intelligent Transportation Systems Conference theme is The Wild Frontier in Intelligent Transportation. The conference brings together researchers, engineers, practitioners, managers, and policy makers from academia, industry, and government to share and discuss the latest in ITS research and development (R&D) results and implementation strategies. It will include dedicated sessions, workshops, and forums at which researchers, practitioners, government experts, and decision makers will share the latest research, success stories, and implementation needs of ITS	www.ieee.org › Conferences & Events
22nd ITS World Congress – Towards Intelligent Mobility - Better Use of Space	Bordeaux, France	5 - 9 October, 2015	The ITS Congress and Exhibition is the world's largest event in intelligent transport systems and services. Through the main theme "Towards Intelligent Mobility - Better Use of Space", the congress focuses on the fact that we are reaching intelligent mobility and what this will change in our lives, but also on the benefits that space can bring to ITS applications. The new satellite constellations for geo-localization, earth observation and communication will bring new opportunities to the ITS world	http://www.itsworldcongress.com/bordeaux-2015/

NAME OF EVENT	LOCATION	DATE	RELEVANT INFORMATION	WEB LINK
23rd ITS World Congress 2016, Melbourne	Melbourne, Australia	10 - 14 October 2016	Australia has been selected as the host national for this prestigious event. Surging growth in international demand will ensure that this gathering of ITS researchers, developers and users will be among the largest meetings in Melbourne during 2016	http://www.its-uk.org.uk/filelibrary/file/ITS-Melb2016-Welcome-ToMelbFlyer-WEB.pdf
V SIBRT Congress / Congreso SIBRT	Mexico DF, Mexico	Date TBA	V SIBRT Congress, Summit of leading citiesin sustainable urban mobility in Latin America / Congreso SIBRT / II Cumbre de ciudades líderes en movilidad urbana sus-tentable de América Latina	http://www.sibrtonline.org/news/335

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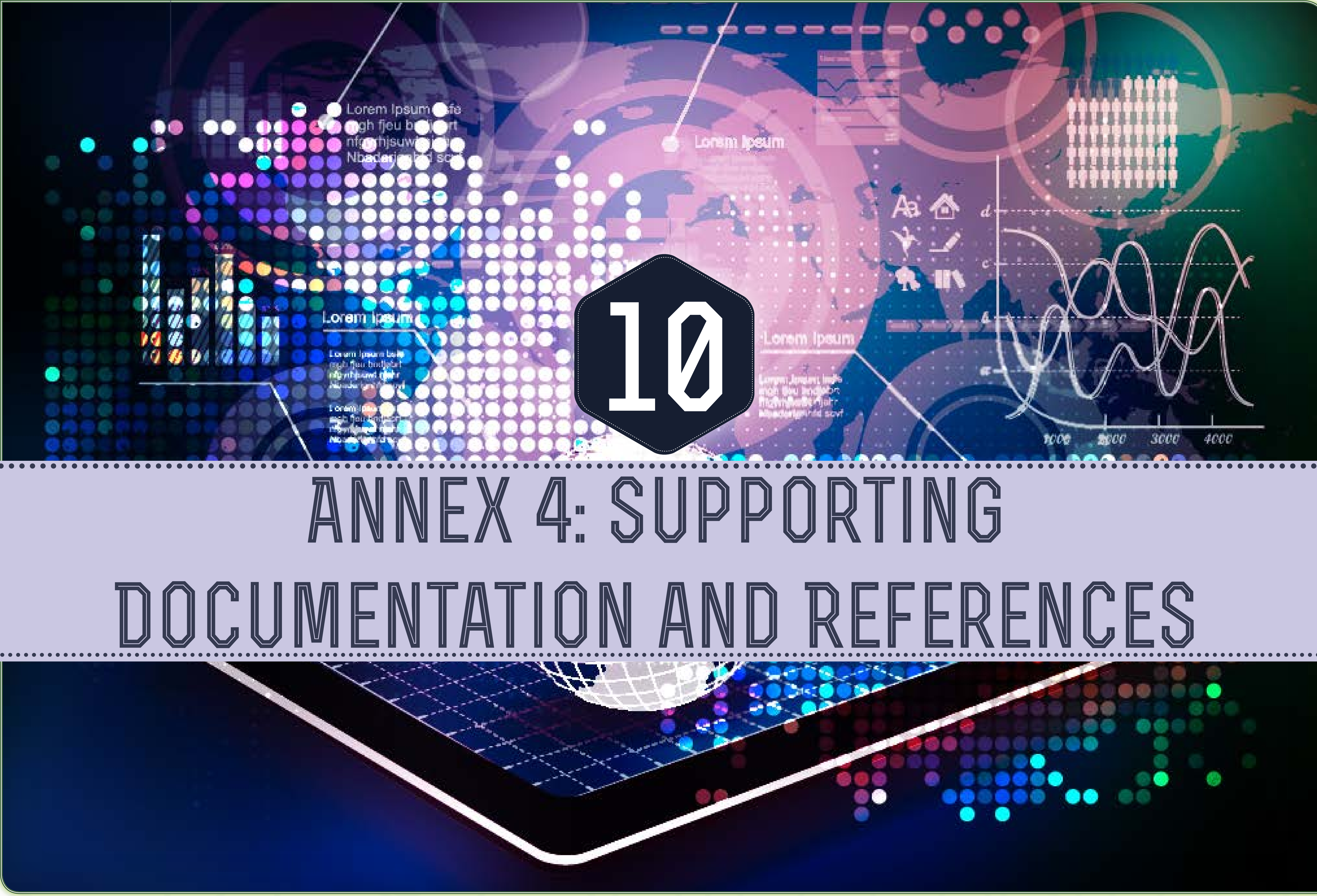
ANNEX 3:
LIST OF ACRONYMS

