

# IT & SOFTWARE TECHNOLOGY IN TRANSPORTATION

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## **ABSTRACT**

Transport system that is sustainable requires best use to be made of existing infrastructure. Intelligent Transportation Systems (ITS) are vital for this. The paper describes the applications of Intelligent Transportation Systems (ITS), systems that deploy communications, control, electronics, and computer technologies to improve the performance of highway, transit (Rail and Bus), and even Air and Maritime transportation systems. Also a discussion on implementation and challenges in deploying ITS has been made. IT for sustainable mobility will pave the way for sustainable development of the national economy.

*Keywords: Intelligent Transport System, Intermodality.*

## **INTRODUCTION**

Information Technology (IT) has transformed many industries, from education to health care to government, and is now in the early stages of transforming transportation systems. While many think improving a country's transportation system solely means building new roads or repairing ageing infrastructures, the future of transportation lies not only in concrete and steel, but also increasingly in using IT. IT enables elements within the transportation system—vehicles, roads, traffic lights, message signs, etc.—to become intelligent by embedding them with microchips and sensors and empowering them to communicate with each other through wireless technologies. In the leading nations in the world, Intelligent Transportation Systems (ITS) brings significant improvement in transportation system performance, including reduced congestion and increased safety and traveler convenience. Unfortunately, India lags the global leaders, particularly Japan, Singapore, USA and South Korea in ITS deployment. For the most part, this has been the result of two key factors: a continued lack of focus on ITS and the lack of the right organizational system to drive ITS in India

### **Benefits of Intelligent Transportation Systems**

Applying information technology to a country's transportation network delivers five key classes of benefits by:

- Increasing driver and pedestrian **safety**,
- Improving the **operational performance** of the transportation network, particularly by reducing congestion,
- Enhancing personal **mobility and convenience**,

- Delivering **environmental benefits**, and
- Boosting productivity and expanding **economic and employment growth**.

The scenarios describe applications of ITS, systems that deploy communications, control, electronics, and computer technologies to improve the performance of highway, transit (rail and bus), and even air and maritime transportation systems.

## **Importance of Intelligent Transportation System**

ITS is implementation of technology, specifically a network of sensors, microchips, and communication devices that collect and disseminate information about the functioning of the transportation system. Transportation systems are really about networks, and much of the value of a network is contained in its information. What intelligent transportation systems do is empower actors in the transportation system—from commuters, to highway and transit network operators, even down to the actual traffic lights themselves—with actionable information (or, intelligence) to make better-informed decisions, whether it’s choosing which route to take; when to travel; whether to mode-shift (take mass transit instead of driving); how to optimize traffic signals; where to build new roadways; what the true cost of roadways are and how best to price their use; or how to hold providers of transportation services accountable for results. The big opportunity at hand is to bring information to bear on transportation networks, transforming them into truly intelligent transportation systems.

## **Understanding Intelligent Transportation System**

Given the wide range of Intelligent Transportation Systems, it is useful to organize discussion of ITS applications through a taxonomy that arranges them by their primary functional intent (with the acknowledgment that many ITS applications can serve multiple functions or purposes). While this list is not inclusive of all possible ITS applications, it includes the most prominent ones, which are the focus of this report (see Table 1). ITS applications can be grouped within five primary categories: Advanced Traveler Information Systems (ATIS), Advanced Transportation Management Systems (ATMS), ITS-Enabled Transportation Pricing Systems, Advanced Public Transportation Systems (APTS), and Fully Integrated ITS Systems (VII and V2V Systems).

<b>ITS Category</b>	<b>Specific ITS Applications</b>
<b>Advanced Traveler Information Systems (ATIS)</b>	Real-time Traffic Information Provision
	Route Guidance/Navigation Systems
	Parking Information
	Roadside Weather Information Systems

<b>Advanced Transportation Management Systems (ATMS)</b>	Traffic Operations Centers (TOCs)
	Adaptive Traffic Signal Control
	Dynamic Message Signs (or “Variable” Message Signs)
	Ramp Metering
<b>ITS-Enabled Transportation Pricing Systems</b>	Electronic Toll Collection (ETC)
	Congestion Pricing/Electronic Road Pricing (ERP)
	Fee-Based Express (HOT) Lanes
	Vehicle-Miles Traveled (VMT) Usage Fees
	Variable Parking Fees
<b>Advanced Public Transportation Systems (APTS)</b>	Real-time Status Information for Public Transit System (e.g. Bus, Subway, Rail)
	Automatic Vehicle Location (AVL)
	Electronic Fare Payment (for example, Smart Cards)
<b>Vehicle-to-Infrastructure Integration (VII) and Vehicle-to-Vehicle Integration (V2V)</b>	Cooperative Intersection Collision Avoidance System (CICAS)
	Intelligent Speed Adaptation (ISA)

