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## Role of GPS in navigation, Fleet Management and other Location Based Services

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### Introduction

Global positioning system (G.P.S.) & its role in advanced transportation projects is inseparable is become a synonym. We people, whenever like to talk or take a project that will automate the management and operations of vehicles & giving real-time information to users, that will lead to cost-effective & satisfied service to customers/passengers, and then planners and other decision-making authorities will not find any other effective tool to select except G.P.S.

### What is GPS?

GPS, which stands for Global Positioning System, is the only system today able to show you your exact position on the Earth anytime, in any weather, anywhere. Ground stations, located worldwide, continuously monitor them. The satellites transmit signals that can be detected by anyone with a GPS receiver. Using the receiver, you can determine your location with great precision. GPS is one of history's most exciting and revolutionary developments, and new uses for it are constantly being discovered.

### GPS Elements

GPS has 3 parts: the space segment, the user segment, and the control segment. The space segment consists of 24 satellites, each in its own orbit 11,000 nautical miles above the Earth. The user segment consists of receivers, which you can hold in your hand or mount in your car. The control segment consists of ground stations (five of them, located around the world) that make sure the satellites are working properly. The GPS satellites each take 12 hours to orbit the Earth. Satellites are equipped with very precise clocks that keep accurate time to within three nanoseconds - that's 0.000000003, or three billionths, of a second. This precision timing is important because the receiver must determine exactly how long it takes for signals to travel from each GPS satellite. To help you understand the GPS system, let's take the three parts of the system - the satellites, the receivers, and the ground control - and discuss them in more detail.

### Satellites in Space

The first GPS satellite was launched in 1978. The first 10 satellites were developmental satellites, called Block I. From 1989 to 1993, 23 production satellites, called Block II, were launched. The launch of the 24th satellite in 1994 completed the system.

### Ground Control Stations and Receivers

#### Ground Control Stations

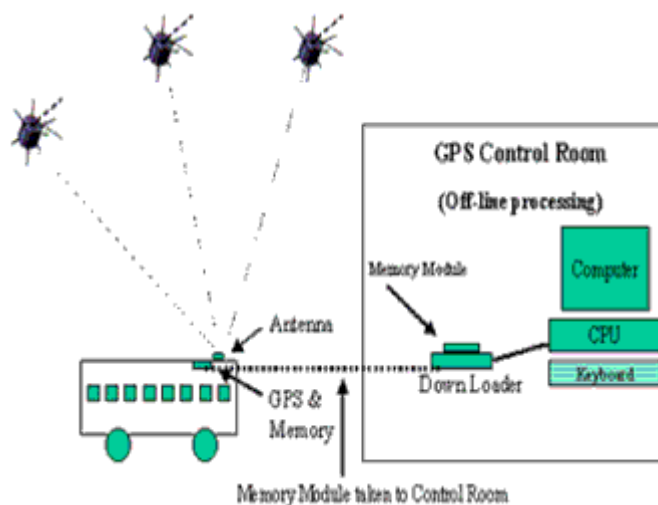
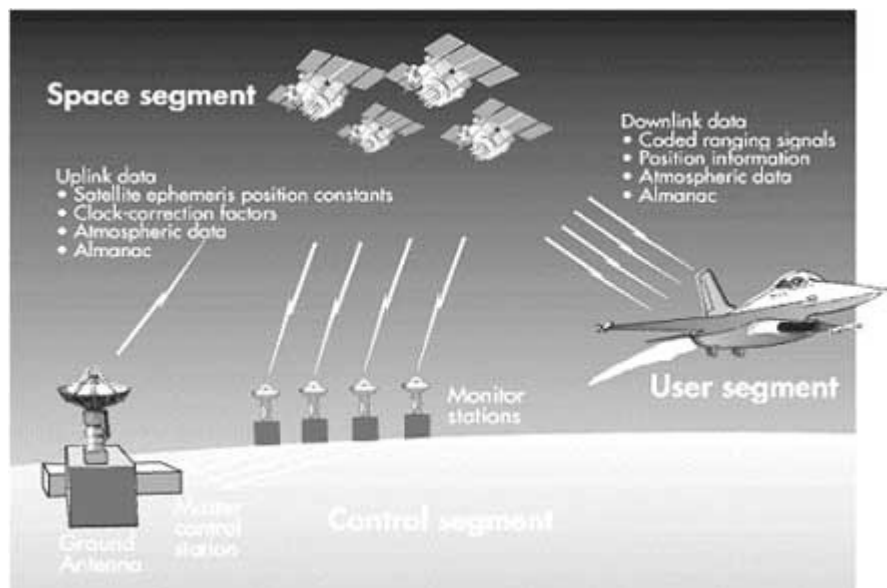
The GPS control, or ground, segment consists of unmanned monitor stations located around the world (Hawaii and Kwajalein in the Pacific Ocean; Diego Garcia in the Indian Ocean; Ascension Island in the Atlantic Ocean; and Colorado Springs, Colorado); a master ground station at Schriever (Falcon) Air Force Base in Colorado Springs, Colorado; and four large ground antenna stations that broadcast signals to the satellites. The stations also track and monitor the GPS satellites.