9. Annex 3: List of acronyms

- **AFC:** Automatic Fare Collection
- **AID:** Automatic Incident Detection
- **ALPR:** Automatic License Plate Readers
- **ANPR:** Automatic Number Plate Recognition
- **API:** Administration Portuaria Integral – Port Authority
- **APPS:** applications
- **ATCS:** Adaptive Traffic Control System
- **ATE:** Automated Traffic Enforcement
- **ATFC:** Automatic Transit Fare Collection
- **AVC:** Automatic Vehicle Classification
- **AVI:** Automatic Vehicle Identification
- **AVL:** Automatic Vehicle Location
- **AVLC:** Automatic Vehicle Location and Control
- **BOT:** Build Operate Transfer
- **BRT:** Bus Rapid Transit
- **CAD:** Computer Aided Dispatch
- **CAPUFE:** Caminos y Puentes Federales de Ingresos y Servicios Conexos – Federal Roads and Bridges of Revenue and Related Services
- **CCT:** Traffic Control Center / Centro de Control de Tráfico
- **CCTV:** Closed Circuit Television
- **CITRAM:** Public Transport Integrated Management Centre
- **CMM:** Traffic Control Center/Centro de Monitoreo de la Movilidad
- **CTA:** Chicago Transit Authority
- **CVO:** Commercial Vehicle Operations
- **DGAC:** Dirección General de Aeronáutica Civil – Civil Aeronautic General Direction
- **DMS:** Dynamic Message Signs
- **DSRC:** Dedicated Short Range Communication
- **ECLA:** Economic Commission for Latin America and the Caribbean (the Spanish acronym is CEPAL)
- **EFE:** Empresa de los Ferrocarriles del Estado State Railway Company
- **EMT:** Empresa Municipal de Transporte Municipal Transport Company
- **EPMMO:** Empresa Pública Metropolitana de Movilidad y Obras Públicas Metropolitan Public Mobility and Public Works Company
- **ESCI:** Emerging and Sustainable Cities Initiative
- **ETC:** Electronic Toll Collection
- **FAST:** Free and Secure Trade
- **FIRJAN:** Industry Federation of the State of Rio de Janeiro
- **GDP:** Gross Domestic Product
- **GHG:** Greenhouse Gas
- **GIS:** Geographic Information Systems
- **GNSS:** Global Navigation Satellite System)
- **GPRS:** General Packet Radio Services
- **GPS:** Global Positioning System
- **HAR:** Highway Advisory Radio
- **ICT:** Information and Communication Technologies
- **ID:** Identification
- **IDB:** Inter-American Development Bank
- **ITS:** Intelligent Transport Systems
- **LAC:** Latin America and the Caribbean
- **LCD:** Liquid Crystal Display
- **LED:** Light Emitting Diode
- **LIDAR:** LIght Distance And Ranging
- **LPR:** License Plate Recognition
- **MDP:** Million Pesos
- **MFFT:** Multilane Free Flow Tolling
- **MINCYT:** Ministerio de Ciencia, Tecnología e Innovación Productiva, Argentina
- **MINPLAN:** Ministerio de Planificación Federal, Inversión Pública y Servicios, Argentina
- **MOP:** Ministerio de Obras Públicas – Public Transport Ministry
- **MTT:** Ministerio de Transportes y Telecomunicaciones Transport and Telecommunications Ministry
- **NFC:** Near Field Communications
- **OBU:** On Board Unit
- **OECD:** Organisation for Economic Co-operation and Development

