GPS AND ITS APPLICATIONS

UNIT V

APPLICATIONS: VEHICLE TRACKING-SIMULTANEOUS GPS-MOBILE COMPUTING-MILITARY APPLICATIONS-RECREATIONAL APPLICATIONS

VEHICLE TRACKING

The **tracking device** is installed into a **vehicle** (or piece of equipment or asset) to gather all sorts of information including speed, idle time, diagnostics, etc. It uses **Global Positioning Systems** (**GPS** satellites) to know the **vehicle** or equipment's location at all times.

Right now, mobile phones, tablets, and smartwatches **use GPS tracking to trace vehicles**. This is the most convenient way to **track** them because you always have your devices with you at all times.

A **vehicle tracking system** combines the use of automatic vehicle location in individual vehicles with software that collects these fleet data for a comprehensive picture of vehicle locations. Modern vehicle tracking systems commonly use GPS or GLONASS technology for locating the vehicle, but other types of automatic vehicle location technology can also be used. Vehicle information can be viewed on electronic maps via the Internet or specialized software. Urban public transit authorities are an increasingly common user of vehicle tracking systems, particularly in large cities.

Active versus passive tracking

Several types of vehicle tracking devices exist. Typically they are classified as "passive" and "active". "Passive" devices store GPS location, speed, heading and sometimes a trigger event such as key on/off, door open/closed. Once the vehicle returns to a predetermined point, the device is removed and the data downloaded to a computer for evaluation. Passive systems include auto download type that transfer data via wireless download. "Active" devices also collect the same information but usually transmit the data in near-real-time via cellular or satellite networks to a computer or data center for evaluation.

Many modern vehicle tracking devices combine both active and passive tracking abilities: when a cellular network is available and a tracking device is connected it transmits data to a server; when a network is not available the device stores data in internal memory and will transmit stored data to the server later when the network becomes available again.

Historically, vehicle tracking has been accomplished by installing a box into the vehicle, either self-powered with a battery or wired into the vehicle's power system. For detailed vehicle locating and tracking this is still the predominant method; however, many companies are increasingly interested in the emerging cell phone technologies that provide tracking of multiple entities, such as both a salesperson and their vehicle. These systems also offer tracking of calls, texts, web use and generally provide a wider range of options.[1]

Typical architecture

Major constituents of the GPS-based tracking are:

1. GPS tracking unit: The device fits into the vehicle and captures the GPS location information apart from other vehicle information at regular intervals to a central server. Other vehicle information can

include fuel amount, engine temperature, altitude, reverse geocoding, door open/close, tire pressure, cut off fuel, turn off ignition, turn on headlight, turn on taillight, battery status, GSM area code/cell code decoded, number of GPS satellites in view, glass open/close, fuel amount, emergency button status, cumulative idling, computed odometer, engine RPM, throttle position, GPRS status and a lot more. Capability of these devices actually decide the final capability of the whole tracking system; most vehicle tracking systems, in addition to providing the vehicle's location data, feature a wide range of communication ports that can be used to integrate other onboard systems, allowing to check their status and control or automate their operation.[2]

2. GPS tracking server: The tracking server has three responsibilities: receiving data from the GPS tracking unit, securely storing it, and serving this information on demand to the user.
3. User interface: The UI determines how one will be able to access information, view vehicle data, and elicit important details from it.

Common uses

Vehicle tracking systems are commonly used by fleet operators for fleet management functions such as fleet tracking, routing, dispatching, on-board information and security. Some vehicle tracking systems are bundled with or interface with fleet management software. Along with commercial fleet operators, urban transit agencies use the technology for a number of purposes, including monitoring schedule adherence of buses in service, triggering automatic changes of buses' destination sign displays once the vehicle approaches the bus terminus (or other set location along a bus route such as a particular bus stop along the route), and triggering pre-recorded (or even synthetic speech) bus stop, route (and its destination) or service announcements for passengers.