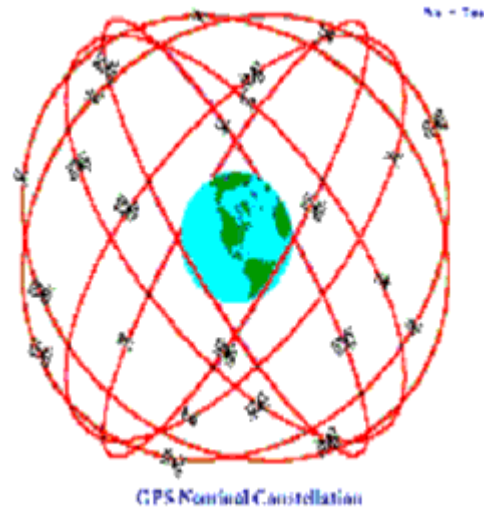
#### Receivers

GPS receivers can be hand carried or installed on aircraft, ships, tanks, submarines, cars, and trucks. These receivers detect, decode, and process GPS satellite signals. The typical hand-held receiver is about the size of a cellular telephone, and the newer models are even smaller weighed only 28 ounces.

### How GPS Works

So you can more easily understand some of the scientific principles that make GPS work, let's discuss the basic features of the system. The principle behind GPS is the measurement of distance (or "range") between the receiver and the satellites. The satellites also tell us exactly where they are in their orbits above the Earth. It works something like this: If we know our exact distance from a satellite in space, we know we are somewhere on the surface of an imaginary sphere with radius equal to the distance to the satellite radius. If we know our exact distance from two satellites, we know that we are located somewhere on the line where the two spheres intersect. And, if we take a third measurement, there are only two possible points where we could be located. One of these is usually impossible, and the GPS receivers have mathematical methods of eliminating the impossible location.





### **GPS Uses in Everyday Life**

The GPS system was developed to meet military needs of the Department of Defense, but new ways to use its capabilities are continually being found. The system has been used in aircraft and ships, but there are many other ways to benefit from GPS. Vehicle tracking is one of the fastest-growing GPS applications. GPS-equipped fleet vehicles, public transportation systems, delivery trucks, and courier services use receivers to monitor their locations at all times.

GPS is also helping to save lives. Many police, fire, and emergency medical service units are using GPS receivers to determine the police car, fire truck, or ambulance nearest to an emergency, enabling the quickest possible response in life-or-death situations.

Automobile manufacturers are offering moving-map displays guided by GPS receivers as an option on new vehicles. Several car companies are demonstrating GPS-equipped vehicles that give directions to drivers on display screens and through synthesized voice instructions.

### **GPS in Navigation**

#### **What is navigation?**

Since prehistoric times, people have been trying to figure out a reliable way to tell where they are, to help guide them to where they are going, and to get them back home again. Cavemen probably used stones, when they set out hunting for food. These marks used to be erased no. of times. The earliest mariners followed the coast closely to keep from getting lost. The next major developments in the quest for the perfect method of navigation were the magnetic compass and the sextant. The needle of a compass always points north, so it is always possible to know in what direction you are going. The sextant uses adjustable mirrors to measure the exact angle of the stars, moon, and sun above the horizon. However, in the early days of its use, it was only possible to determine latitude (the location on the Earth measured north or south from the equator) from the sextant observations. Sailors were still unable to determine their longitude (the location on the Earth measured east or west).

In 1761, a cabinetmaker named John Harrison developed a shipboard timepiece called a chronometer, which lost or gained only about one second a day - incredibly accurate for the time. For the next two centuries, sextants and chronometers were used in combination to provide latitude and longitude information.

In the early 20th century several radio-based navigation systems were developed, which were used widely during World War II. A few ground-based radio-navigation systems are still in use today. One drawback of using radio waves generated on the ground is that you must choose between a system that is very accurate but doesn't cover a wide area, or one that covers a wide area but is not very accurate. High-frequency radio waves (like UHF TV) can provide accurate position location but can only be picked up in a small, localized area. Lower frequency radio waves (like AM radio) can cover a larger area, but

are not accurate.