- **ORT:** Open Road Tolling
- **PAHO:** Pan American Health Organization
- **PIARC:** Permanent International Association of Road Congresses
- **PIMUS:** Sustainable Urban Mobility Integral Plan
  Plan Integral de Movilidad Urbana Sustentable
- **PND:** Strategic National Development Plan
- **PPP:** Public Private Partnership
- **RADAR:** Radio Distance And Ranging
- **RFID:** Radio-frequency identification
- **RTI:** Real Time Information
- **RTP:** Red de Transporte de Pasajeros – Passenger Transport Network
- **RWIS:** Road Weather Information System
- **SCATS:** Sydney Coordinated Adaptive Traffic System
- **SCOOT:** Split Cycle Offset Optimization Technique
- **SECTRA:** Secretaría de Planificación de Transporte
  Secretariat for Transport Planning
- **SIE:** Safety information exchange
- **SIIV:** Sistema Integral de Identificación Vehicular - Integral Vehicle Identification System
- **SITEUR:** Servicios de Tren Eléctrico Urbano- Electric Urban Rail Servicies
- **SME:** Small Medium Enterprises
- **SMS:** Short Message Service
- **STCM:** Sistema de Transporte Colectivo Metro
  Metro Public Transport System
- **SUBE:** Contactless Smart Card/
  Tarjeta del Sistema Único de Boleto Electrónico
- **TFT:** Thin Film Transistor
- **TMCs:** Traffic Management Centers
- **UMTS:** Universal Mobile Telecommunications System
- **UOCT:** Unidad Operativa de Control de Tránsito
  Operational Traffic Control Unit
- **USD:** United States Dollar
- **VES:** Video Enforcement System
- **VMS:** Variable Message Signs
- **VSLS:** Variable Speed Limit Sign
- **WAN:** Wide area network
- **WiFi:** Local area wireless technology
- **WiM:** Weigh-in-Motion
- **ZEAL:** Zona de Extensión y Apoyo Logístico – Extension Zone and Logistical Support



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ANNEX 4: SUPPORTING DOCUMENTATION AND REFERENCES

CANADA

- The World Road Association-PIARC – ITS Handbook

EUROPE

- The World Road Association-PIARC – ITS Handbook
- The World Road Association-PIARC – Road Tunnels Manual
- FRAME: European Intelligent Transport System (ITS) Framework Architecture: http://www.frame-online.net/
- E-FRAME – Extend FRAMEwork architecture for cooperative systems. D13 — Consolidated User Needs for Cooperative Systems. Version 1.0
- TRACE – Review of crash effectiveness of Intelligent Transport Systems

