CHAPTER 8

Intelligent Transport Systems

Keywords: Intelligent transportation, in-vehicle navigation, emergency response, traffic management

8.1 Intelligent Transport Systems (ITS)

The ITS can be defined as the application of advanced sensor, computer, electronics, and communications technologies and management strategies in an integrated manner providing traveler information to increase the safety and efficiency of the surface transportation system and the goal of ITS is to apply modern computer and communications technologies in transportation systems, resulting in improved mobility, safety, air quality, and productivity.

ITS introduces transportation database requirements beyond the traditional requirements of maintaining arc/node topology, two-dimensional geo-referencing and linear referencing of events within transportation features. A fully developed ITS requires a high-integrity, real-time information system that will receive inputs from sensors embedded within transportation facilities and from vehicles equipped with Global Positioning System (GPS) receivers. Information will be updated continuously in a system of databases that maintains a dynamic model of the integrated, multi-modal transportation system. This data will be used to provide route information and navigation to travellers as well as update traffic control devices such as timed traffic lights and variable message signage in real-time. ITS data requirements can also go well beyond maintaining the performance of transportation system components.

This brief description of ITS implies the following functional requirements for ITS databases:

1. ITS requires navigable data models, that is, data models that can locate a vehicle within the map reference frame and provide navigation functions based on this position as well as other information about current and anticipated system performance.

2. The diverse ITS databases must be integrated in a manner that is seamless to travellers. Seamless integration must occur among the diverse data within an ITS jurisdiction as well as across jurisdictions.
3. Finally, the data must be interoperable, that is, easily exchanged and accessed among heterogeneous system components and among different ITS. We need ITS to have less congested roads, to improve the efficiency of the transportation system, to mitigate the number of accidents, to reduce the air pollution etc., which are the associated problems with the transport infrastructure. For years, we have sought to solve many of these problems by merely building more highways. Pouring additional asphalt and concrete added capacity but did not address the underlying problems of our transportation system. Fulfilling the need for a national system that is both economically sound and environmentally efficient requires a new way of solving our transportation problems. The ITS also has a Promising market for example, US market for ITS is estimated to grow from $5 billion to $35 billion by 2010 and $700 billion is expected to be spent on transport infrastructure in the Asia Pacific market.

In the context of ITS, positioning systems measures the location of cars, trucks, automobiles, buses, and trains. Examples of positioning systems include Loran, Omega, the Global Positioning System (GPS), radar, sonar, terrestrial vehicle tracking systems, and dead reckoning (DR) systems. Many advanced aspects of ITS are not possible without positioning systems.

8.2 Components of ITS

There are major ITS research and development programs in the United States, Europe, and Japan. On a smaller scale, there is also ITS activity in Australia and other countries. Based on the ITS America Strategic Plan there are five functional areas in ITS.

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

Advanced Traveller Information Systems (ATIS) are systems that provide information directly to the traveller. An important service will be route guidance, where the driver is
informed of the best route to travel in order to reach a particular destination, taking into account road congestion conditions. In addition, it will be possible to receive other useful information such as the location of nearby restaurants, parking space availability, and other geographically relevant information.

Advanced Vehicle Control Systems (AVCS) are the most ambitious of the functional areas. Ultimately, it will involve having the vehicle controlled by computer so that it can travel along the highway without human intervention. In the short term, this functional area will involve collision warning systems and intelligent cruise control. Examples of the latter system are already being demonstrated by car manufacturers, with test cars being able to maintain a constant distance from the car in front.

Commercial Vehicle Operations (CVO) involve the use of automatic vehicle location systems linked with computer-aided dispatch systems to permit sophisticated management of commercial vehicle fleets. These systems provide more efficient dispatch and scheduling, as well as increased driver safety. Examples of such systems have already been deployed. These systems also have application to fleets of emergency vehicles such as ambulances, fire engines, and police vehicles.

Advanced Public Transport Systems (APTS) will involve the development of special-purpose public transport information and control systems. These will provide passengers with information on the arrival times of buses or trains; allow smart card payment of fares, and a much higher level of operational efficiency. In addition, it will be possible to use ATMS and ATIS to provide higher priority to buses and trams. This area is also likely to see the development of personalized public transport that will provide a service that is intermediate in terms of cost, timeliness, and proximity between buses and taxis.

8.3 Technologies required in ITS

As defined by the United States Department of Transportation, Intelligent Transportation Systems (ITS) apply “well-established technologies in communications, control, electronics and computer hardware and software to improve surface transportation system performance”.