## Advanced Traveler Information Systems



Perhaps the most-recognized ITS applications, Advanced Traveler Information Systems (ATIS) provide drivers with real-time travel and traffic information, such as transit routes and schedules; navigation directions; and information about delays due to congestion, accidents, weather conditions, or road

repair work. The most effective traveler information systems are able to inform drivers in real-time of their precise location, inform them of current traffic or road conditions and surrounding roadways, and empower them with optimal route selection and navigation instructions, ideally making this information available on multiple platforms, both in-vehicle and out. There are three key facets to the provision of real-time traffic information: collection, processing, and

dissemination, with each step entailing a distinct set of technology devices, platforms, and actors, both public and private. This report will examine several countries' strategies regarding the provision of real-time traffic information.

Vehicles increasingly have telematics devices, whether a factory-installed GPS system or one purchased after-market. Analysts expect that number of such vehicles grow to 40 percent of Indian vehicles by 2012. By 2012, telematics projects to be a \$9.3 billion market worldwide.

Other advanced traveler information systems make parking easier, as cities from Singapore to Stockholm to San Francisco are deploying systems that indicate to drivers where vacant spaces can be found in the city, and even allow drivers to reserve spaces in advance. Studies have shown that 30 percent or more of urban traffic in large cities consists of drivers circulating as they search for parking

## Advanced Transportation Management Systems

Advanced Transportation Management Systems (ATMS) include ITS applications that focus on traffic control devices, such as traffic signals, ramp metering, and the dynamic (or "variable") message signs on highways that provide drivers real-time messaging about traffic or highway status. Traffic Operations Centers (TOCs), centralized traffic management centers run by cities and states worldwide, rely on information technologies to connect sensors and roadside equipment, vehicle probes, cameras, message signs, and other devices together to create an integrated view of traffic flow and to detect accidents, dangerous weather events, or other roadway hazards.



Adaptive traffic signal control refers to dynamically managed, intelligent traffic signal timing. Many countries' traffic lights use static, outdated timing plans based on data collected years or decades before. Giving traffic signals the ability to detect the presence of waiting vehicles, or giving vehicles the ability to

communicate that information to a traffic signal, perhaps through DSRC-enabled communication (assuming both the vehicle and traffic signal are DSRC-equipped), could enable improved timing of traffic signals, thereby enhancing traffic flow and reducing congestion.

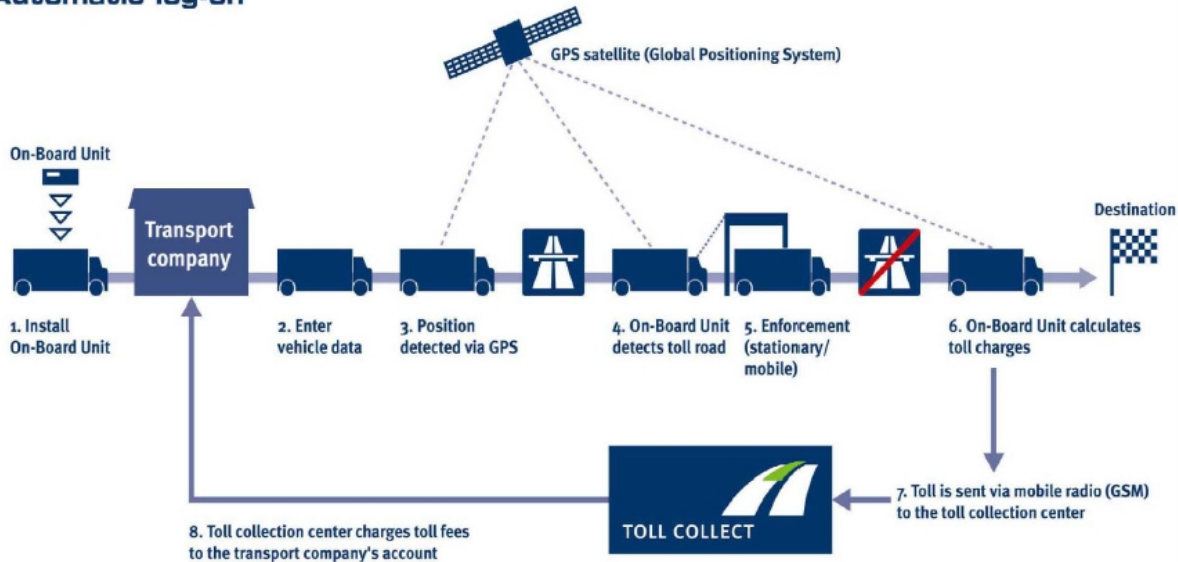
Another advanced transportation management system that can yield significant traffic management benefits is ramp metering. Ramp meters are traffic signals on freeway entrance ramps that break up clusters of vehicles entering the freeway, which reduces the disruptions to freeway flow that vehicle clusters cause and makes merging safer.