Scientists decided that the only way to provide coverage for the entire world was to place high-frequency radio transmitters in space. A transmitter high above the Earth sending a high-frequency radio wave with a special coded signal can cover a large area. This is one of the main principles behind the GPS system.

Navigation can be required in land, air and water or in sea. Everyplace navigation can be provided with some modification in the process of getting the data and way of processing of data and accuracy of the data required for each purpose.

### Navigation in Land

GPS improves efficiency on land as well. The capabilities of satellite navigation, when coupled with communications and modern computerized management systems can help meet many of the transportation challenges facing all modes of surface transportation.

Currently, it is being used to add a new dimension for automatic vehicle location and in-vehicle navigation systems. GPS helps motorists find their way by showing their position and intended route on dashboard displays.



The NAVSTAR and GLONASS systems use the principle of trilateration. That is, the user's receiver determines the distance from the user to each of several satellites. Since the positions of the satellites are known, either through previous publication or as part of the satellite's broadcast information, the user's position can be calculated.

Display of the position of the vehicle can be taken on an instrument of a size of a mobile phone or palmtop. A central monitoring station or service providing central station can observe the position. The various services that can be provided by the central monitoring station can be as follows:

- When emergency assistance is required, that can be in a stage of health problems, lost of way.
- In a search of facilities in a highway such as public conveniences or restaurant etc.
- Search of a route that is short, less congested and that will touch the required places or facilities in need.
- List is very long and end less. As long as technology helps, as the navigation facilities will reach to a point, at which when vehicles will become smart vehicle, which is self-driven vehicles. In which we have to give only the destination then sit a back, read newspaper or talk on a phone, vehicle will take us to our destination.
- GPS integrated with VHF and HF radios are being offered to Army, Navy and Air force. It aids the soldier in navigating without the help of a map and automatic reporting of the position of the troop to control station.

### Transit

Transit was the first operational satellite navigation system. The Transit system allowed the user to determine position by measuring the Doppler shift of a radio signal transmitted by the satellite. The user was able to calculate position to within a few hundred meters.

The system has several drawbacks.

- The system is inherently two-dimensional.
- The velocity of the user must be taken into account.
- Mutual interference between the satellites restricted the total number of satellites to five. Thus, satellites would only be visible for limited periods of time.

These drawbacks pretty much eliminated aviation applications and severely limited land-based applications.

### NAVSTAR

The NAVSTAR GPS system is a satellite-based radio navigation system developed and operated by the U.S. Department of Defense (DOD). The NAVSTAR system permits land, sea, and airborne users to determine their three-dimensional position, velocity, and time 24 hours a day, in all weather, anywhere in the world with a precision and accuracy far better than other radio navigation systems available today.

The NAVSTAR system performs another function besides positioning and time transfer. NAVSTAR satellites carry nuclear explosion detection equipment.

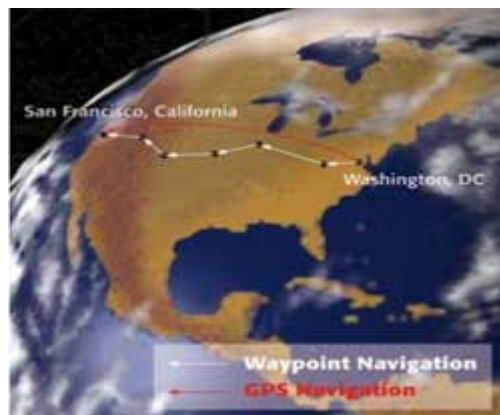
### GLONASS

Current Russian satellite-based positioning system - counterpart to NAVSTAR

### Sea Navigation

Satellite navigation provides unprecedented accuracy and capabilities for mariners. GPS is a powerful tool that can save a ship's navigator hours of celestial observation and calculation. GPS has improved efficient routing of vessels and enhanced safety at sea by making it possible to report a precise position to rescuers when disaster strikes.

GPS aids the fishermen in reaching the probable fishing zones (PFZ) accurately and avoids blind netting. VIS system monitors the vessels on the sea at the shore station any point of time. It aids in rescuing operation in case of emergencies and helped in avoiding smuggling and poaching activities. Accesses to fast and accurate position, course, and speed information will save time and fuel through more efficient traffic routing.