Central to most ITS activities are four categories of technologies:
1. Sensing – the ability to note the position and speed of vehicles using the infrastructure (e.g. rail lines, roadways, bridges, tunnels).

2. Communicating – the ability to send and receive information, between vehicles, between vehicles and infrastructure, and between infrastructure and centralized transportation operations and management centres.

3. Computing – the ability to process large amounts of data collected and communicated so that conclusions can be drawn and assessments made.

4. Algorithms – computer programs which process information gathered by ITS and develop operating strategies for transportation facilities.

### 8.4 ITS Architecture

There are number of ongoing efforts to define the likely architecture of ITS. These include the United States national architecture development, Japanese endeavours and the European activity etc. Of these efforts, the first to be completed is the U.S architecture (Figure - 8.1) since it is likely to strongly influence architecture development in other regions.

Architecture can be described in terms of a logical architecture and a physical architecture. A logical architecture identifies the important data flows and processes necessary for ITS. Normally the physical architecture identifies the physical components of the system and the manner in which they can be interconnected. The data flow diagram shows the flow of data between different processes. Each important function is defined in terms of a process description, which makes the primary decomposition.

Various subsystems which can be identified in this architecture are

- Manage traffic
- Manage commercial vehicles
- Vehicle monitoring
- Manage transit
- Manage emergency services
- Provide electronic payment services
- Plan system deployment and implementation
8.5 Integration of ITS and GIS

There is a close relationship between intelligent transportation systems and GIS. Here ITS rely upon GIS for their underlying spatial base on which to make decisions and also the efficient storage space for large quantity of information the advance technologies provide. Some of these areas include in-vehicle navigation systems, emergency response and incidence management, commercial vehicle operations, traffic management, electronic payment and advanced vehicle control and safety systems.

8.5.1 In-Vehicle Navigation Systems

They provide route guidance to the drivers as they navigate along a route (selected by the driver or the best route algorithm). It provides turn-by-turn directions, street names, distances, intersections and landmarks that allow travelers to easily navigate in unfamiliar cities (Figure - 8.2). In vehicle navigation system depends on maps generated by GIS. Data accuracy is a critical requirement in navigation. Earlier static maps were used. But their use was limited.
because of their inability to provide roadway data that may change on a daily basis (e.g. construction zones, new streets road closure etc.). Real time traffic conditions are provided with the help of radio link or changeable message sign that give condition information. This real time information is really challenging because the algorithm must process position information, perform address and map matching, and display the Digital Road Map (DRM) to the driver. If the driver misses a turn, the system must be able to compute a new best route “on the fly” and provide new guidance information.

8.5.2 Emergency Response and Incident Management

This application requires the highest level of accuracy in spatial data. Here by combining it with GPS the actual location of an accident can be determined in a GIS map and the traffic can be re routed according to the requirement. Figure - 8.3 is an image showing the services of emergency response unit at an accident location.

8.5.3 Commercial Vehicle Operations

They use GIS maps to support freight mobility in three general areas: fleet management, customer service, and international border crossing passage. Fleet management (Figure - 8.4) includes monitoring location, load condition, vehicle condition, finding stolen vehicles avoiding traffic congestion and providing emergency support.
Figure - 8.3: Image Showing the Services of Emergency Response Unit at an Accident Location

It uses Automatic Vehicle Location (AVL). Vehicle tracking is the essence of fleet management. All the fleets are fitted with GPS units and are traced at every point of time. The base map can be the GIS map giving clear details about the road network layer and so on. Apart from utilizing the data generated by the vehicle tracking system for enforcing the schedule of the bus, this data also provides important inputs for decision making. The system facilitates computations like exact distance traveled in a given time span, speed of the vehicle at a given location, analysis of the time taken by the vehicle to cover certain distance and so on. It becomes a very powerful tool in case of transport corporations hiring private buses, as computation of the distance traveled, based on which payments are made, becomes totally objective.

Figure - 8.4: Fleet Management Systems

8.5.4 Traffic Management
Real time information about congestion in GIS (Figure - 8.5) will help a transportation agency in introducing traffic control strategies like congestion pricing or ramp metering. GIS maps helps in identifying the congestion locations. It will also help in providing real time information to drivers on highways about congestion, accident situations ahead.