### ITS-Enabled Transportation Pricing Systems

ITS have a central role to play in funding countries’ transportation systems. The most common application is electronic toll collection (ETC), also commonly known internationally as “road user charging,” through which drivers can pay tolls automatically via a DSRC-enabled on-board device or tag placed on the windshield (such as E-Z Pass in the United States).

ITS-enabled countries are evaluating for financing their transportation systems is a vehicle miles

#### Automatic log-on



traveled (VMT) fee system that charges motorists for each mile driven. VMT fee systems represent an alternative to the current fuel taxes and other fees that many countries and states use to finance their transportation systems.

### Advanced Public Transportation Systems



Advanced Public Transportation Systems (APTS) include applications such as automatic vehicle location (AVL), which enable transit vehicles, whether

bus or rail, to report their current location, making it possible for traffic operations managers to construct a real-time view of the status of all assets in the public transportation system. APTS help to make public transport a more attractive option for commuters by giving them enhanced visibility into the arrival and departure status (and overall timeliness) of buses and trains. This category also includes electronic fare payment systems for public transportation systems.

## **Vehicle-to-infrastructure Integration (VII) and Vehicle-to-vehicle (V2V) Integration**

Vehicle-to-infrastructure integration is the archetype for a comprehensively integrated intelligent transportation system. To deploy and enable a communications infrastructure that supports vehicle-to-infrastructure, as well as vehicle-to-vehicle, communications for a variety of vehicle safety applications and transportation operations. DSRC-enabled tags or sensors, if widely deployed in vehicles, highways, and in roadside or intersection equipment, would enable the core elements of the transportation system to intelligently communicate with one another, delivering a wide range of benefits. Such technology could enable cooperative intersection collision avoidance systems (CICAS) in which two (or more) DSRC-equipped vehicles at an intersection would be in continuous communication either with each other or with roadside devices that could recognize when a collision between the vehicles appeared imminent (based on the vehicles' speeds and trajectories) and would warn the drivers of an impending collision or even communicate directly with the vehicles to brake them. By combining both vehicle-to-vehicle and vehicle-to-infrastructure integration into a consolidated platform, would enable a number of additional ITS applications, including adaptive signal timing, dynamic re-routing of traffic through variable message signs, lane departure warnings, curve speed warnings, and automatic detection of roadway hazards, such as potholes, or weather-related conditions, such as icing.



Another application enabled by vehicle-to-infrastructure integration is intelligent speed adaptation (ISA), which aims to assist drivers in keeping within the speed limit by correlating information about the vehicle's position (for example, through GPS) with a digital speed limit map, thus enabling the vehicle to recognize if it is exceeding the posted speed limit. The system could either warn the driver to slow down or be designed to automatically slow the vehicle through automatic intervention.

## Key Underlying technologies for ITS

- Global Positioning System (GPS).
- Dedicated-Short Range Communications (DSRC).
- Wireless Networks.
- Mobile Telephony.
- Radio wave or Infrared Beacons.
- Roadside Camera Recognition.
- Probe Vehicles or Devices.

## Challenges in Implementing ITS

Given the technical feasibility and significant benefit-cost ratios, why have ITS systems not been deployed more broadly, especially in lagging nations? One reason is that there are a number of challenges involved in developing and deploying intelligent transportation systems. ITS face a range of challenges, including system interdependency, network effect, scale, funding, political, institutional and other challenges. Some challenges are inherent to intelligent transportation systems across all countries; others are specific challenges faced with regard to deploying intelligent transportation systems in India.

The implementation initiative for ITS is divided into two major Categories:

- First-generation, or autonomous, systems
- Second-generation, or cooperative, systems

**First-generation systems** focus more on the vehicle as an isolated unit capable of gathering some external inputs but operating mostly within its own sphere of information. The following three descriptors offer insight into how this is accomplished:

- Advanced vehicle sensors and communications systems integrate with onboard navigation systems.
- Advanced GPS coordinates with digital mapping and location based services.
- Vehicle and infrastructure information emphasizes safety and efficiency.