### Navigation in the Air

Satellite navigation is being widely used by aviators throughout the world to overcome many of the deficiencies in today's air traffic infrastructure. Pilots rely on GPS to navigate to their destinations. With its accurate, continuous, all-weather, three (GPS only) and four (GPS with augmentations) dimensional coverage, satellite navigation offers an initial navigation service that will satisfy many of the requirements of users worldwide.

Many worldwide airline fleets are installing GPS airborne receivers for immediate use in enroute and non-precision approach operations. GPS offers a navigation service that is equal to, and in most cases better than the existing ground-based systems, yet at a fraction of the cost. GPS offers an inexpensive and reliable supplement to existing navigation techniques for aircraft. Civil

aircraft typically fly from one ground beacon, or waypoint, to another. With GPS, an aircraft's computers can be programmed to fly a direct route to a destination.

In the aviation sector, GPS has resulted in significant cost savings and increases in overall system efficiency. Many aviation authorities are also taking the necessary steps to allow for more advanced use of GPS within their respective airspace.

The implementation of this technology in a country or region will provide the following benefits to aviation transportation:

- Enhance safety of flight throughout the region.
- Create a seamless navigation service throughout the entire CAR/SAM region, based on a standardized navigation service and common avionics.
- Increase system capacity.
- significant savings from shortened flight times and reduced fuel consumption.
- Improve ground and cockpit situational awareness.
- Increase landing capacity for aircraft and helicopters.

### **Fleet Management**

A vehicle tracking system can thus be defined as a part of a fleet management system, which enables the fleet operator to find out the location of the vehicle throughout the journey of the vehicle, against time.

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 computation of exact distance traveled in a given time span, computation of the speed of the bus 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 the operating agencies.

Paper now will discuss about public transport only. Later fleet management in the case of rail and aviation sector will be discussed.

### **Fleet management for public transport vehicles**

Fleet Management incorporates many of the vehicle-based technologies and innovations for more effective vehicle and fleet planning, scheduling, and operations. Fleet Management focuses on the vehicle, improving the efficiency and effectiveness of the service provided (the "supply side"), and on passenger safety. This makes the transit more efficient and reliable, it should be more attractive to prospective riders, transit operators, and the municipalities they serve.

The technologies and innovations described are:

### **Communications Systems**

The transportation community already makes substantial use of communications in everyday operations. The application of different technologies to public transportation will bring about additional communications requirements. APTS and Smart

Vehicle technology will require communications for such integrated functions as:

- Bus and control center communications
- Fare payment;
- Adaptive signal systems;
- Wayside/transfer center transit and On-board information inter modal information.

Of all the APTS functions requiring communications, by far the most critical is the bus/control center link. The application of new communication technologies to the transit industry has been limited. Transport companies are now replacing their older analog communications systems with newer digital systems, and a number have converted or are planning to convert to either analog or digital trunked communications system. In a trunked system, the available spectrum is partitioned

into a number of channels and received or transmitted signals are automatically directed to whatever channel is currently unused.

### **Geographic Information Systems**

A geographic information system (GIS) has been described as “A system of computer hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modularity and display of spatially referenced data...” In the transit environment, GIS can be used for solving complex planning problems, operations planning, and other management and operational needs, including AVL operations.

GIS is a combination of an electronic map and a relational database that allows a user to visualize and analyze the relationship between non-related data whose only common feature is that the information shares similar geographic location,

GIS can be used for the display and/or analysis of the following that can be linked with GPS for the fleet management.

- Bus routes, streets, parking lots, facilities, shelter locations, ridership loadings, running times, scheduling, bus assignments,
- Bus route maps, trip planning route choices, on-time performance data, multi-media displays, pass sales outlet planning
- Customer address location, service qualification determination, and service performance statistics

Since information on GIS systems was not solicited during the data collection effort for this report, it is not possible to judge the extent of GIS deployment. However, transit operators with global positioning system AVL systems usually also have a GIS.

### **Automatic Vehicle Location**

Use of AVL in transit applications is growing, driven by the following expected benefits:

- Increased overall dispatching and operating efficiency;
- More reliable service, promoting increased ridership;
- Quicker response to service disruptions;
- Inputs to passenger information systems;
- Increased driver and passenger safety and security;
- Quicker notice of mechanical problems with the vehicles, reducing maintenance costs;
- Inputs to traffic signal preferential treatment actuators; and

The system operates by measuring actual real-time position of each vehicle, and relaying the information to a central location.