![Figure - 8.5: A Real Time Traffic Congestion Information System](image)

### 8.6 Integration of GIS and Positioning Systems

Spatial data is the crucial component of a GIS. The important sources of spatial data are the already existing digital files, maps, which can be digitized, and more recently GPS. GPS (mapping type receivers) can be used to map an area and the data can be converted into GIS compatible forms. GPS-GIS integrated systems have some important applications in the field of Transportation engineering. These applications include vehicle tracking system for fleet management, vehicle navigation systems, and network travel time studies. GPS-GIS integrated systems can be used to predict the parameters in the car following theories, improving the trip reporting procedures.

**8.6.1 Recording GPS Data in GIS:**

**Continuous logging:** data is recorded to geographic layer at set time-interval. Example include

- Creating a digital road map by driving an automobile equipped with GPS
- Record a rail-line with a railcar-mounted GPS receiver
- Record the position of a pickup-and-delivery vehicle at various times
- Record the position of a vehicle on highway at certain intervals to calculate average speed

**On-call logging:** Position of GPS is recorded only when it is indicated to record the current position of the receiver. Examples include
- Record the position of manholes, telephone poles, or other fixed infrastructure location
- Mark the location of bridges, guard rails, or signposts along a road or highway.

### 8.6.2 Types of Positioning Systems

The major function of positioning systems can be divided into two categories: self-positioning and remote positioning. In self-positioning, the objects themselves determine where they are in remote positioning; a central operations system determines the location of the vehicles. The GPS is an example of a self-positioning system. Radar is an example of a remote positioning system. Of course, an inherently self-positioning system can function as a remote positioning system if each object transmits its position to a central operations centre using mobile communication links. This is an indirect remote positioning system. Similarly, an inherently remote Positioning system can function as a self-positioning system if the central operations centre transmits the relevant location information to each object via a mobile communication link. This is an indirect self-positioning system. Some systems may carry out the remote and self-positioning function at the same time. Positioning systems can be divided into three basic classes: signpost, wave-based, and dead reckoning (DR). Positioning systems play a key role in transportation areas, including the following:
- In-vehicle navigation;
- The collection of probe vehicle data to assist dynamic route guidance;
- Positioning systems are a key element of more efficient computer-aided dispatch systems;
- The use of radar for the purposes of collision avoidance;
- Radar is used for automated cruise control
• Automatic traffic control systems rely on positioning systems such as loop detectors in order to monitor traffic flow;
• Stolen vehicle recovery will be enhanced by systems that allow police to track down the stolen car;
• The efficacy of distress alarms will be greatly increased by the use of positioning systems to identify the location of an emergency;
• Dynamic bus information systems that are able to predict the arrival of buses should improve the service level of public transport systems.

8.6.2.1 Signpost Systems

Conceptually, these are the simplest form of positioning systems. They measure position by virtue of the fact that the vehicle is located close to a specific reference point, a signpost. The simplest example is a person recognizing an identifiable landmark. Automated versions are often called proximity beacon systems. They work by the reception of radio, light, or sound waves. An example of such a system is the New South Wales government's Roads and Traffic Authority's Automatic Network Travel Time Measurement System (ANTTS). The two important elements of these automated systems are the vehicle-mounted "tag" and the roadside unit. There will normally be a number of widely dispersed beacons, allowing the monitoring of the vehicle's trajectory.

The system can be self-positioning, in which case the vehicle has a tag that picks up the signal from the beacon. This signal will normally have some identification code so that the vehicle knows to which beacon it is 'in proximity'. The system can also be remote positioning if the beacon senses the presence of the tag on the vehicle. In this case, the tag emits some form of identification code in order that the system knows which vehicle is being interrogated.

8.6.2.2 Wave-Based Systems

A wave-based system is one that uses the propagation properties of waves to determine position. An example is a radar system that uses the far-field planar wave front and the finite propagation time of electro-magnetic waves. A wave-based positioning system will need one
or more reference sites. The positions of vehicles are measured relative to these sites. Each reference site may have a transmitter or receiver, or both. Each vehicle may have a transmitter, receiver, reflective elements, or some combination of these. For example, in the case of GPS, each satellite is a reference site - there is a transmitter on each satellite. A mobile vehicle will have a GPS receiver that picks up the signals from the satellites and uses time-of-arrival information to calculate position. In simple radar system there is one reference site fitted with both a transmitter and a receiver. The ‘targets’ reflect the radio energy back to the reference site.