To move forward, **Second-generation system** initiatives are established, which will manage the vehicle's performance in the context of the overall system.

The vehicle is no longer seen as a singular element in the roadway environment; instead, all elements (including other vehicles and the infrastructure itself) work together as a system. The two descriptors offered for this second-generation ITS are the following:

- Intelligent vehicles are able to link to one another and exchange information with the roadway infrastructure with increasingly greater intelligence as more data and information are acquired.

- Sensors, system architecture, software, and positioning technologies integrate the vehicle within a global road safety system.

## **IT Aiding Intermodality for Freight Transport**

### **Smooth information exchange**

Since many different parties are involved in intermodal transport chains, electronic data interchange and telecommunications are essential to facilitate and integrate operations. Pilot systems have been developed as a first step towards the creation of a unified and standardized system, aimed at providing open access to information services.

### **Towards Electronic Freight Market Places**

Research has demonstrated the feasibility of e-business practices in the intermodal market. Various systems, including Internet-based solutions, have been successfully piloted. These support the pre-contract stage of intermodal transport and provide clients with status information on their shipments. Low cost solutions have been tested for small and medium-sized enterprises. Research has also produced a conceptual information model covering the information needs of all actors along the entire transport chain.



### **Seamless tracking and tracing**

Manual monitoring of the movement of goods along a transport chain is time consuming owing to the differences in methods used by the various parties. In response, a distributed system has been tested for the tracing of communications chains and tracking of general cargo. The lack of a low-cost and robust solution for read/write tags remains a significant obstacle to investment for many companies.

### **Intermodal terminal operations**

Freight transshipment at nodal points adds costs and transport time to the door-to door movement of freight, and represents one of the main bottlenecks in using intermodal transport. The efficiency of the transfer between ships, barges and land transport modes is particularly important if short-sea shipping and inland waterways are to be integrated into European transport networks.

### **Integrating waterborne transport into intermodal chains**

To support market transformation, innovative solutions for managing integrated logistic chains need to be included in large-scale demonstrations. Therefore one project will support the integration of ports into intermodal transport chains by offering new tools to ease the management of data. Another project will demonstrate web based client applications and advanced Electronic data interchange (EDI) solutions in different supply chains for increasing the competitiveness of inland navigation within intermodal door-to-door transport operations.

### **Vessel traffic management and information services (VTMIS)**

Interconnection of existing information systems has been demonstrated at a number of test sites, with the aim of establishing methods for information exchange within a Europe-wide VTMIS network. Successful value-added services have been demonstrated based on technologies such as automatic identification systems and electronic chart and display information services.

Benefits include:

- Better dissemination of traffic information for operations management.
- Access to vessel data and access to cargo data when required for safety reasons.
- Improved contingency planning and access to marine pollution information.

### **Lessons for Nations that Seek to Be ITS Leaders: Ten Policy Principles**

This section lays out ten policy principles for ITS that transportation policymakers the world over should follow, and identifies where the India, in the aggregate, stands vis-à-vis world leaders in exemplifying these principles.

1. Recognize intelligent transportations systems as a “force multiplier” for the transportation network.
2. ITS enable countries to shift to performance-based transportation systems by facilitating better collection of data to measure performance

3. Governments have an important role to play in convening and co-developing platforms that enable industry, academic, association, and government entities at the federal, state, and local levels to collaborate on the development of intelligent transportation systems and technology
4. Governments need to articulate an ITS vision for their country (state, or community)
5. Governments must provide funding for both ITS R&D and deployment
6. The most successful countries view their ITS investments as creating a platform through which the private sector can develop value-added products and services
7. Governments have a critical role to play in spearheading the co-development of interoperable standards for intelligent transportation systems and platforms
8. Leading countries have fostered close alignment between transportation and telecommunications regulatory agencies and technology communities in their countries, recognizing the critical importance of allocating wireless spectrum or radio frequencies for intelligent transportation systems
9. Governments should fund deployment of infrastructure to collect real time-traffic information.
10. Develop a national ITS technical architecture that can serve as the template for the implementation of ITS at federal, state or provincial, and regional, community, or local levels.

## **Conclusion**

Information technology (IT) has already revolutionized many industries, and now appears poised to transform countries' transportation systems.

Indeed, IT is likely to emerge as the major tool to solve surface transportation challenges over the next several decades, as an "*INFO STRUCTURE*" gets built alongside countries' physical transportation infrastructure.

In fact, the scenarios described above are not visionary or futuristic; they are real, already exist in several countries today, and are Systems available to all countries that focus on developing and deploying them.

So the question for India is not "**How?**" but it is "**How soon?**"

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