### **Automatic Passenger Counters**

Automatic Passenger Counters are a well-established, automated means for collecting data on passenger boarding and alighting by time and location. These data may be used for a number of applications, both real-time and delayed, including:

- Input to dispatcher decisions on immediate corrective action
- Input to real-time passenger information systems
- Future scheduling
- Positioning new shelters for waiting passengers

The two most common technologies used to register boardings and alightings are infrared beams and treadle mats. Two infrared beams are typically placed across the passengers' path as they board or alight the vehicle. As a passenger boards, he or she interrupts the beams in a particular order, and the APC registers the boarding. Likewise, as a passenger alights, he or she interrupts the beams in the reverse order, and the APC registers the alighting. These various data regarding

- No of passengers in the bus.
- Distance up to that they traveled.
- Money collected on real-time basis.
- Enabled central control station for the total computer aided dispatch (CAD)

CAD intelligently can perform its operation such that it can control the dispatch of vehicles by taking the real time demand on the route, it can make necessary change in the route of the vehicle when the vehicle are in a congested route. This automated monitoring can reduce

chances of manually taken false decisions.

### **Fleet management for commercial vehicles**

Regarding the commercial applications of the GPS it is now in use for tracking of goods vehicle. Delivery trucks can receive GPS signals and instantly transmit their position to a central dispatcher. These enable the commercial operators to plan their operations and help the users to take decision about use of their consignee when they will get it.

### **Use of GPS in fleet management mainly leads to**

- Efficient, optimized, flexible, and user-preferred route structures.
- Reduce costs to each organization while increasing overall benefits to individual of States and the entire region.
- Delivery companies will be able to plan routes for deliveries in the optimum efficiency.

The entire above can provides a source of revenue for the Government and assist in funding of an integrated transportation system.

### **Fleet management for aircrafts**

All aircraft equipped with certified GPS receivers will have the needed accuracy, integrity, and availability for them to use GPS. Use of GPS as navigation assistance can lead to a proper fleet management. It can assist in automated dispatch of aircrafts by using the full serving capacity of the runway or other management facilities. Automation leads to improvement in the efficiency by decrease of manpower, time loss and miss handling.

### **Fleet management for railways**

Many rail systems are comprised of long stretches of single track. Precise knowledge of where a train is located is essential to prevent collisions, maintain smooth flow of traffic, and minimize costly delays due to waiting for clearance for track use. Satellite navigation provides a sound position-locating capability for rail traffic management systems, be it to manage the movement of cars and engines in switchyards, or to ensure the safety of work crews. Current technology will also allow for fully automated train control through the use of a differential GPS capability, digital maps and onboard inertial units. Systems in western countries such as New York where

the total fleet arriving and departure is control automatically by control station, which are getting the position of the vehicle using GPS. These facilities enable the operators to remove the human factor from the fleet management operations. These increase the efficiency of the operations with any much complication in the management.

All these fleet management are in the part of the operations. Except these there are so many operations will also become automated with the use of GPS.

These are some applications

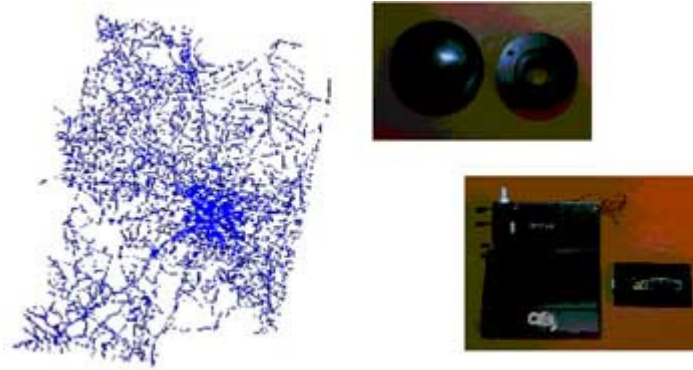
- Generation of reports for the daily or online operations fleet operations.
- Generation of the automated pay bill to the private operator.
- Generation of the origin and destination data for the future route rationalization and schedule change.
- Authenticity check for public complaints regarding the in efficient operations etc.

### **Fleet management and GPS in India**

- In India Andhra Pradesh State Road Transport Corporations (APSRTC) first started the management of inter state fleets using GPS. But the system not function very well.

### **Banagalore Metropolitan Transport Corporation (BMTc)**

The Department of Electronics funded project of Bangalore Metropolitan Transport Corporation. An application of the projects is to control of private operators by obtaining information on route traveled by the bus and timing. The target is to generate billing information based on route kms traveled. The route kms data will be validated by the vehicle monitoring system at the control center for violations in route and time. The system generates several reports and statements based on queries such as buses plying in a given route at a given time of the day, etc.