IDB

- Avances en seguridad vial en América Latina y el Caribe (2010-2012)
- Incorporación de Sistemas Inteligentes de Transporte en Latinoamérica – White Paper (Octubre de 2012)
- Low carbon technologies can transform Latin America's bus fleets
- Mitigation Strategies and Accounting Methods for Greenhouse Gas Emissions from Transportation.
- Tránsito y Transporte Público urbano en Brazil (Vivas Motta, M.A) -2002
- Lessons from Urban Transport in Latin America and the Caribbean (Vera Lucia Vicentini)- 2010
- Aspectos Generales y Metodológicos Específicos de Sistemas de Transporte Inteligentes – ITS (SECTRA)- 2000
- Logistics as a Driver for Competitiveness in LAC (Jose Luis Guasch) -2011

ISO STANDARDS

- INTERNATIONAL STANDARD ISO/DIS 14813-1. Intelligent transport systems — Reference model architecture(s) for the ITS sector – Part 1: ITS service domains, service groups and services

ITS ASOCIATIONS

- See section 6.1 *List a network of experts for ITS applications* of this report.
- JAPAN
- Ministry of Land, Infrastructure, Transport and Tourism: System Architecture: http://www.mlit.go.jp/road/ITS/

OTHER ORGANIZATIONS

- THE WORL BANK: http://www.cepal.org/Transporte/
  - Intelligent Transportation Systems for Commercial Vehicle Operations (ITS/CVO)
  - World Bank Urban Transport: http://go.worldbank.org/1K4AXE3VM0
- CEPAL: http://www.cepal.org/Transporte/
- International Modal split statistics: http://wz4t.com/indicators/systems/modal_split__public_transport
- Vehicles registered internationally: http://apps.who.int/gho/data/node.main.A995

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- Latin American Trade and Transportation Studies (LATTS1)
- La brecha de infraestructura en América Latina y el Caribe (Perrotti, D. E; Sánchez, R.J) - 2011
- CAF- Desarrollo urbano y movilidad en América Latina - 2011
- Sistemas Inteligentes de Transporte: Oportunidades para una logística sostenible y competitiva (Pérez Salas, G.)
- Capitalising On Public Transport: Reducing GHG Emissions In Latin American Cities – ELLA (Evidence and lessons from Latin America)
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- Telemática: un nuevo escenario para el transporte automotor (Pérez, G.) – 2001
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- Bicycle-Sharing Schemes: Enhancing Sustainable Mobility In Urban Areas (Midgley, P) – 2011 United Nations
- Global status report on road safety (WHO) – 2013
- The Global Competitiveness Report 2013–2014
- Road Safety Facts in the Region of the Americas, (PAHO) -2013.
- Guidebook for Enhancing Resilience of European Road Transport in Extreme Weather Events (2014)
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- Ecobici (Buenos Aires - Argentina): http://ecobici.buenosaires.gob.ar/
- Ecobici (Bogota -Colombia): http://www.ecobicis-colombia.com/
- EnCicla (Medellin (Colombia): http://encicla.gov.co/
- Mobilicidade (Brazil): http://www.mobilicidade.com.br/
- B'easy (Providencia - Chile): http://www.providencia.cl/servicios/ciclovias