8.6.2.3 Dead Reckoning (DR) Systems

These are systems that rely on sensing the components of the vehicle's acceleration or velocity. This information is then integrated to determine the track of the vehicle. Consider, for example, a compass and odometer system. The odometer integrates the angular velocity of the vehicle’s wheels in order to estimate the distance travelled. The compass defines the direction of travel. The combined information can be used to track the course of the vehicle. Other sensor technologies used in DR systems include gyroscopes and accelerometers.

8.6.3 Role of Positioning Systems in ITS

8.6.3.1 Suitability of Different Positioning Systems for ITS Applications

The applications of positioning systems in ITS were identified as:-

- General fleet operations
- Fixed-route fleet operations
- Distress calling
- Congestion detection
- Geographic filtering
- Route guidance
- Vehicle security
- Automated highway system
Below is description of each of these areas by discussing the suitability of the various types of positioning systems for these applications. I will be mostly making comparisons on the basis of single-mode systems.

8.6.3.1.1 General Fleet Operations

Description:

General fleet operations involve using position information for the purpose of more efficient dispatch of vehicles as well as monitoring overall fleet performance. In most cases, the positioning facility would be an adjunct to a computer-aided dispatch system. The major benefit of positioning for fleet applications is that it makes it possible to send the closest vehicle to a dispatch point, with consequent savings in fuel and time. This can be used for both commercial vehicle operations and emergency vehicle management. Fleets vary in size from two vehicles to tens of thousands. Given that the cost of the in-vehicle unit can be offset against productivity gains, an acceptable cost for the in-vehicle unit will range from low to medium. The required accuracy will depend on the size of the fleet and the total area being serviced. For many vehicle fleets, a medium level of accuracy would be sufficient, of the order of 100m to 500m. This is because the savings gained by better accuracy are negligible unless the fleet is very large. For fleet operations in metropolitan areas, wide area coverage is sufficient. For inter-state/inter-country fleet operations, a positioning system with global coverage is more likely to satisfy the requirements. Fleet operations typically can withstand some areas of poor coverage, and the routing decision can be made on the basis of last known position. If the system is used solely for fleet operations rather than vehicle security, then there will not be a strong demand for anti jam features in the positioning system design. All fleet operations will require an uplink or, alternatively, a remote positioning system, to transmit position back to the fleet management headquarters. In most cases, an uplink/downlink capability will be needed to allow efficient dispatch and monitoring of vehicle status.

Suitable positioning systems:

A remote positioning system has a natural advantage for fleet operations because self-positioning systems must be augmented with a communication link in order to address this
fleet operations application. Satellite positioning systems have an advantage for very wide area fleet operations (e.g., interstate trucking), whereas terrestrial systems can satisfy the needs of metropolitan-based fleets. Signpost systems are less suitable for fleet operations unless the very large infrastructure costs necessary to cover an entire city can be shared with many other applications. Dead reckoning systems are possibilities but would have to be augmented with a communication system. In addition, DR needs an auxiliary absolute positioning system unless the fleet drivers are sufficiently disciplined to key in coordinates upon system initialization or following ‘loss of lock’.

The natural advantage of remote positioning systems is somewhat eroded by the fact that fleets need a two-way communication system for dispatch and safety considerations. For example, GPS augmented by a satellite communication system has been successfully used for trucking operations. The advantage of a remote positioning system will be further eroded for very large fleets if the capacity of the system is exceeded.

8.6.3.1.2 Fixed-Route Fleet Operations

Description:

Other types of fleet applications are the enhancement of public transport systems by advanced control systems, provision of information about arrival time to the public(Figure - 8.6 and 8.7), and priority at signalled intersections for buses and trams. Applications requiring only control and provision of information need similar levels of accuracy to general fleet operations. Systems that implement priority will be sensitive to positioning errors and need accuracies of at least 100m, but only at critical points (e.g., just before a signalled intersection). An important attribute of this application is that most of the vehicles run on fixed routes, requiring coverage only along those routes. The attributes of this application are similar to general fleet operations with respect to the number of users, anti-jam specifications, data communication needs, and requirement for privacy.
Suitable positioning systems:

This application differs from general fleet operations in that signpost systems can be effective because of the fixed-route nature of the services as is the case for general fleet operations where remote positioning systems have an advantage. Satellite and terrestrial remote positioning solutions can be cost effective if shared with other applications. For rural applications, satellite-based systems are likely to be preferred. Increasingly, public transport fleets are fitted with two-way communications, which can make self-positioning systems cost effective. The fixed-route nature of the application can lead to some very simple solutions.
For example, a bus tracking system could use an odometer to keep track of how far each bus has moved along its route. The implicit one-dimensional nature of a route means that a compass or other turn sensor is not necessary, unless the driver departs unexpectedly from the route.