The GPS receiver is mounted on the target vehicle. The latitude and longitude of the vehicle, transmitted by the GPS module is written into local memory. Off-line monitoring system process the stored information in the memory of the GPS receiver to derive the required vehicle monitoring information. Management of a bus fleet essentially involves ensuring timely arrival and dispatch of buses. These also ensure that the bus touches the enroute points as per schedule. Urban Transport Corporation in a city of Bangalore has 2300 buses and about 33000 trips, and these trips pass through repeatedly about 1000 bus stops in the city. These systems will give as a relief from conventional sort of vehicle tracking is carried out manually by posting traffic controllers/timekeepers at some important points. This manual tracking doesn't give enough accuracy. It totally depends on human alertness. On the other side GPS data is very authentic and tamper-proof, and the data generated in the form of entries can be easily used for computer processing.

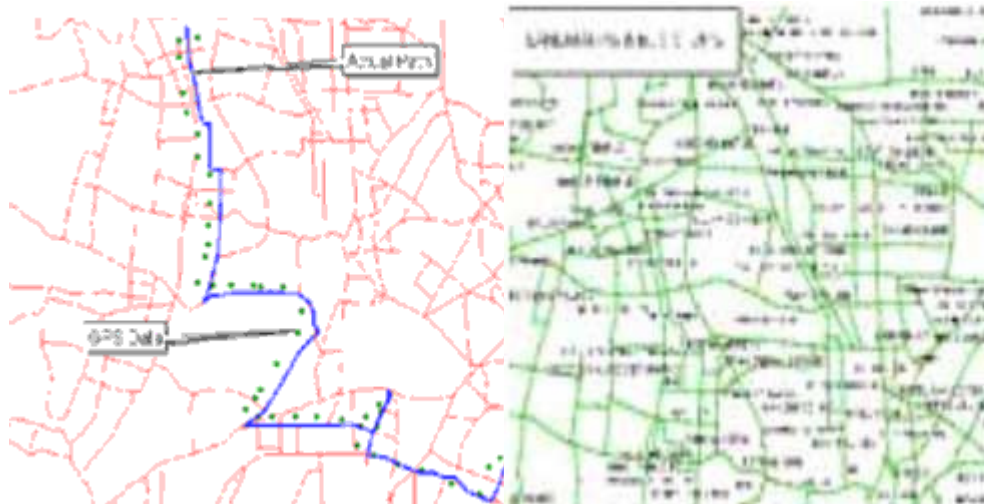
To develop a vehicle-tracking project for fleet management following steps is generally followed

- Digitizing the road map for the city.
- Developing the GPS receiver module.
- Development of software, which provides interface between the GIS and the GPS.
- Development of the error correction software.
- Development of the analysis software

The GPS receiver module constituted the heart of the system. Each receiver has a facility to store the unique ID and was capable of recording the coordinates of its location every minute. A memory module was also added to the receiver, which was capable of storing the recordings of three days. In every record, the first entry represents the Latitude-N and the second entry indicate Longitude-E (both in degrees, minutes and seconds), followed by Time (in Hour, Minute and Second) and Date. When the GPS coordinates were plotted on the GIS map of the city it was found that the recordings were not exactly sitting on the roads. There were several errors responsible for this. the resolution of the satellite map was only 20 meters, digitization has to be done by manually tracing the satellite image some errors crept in at that stage, selective availability of the GPS signals, the signals are not 100% accurate. In order to overcome this problem software was developed which was capable of pulling these coordinates onto the correct road thus facilitating further processing.

Generation of each schedule was a necessary output in order to find out whether the bus performed punctually as per the schedule. For this purpose the location of the bus was required periodically. The time interval could vary from a minute to half an hour. The GPS module throws up this data in terms of the latitude and the longitude, but for a traffic controller, it is very difficult to interpret. Therefore on the GIS road map of the city, landmarks were identified at every 200 meters length and a layer was created where the coordinates of all these landmarks were fed. Software was designed which would convert the latitude and the longitude given by the GPS into the nearest landmark and then generate a log-sheet giving the location of the bus at periodic intervals in terms of the landmarks.

Here the first figure in the block gives the kilometer covered from the previous point, the second figure gives the time. Also at the end, the distance traveled by the bus in a specified time interval is also indicated. Another software was developed which would animate the movement of the bus.