US

- **RITA- Research and Innovative Technology Administration. ITS Taxonomy.pdf**
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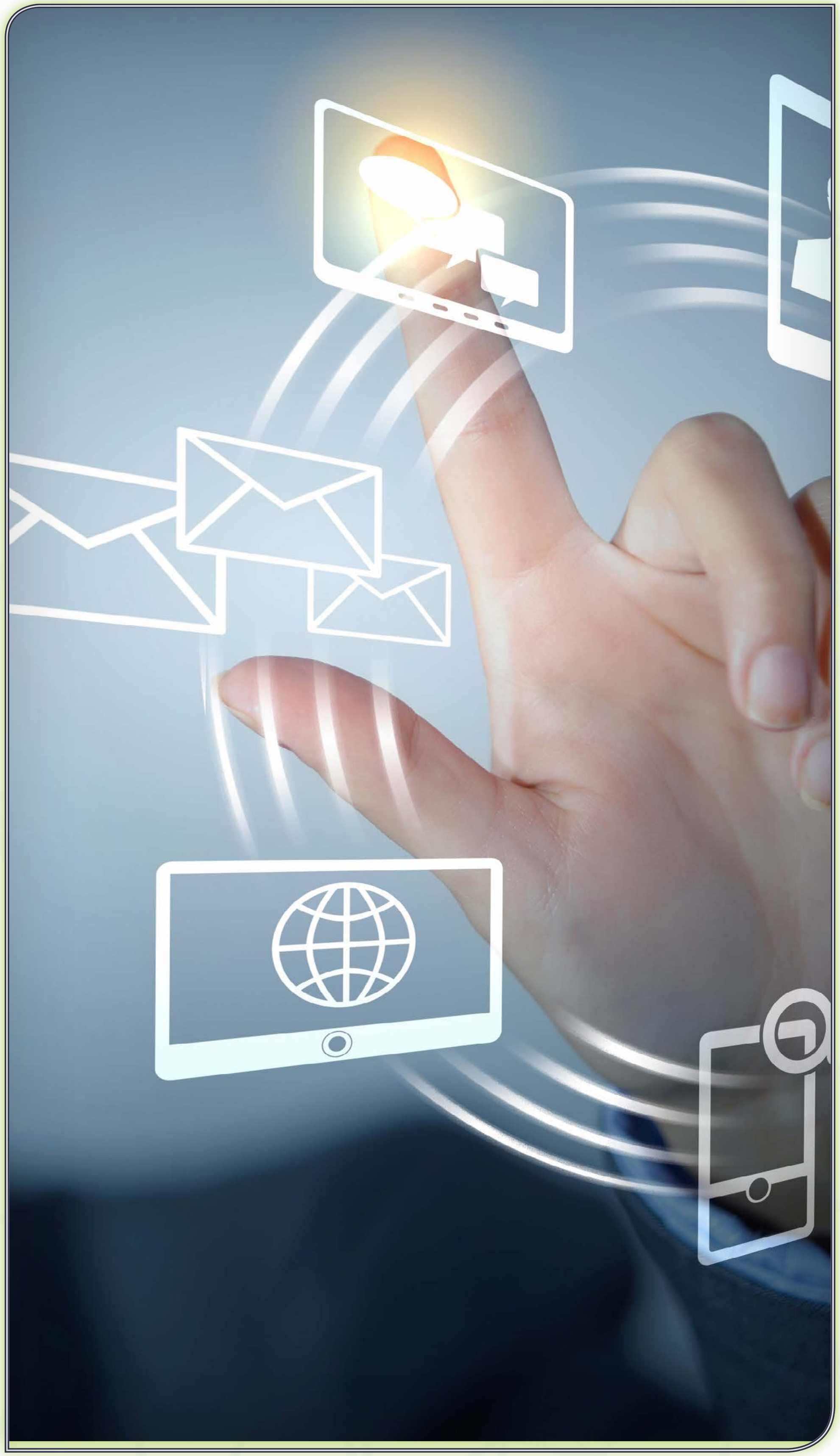
- **RITA- Research and Innovative Technology Administration. ITS.** http://www.itskrs.its.dot.gov/
- **ITERIS – National ITS Architecture Version 7.0:** http://www.iteris.com/itsarch/
- **Texas A&M Transportation Institute**
- **Feder Highway Administration:** http://www.fhwa.dot.gov/
- **ITS Benefits, Costs, Deployment and Lessons Learned: 2011 Update**
- **Central Intelligence Agency:** https://www.cia.gov/library/publications/the-world-factbook/

UK

- **Transport for London:** http://www.tfl.gov.uk



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20 Bicycle-Sharing Schemes: Enhancing Sustainable Mobility In Urban Areas (Midgley, P) – 2011 United Nations

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