8.6.3.1.3 Distress Calling

Description:

There are a range of situations in which position measurement is of a very high value but the frequency of use is very low. Such occasions include car accident, driver under attack, crash, and car breakdown scenarios. This application area is derived from providing driver and traveller services. The application could ultimately have a very large number of users, but the probability of any particular user being in distress is fortunately quite low. Coverage will need to be very wide area, covering all metropolitan and most rural areas of the country. There may be some need to develop an anti jam capability. There is no inherent need for data transmission, but there will be a need to identify the caller. Privacy issues should be carefully considered in the development of these systems.

Suitable Positioning Systems:

In the United States, the requirement to locate all mobile telephones places severe constraints upon the possible solution. For existing hand-sets, this means that a remote positioning system solution that locates using the signals transmitted by the handsets is the most feasible solution. For new handsets, there are a variety of self-positioning solutions that make use of the communication channel afforded by the cellular system.

8.6.3.1.4 Congestion Detection

Description:

Congestion detection (Figure - 8.8) involves tracking probe vehicles in order to deduce traffic congestion patterns. The system will make a large number of measurements and so will be
tolerant to individual measurement errors. Accuracy of the order of 100m is sufficient to assign vehicles to the correct link of a freeway system and calculate direction of travel. However, such accuracy may not be sufficient to directly measure speed of travel. Therefore, an ancillary method of measuring speed could be needed, such as using Doppler data. This application will be tolerant to coverage of black spots, though if a black spot corresponds to a critical location (e.g., a bridge), some compensation will be needed. The basic distinguishing feature of this application area is the need to track a very large number of vehicles, to only a medium degree of accuracy, in an anonymous fashion. The coverage will mainly be needed in metropolitan areas. There is no need to develop an anti jam capability. There is no inherent need for data transmission. For privacy reasons, it is important that the tracking of the vehicles be done anonymously (unless the owner has granted permission).

Figure - 8.8: Real Time Congestion Information at Various Sections in Bangalore

Suitability of Positioning Systems:

Terrestrial remote positioning systems are well suited to this application because congestion is mainly an issue in metropolitan areas. Terrestrial system can have better coverage than
satellite systems in metropolitan areas. Terrestrial self-positioning systems are a possibility but will require very inexpensive data links because of the requirement of a very low cost per measurement. A likely implementation will be cellular-telephone-based positioning systems because of the large number of mobile telephones used in many cities around the world. There is an interesting application of a signpost system to this application. The ANTTS system is successfully used to track probe vehicles in Sydney, Australia. This is despite the fact that ANTTS interrogators are only installed on a limited number of routes and there is only a relatively small number of probe vehicles (approximately 700). The reason that the system is successful is that the routes have been chosen as being the most significant from a traffic management viewpoint (i.e., the main arteries), and the probe vehicles are mostly regular peak-hour travellers on these main arteries. Although useful, this system does not give indications of congestion throughout the city. A much more extensive network of interrogators and many more probe vehicles would be required to do this.

8.6.3.1.5 Route Guidance

Description:

Route guidance (Figure - 8.2) involves giving timely, turn-by-turn information to guide a driver from origin to destination. Dynamic route guidance makes routing decisions based on current traffic information. Route guidance and dynamic route guidance are very demanding in terms of positioning system performance. This application derives from providing driver and traveller services. Ultimately, there will be a very large number of drivers using this service. An early sale to luxury vehicle owners allows a medium price for the in-vehicle unit, but ultimately the price will need to drop to a low level for the mass market. The basic requirement for route guidance is to place the vehicle on the roadway, so the required accuracy is of the order of 5m. Coverage will need to be very wide, covering both rural and metropolitan areas. For dynamic route guidance, it will also be necessary to have a communication link. It will also be important that drivers know that they cannot be tracked without permission.

Suitability of positioning systems:
This is a very demanding application. At present, a map-aided system with satellite-based augmentation (GPS), is the most practicable solution. For dynamic route guidance, it will be necessary to have a separate communication link.