### Automatic Fleet Management System for Delhi Transport Corporation (DTC)

#### Limitations of Present Operation

DTC is facing with some problems. Some of that are given below

- Fleet mobilization Operations - Manual
- Depends upon efficiency of Fleet controller
- Absence of real time Monitoring & Regulating
- Higher Operating Costs
- Prone to Human Errors – unintentional & intentional
- Absence of historical data for optimizing

There are some parts of the advanced management fleet operations that DTC planning to implement by January 2002.

#### Elements of fleet management

- Automatic Vehicle and Monitoring System
- Automatic Fare Collection System
- Customer services
- Integrated Information System
- Integrated Computerized Spare Parts Management system

Vehicle Tracking System based on DGPS Vehicle mounted unit called Nirdeshak that collects-position data & interfaces with automatic fare collection system in bus. Vehicle information transmitted to central control station in real time using communication system.

#### Pilot Project of DTC

In first phase Project is planned for 200 vehicles on 39 routes from two depots – IP DEPOT and BBM I DEPOT. Central Control Station will be at DTC HQ at IP-ESTATE. Relevant application software for management of operations - display, messaging, logging, analysis, reports etc are planned. There will be a Smart card interface for the collecting fare from the buses. Monitoring and regulating fleet operation will be at DTC units at IP Estate and Scindia House where in real time on GIS map vehicles real time can be seen.

Bus Location can be noted at any instant of time within 5 meters. There is a possibility of checking of that buses are adhering to their routes or not, following the time schedules or not. Stopping at designated bus stops or not. No. Of trips covered in each shift can be easily measured. There is Two way instant messaging is possible for Accidents, breakdowns, medical, emergency, riots etc. then the provision of immediate dispatching assistance vehicle is also there. Re-scheduling /Re-routing services in case of traffic jams, roadblocks, picketing can be done. Automatic generation, collection, storage, retrieval & analysis of vehicle data will help operators to analysis the operations on the real time basis. Vehicle data is to be sent to the Central Server automatically – with an avoidance manual collection & verification of data that will eliminate human errors in collecting data. And help in reducing malpractice. One of the main part of the fleet management

will be the preparation of the bill (playbill) for private operators and schools. These will become very much accurate and no human malpractice can be done. All these operation will lead to automation in the operation will lead to a efficient operations and fleet management.

### **Traffic Signals Priority**

Rising traffic congestion all over the world calls for new Intelligent Traffic Systems that can improve public transport and vital services such as emergency vehicle operations.

The objective with the Traffic signals priority project is to create an improved emergency services in order to create

- Lower response time.
- Eliminate dangerous passing of red lights.
- Provide warnings to hospitals of arriving ambulances, and to create an increased passenger satisfaction with improved public bus services in order to: ?Decrease delays.
- Enable faster routes.
- Provide information to passengers Giving green light to ambulances, fire fighters and other emergency vehicles allows these to pass through a city faster, cutting the response time with vital minutes.
- Giving green light to buses when these are late can cut delays in bus services and thereby improve passenger satisfaction.
- Going one step further and always give green light to buses can be used to cut journey time – making public transport a more attractive alternative to private transport.

### **General Method for providing traffic signal priority**

The bus location information and predicted intersection arrival times will then be passed along to the traffic control center. The control center may use one from a set of strategies that we explore to determine if a bus should be given priority or not. For example, if the computer notices that a particular bus is running excessively behind schedule, the bus will be flagged and given a greater priority in evaluating the value of its request for green preemption. This computer system will use an algorithm to be developed to allocate priority between buses (late, on-time, express, dial-a-ride, etc.) and general traffic flow. The computer will also require input from the bus system regarding passenger loading and unloading at stops in the vicinity of the actively controlled intersections. The central controlling computer will need real-time input from traffic detectors to accurately determine the traffic volumes that conflict with the various bus movements.

### **Bus Priority in SCOOT**

A facility was introduced as part of SCOOT 3.1 in 1995 to integrate active priority to buses or other public transport vehicles with the common SCOOT UTC system. The method of doing this is described below:

#### **Detection and Identification**

The SCOOT kernel software allows for buses to be detected either by selective vehicle detectors (SVD), i.e. using bus loops and bus-borne transponders, or by an automatic vehicle location (AVL) system as GPS. Where SCOOT is given a bus identifier as part of the bus detection, it can match this detection with a previous detection of the same bus.