8.6.3.1.6 Vehicle Security

Description:

Vehicle security applications involve the prevention of vehicle hijacking/robbery or the recovery of stolen vehicles. The distinguishing features of this application are a need to hide the in-vehicle unit (implying a small in-vehicle unit) and a high anti jamming margin.

The stolen vehicle recovery application could have a very large number of users, though a low probability of anyone user needing service. If used in the luxury end of the car market, the in-vehicle cost could be at medium level, but for the mass market the cost will need to be low. Accuracy on the order of 100m is probably sufficient, though there may be the need for some ancillary method of homing in on hidden vehicles. Coverage in metropolitan areas is probably acceptable. There is a need of an uplink to allow notification of theft. In this case, owners will need to provide advance consent to track the vehicle in the case of theft.

Suitability of Positioning Systems:

Dead reckoning systems might find application for stolen vehicle recovery; however, such systems are susceptible to being disabled easily by cutting the lines to the sensors.

Signpost systems will only be suitable if there is already an extensive network for other applications. The fact that most thefts occur in metropolitan areas means that terrestrial systems can provide sufficient coverage. The susceptibility to jamming is an important issue in this application, which argues for remote positioning systems. The above analysis indicates the closest fit for this type of application will be terrestrial wave-based remote positioning systems.
8.6.3.1.7 Automated Highway System

Description:

The automated highway system (AHS) is the most demanding application of positioning systems. It requires extremely accurate, highly reliable, continuous monitoring of the vehicle location with respect to surrounding vehicles. Ultimately, this application will support a large number of users. It is not possible at this time to predict acceptable in-vehicle costs. The positioning systems used for road following and station keeping will need to have accuracy of the order of centimetres. There might also be a need for an absolute position system with accuracy of the order of 5m. The coverage will need to be both rural and metropolitan. Most of the architectures being considered for the AHS envisage a requirement to communicate with the roadway, so a two-way communication system will be needed. It will be important to maintain driver privacy in order to gain public acceptance of this system.

Suitability of positioning systems:

None of the current single-mode positioning systems are sufficiently capable for this application. A possible implementation might include GPS, map-aided DR, laser/radar/sonar station keeping, magnetic sensors (to follow studs in roadways), and vision (to detect pedestrians and other unexpected obstacles).

8.7 Other ITS Applications

8.7.1 Driver Information System

They provide information about congestion and construction activities, as well as information about detours, weather, and hazardous roadway conditions. A wide variety of technologies may be used to communicate with the driver (Figure - 8.9).

Driver information is valuable not only in urban areas where congestion reports are common, but also in rural areas where construction and weather information may be most critical. Information may allow corridor travelers to avoid congestion before entering the urban area.
8.7.2 Electronic Payment Technologies

Here ITS technologies are used for automatic toll collection in high ways (Figure - 8.10). Vehicles are equipped with electronic devices called transponders or “tags” that are radio frequency identification devices (RFID), which are then read by overhead antennas. When driving through a former toll plaza or below an open road gantry, the RFID tags communicate with RFID readers. Tags range from simple to highly sophisticated devices. Simple tags are “read-only,” meaning that they can provide an identification number to overhead readers using power from incoming radio frequency energy. More sophisticated tags are battery-powered, and have processing power and memory.

8.7.3 Identifying Traffic Signal Violation at Intersections

A web based information system showing the photo snaps at a junction in Bangalore is shown in Figure - 8.11. Such a system can be used to identify the possible traffic violations at junctions, note the vehicle number and impose fine.
8.7.4 Identification and Availability of Parking Places

ITS linked online can be used by a traveler in identifying places where he can park his vehicle in a CBD prior to his trip (Figure - 8.12). It will be very helpful for travelers in choosing a mode for a trip according to the availability of parking places. The figure shows identified parking places in Bangalore city which is available online.

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Figure - 8.10: Electronic Toll Collection at a Toll Plaza

Figure - 8.11 Cameras set up in Various Junctions of Bangalore along with Real Time Image of a Junction

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Chapter-8: Intelligent Transport Systems

Course Title: Geo-informatics in Transportation Engineering
Course Co-ordinator: Dr. Ashish Verma, IISc Bangalore

NPTEL Web Course (12th Aug. 2011)
Exercises

1. What are the components of ITS and what are its advantages?
2. Explain the role of GIS in ITS.
3. How can we record a GPS data in GIS.
4. What are positioning systems and what are its different types?

Assignments

1. Using GPS track co-ordinates and routes while travelling on a particular road stretch (the vehicle can be bicycle, car or anything else).