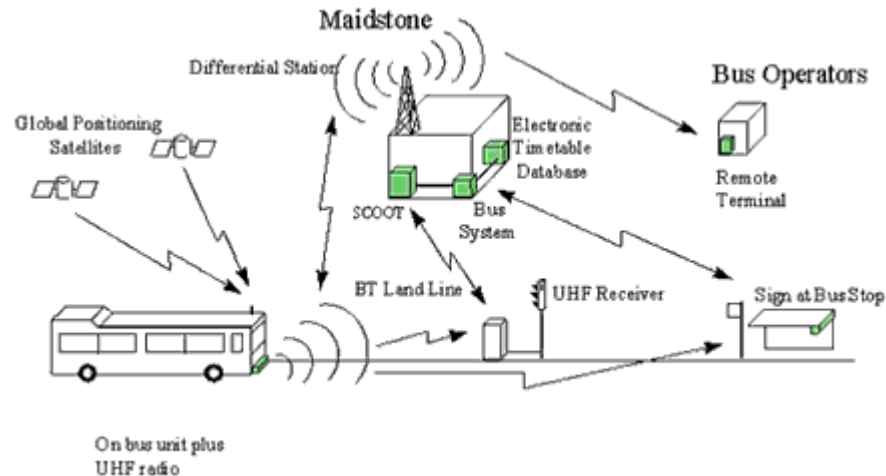


### **Bus Modeling**

Buses are modeled by SCOOT as queuing with other vehicles. This allows buses to be given priority even though other vehicles may delay them. The effect of bus lanes can also be modeled, including those, which end before the stop line.

### Optimisation

The signal timings are optimized to benefit the buses by either extending a current green signal (an extension) or causing succeeding stages to occur early (a recall). Extensions can be awarded centrally, or the signal controller can be programmed to implement extensions locally on street (a local extension).



### Local extension

Extensions awarded in the controller can be advantageous as they eliminate 3 to 4 seconds transmission delay from street to computer and back to street, and so allow the system to grant extensions to buses which arrive in the last few seconds of green

### Recovery

Once the bus has passed through the signals, a period of recovery occurs to bring the timings back into line with the normal SCOOT optimization.

### Restrictions on priority

The amount of priority given to buses can be restricted depending on the saturation of the junction as modeled by SCOOT. This means that bus priority will be most effective at junctions, which have spare capacity.

### Bus SCOOT and Bus Detection Systems.

The logic of bus priority does not depend on the method of detecting buses, which can vary from system to system. The method of detection can be based on transponders; it can be derived from Automatic Vehicle Location; or it can be based on some other system that provides suitable information. Suitable information is the key element in SCOOT Bus Priority. SCOOT requires an indication of the presence of a bus on a link, the free flow journey time of the bus to the stop line and the queue clear time of a vehicle queue reaching to the bus detection position.

The presence of a bus does not have to be indicated at a fixed location on a link, and information on a bus can be presented more than once on the same link.

It is hoped that, by providing priority on a selective basis, the following benefits will be achieved:

- Improvement in travel time regularity/reliability
- Reduced passenger waiting times
- Priority targeted towards higher occupancy buses
- Reduced impact on other traffic

In London, the AVL system provides real time bus location and headway data, which is used by a new headway regularity algorithm to determine the best level of priority required for each bus.

To provide real time information to the passenger waiting at the bus stops is the one of the applications of the usefulness of the GPS in the location based services.

Bus Priority Survey Results are found in London gives reductions of the order of 16 to 22 % in the delay of vehicles in the intersection.

#### **Accuracy of the GPS –system in signal priority**

The pure GPS (General Position System) -location data is not accurate enough because of the random disturbance of the GPS -system. This is not a problem, however, for the bus detection system because the GPS -location data is used only for location of the bus stop: the bus is located only when the front door of the bus is opened at a bus stop.

The figure on the right is an example of points where the detection messages to the traffic signals are sent by the bus. Each detection area can be found from the figure. This will prove that the accuracy of the GPS -location is good enough for detecting bus stops correctly.



#### **GPS and incident management**

Incident management in a highway or in any urban road can be done effectively using GPS. When some incident is happened then disruptions in the movement of the vehicles can be tracked by the GPS transponders by sending message to the control station for help.

#### **Conclusions**

The immediate and exponential benefits offered by GPS result in a safer and more efficient transportation infrastructure, which can positively influence trade potential and economic viability of a region. GPS can truly serve as a catalyst for trade and economic growth for individual those who take advantage of it. Use of GPS in the head of navigation, fleet management and some location-based services are numerous and it depend on the technologist how they want to use it for what purpose. India also in stage to implement GPS to solve some of its problems in the field of transportation. But this is a very late start we have to go a long way to problems that now looks to be impossible to solve by using conventional methods.

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