The American Public Transportation Association estimated that, at the beginning of 2009, around half of all transit buses in the United States were already using a GPS-based vehicle tracking system to trigger automated stop announcements.[3] This can refer to external announcements (triggered by the opening of the bus's door) at a bus stop, announcing the vehicle's route number and destination, primarily for the benefit of visually impaired customers, or to internal announcements (to passengers already on board) identifying the next stop, as the bus (or tram) approaches a stop, or both; the latter are often also displayed on an internal LED display or LCD monitor connected to the system while the loudspeakers play them. Data collected as a transit vehicle follows its route is often continuously fed into a computer program which compares the vehicle's actual location and time with its schedule, and in turn produces a frequently updating display for the driver, telling him/her how early or late he/she is at any given time, potentially making it easier to adhere more closely to the published schedule.

Such programs are also used to provide customers with real-time information as to the waiting time until arrival of the next bus or tram/streetcar at a given stop, based on the nearest vehicles' actual progress at the time, rather than merely giving information as to the *scheduled* time of the next arrival.[4] Transit systems providing this kind of information assign a unique number to each stop, and waiting passengers can obtain information by entering the stop number into an automated telephone system or an application on the transit system's website.[4][5]

Some transit agencies provide a virtual map on their website, with icons depicting the current locations of buses in service on each route, for customers' information,[6] while others provide such information only to dispatchers or other employees.

Other applications include monitoring driving behavior, such as an employer of an employee, or a parent with a teen driver.

Vehicle tracking systems are also popular in consumer vehicles as a theft prevention, monitoring and retrieval device. Police can simply follow the signal emitted by the tracking system and locate the stolen vehicle. When used as a security system, a Vehicle Tracking System may serve as either an addition to or replacement for a traditional car alarm. Some vehicle tracking systems make it possible to control the vehicle remotely, including

block doors or engine in case of emergency. The existence of vehicle tracking device then can be used to reduce the insurance cost, because the loss-risk of the vehicle drops significantly.

Vehicle tracking systems are an integrated part of the "layered approach" to vehicle protection, recommended by the National Insurance Crime Bureau (NICB) to prevent motor vehicle theft. This approach recommends four layers of security based on the risk factors pertaining to a specific vehicle. Vehicle Tracking Systems are one such layer and are described by the NICB as "very effective" in helping police recover stolen vehicles.

Some vehicle tracking systems integrate several security systems, for example by sending an automatic alert to a phone or email if an alarm is triggered or the vehicle is moved without authorization, or when it leaves or enters a geofence.

Other scenarios in which this technology is employed include:

- Stolen vehicle recovery: Both consumer and commercial vehicles can be outfitted with RF or GPS units to allow police to do tracking and recovery. In the case of LoJack, the police can activate the tracking unit in the vehicle directly and follow tracking signals.
- Asset tracking: Companies needing to track valuable assets for insurance or other monitoring purposes can now plot the real-time asset location on a map and closely monitor movement and operating status.
- Field service management: Companies with a field service workforce for services such as repair or maintenance, must be able to plan field workers' time, schedule subsequent customer visits and be able to operate these departments efficiently. Vehicle tracking allows companies to quickly locate a field engineer and dispatch the closest one to meet a new customer request or provide site arrival information.
- Field sales: Mobile sales professionals can access real-time locations. For example, in unfamiliar areas, they can locate themselves as well as customers and prospects, get driving directions and add nearby last-minute appointments to itineraries. Benefits include increased productivity, reduced driving time and increased time spent with customers and prospects.
- Trailer tracking: Haulage and Logistics companies often operate lorries with detachable load carrying units. The part of the vehicle that drives the load is known as the cab and the load carrying unit is known as the trailer. There are different types of trailer used for different applications, e.g., flat bed, refrigerated, curtain sider, box container.
- Surveillance: A tracker may be placed on a vehicle to follow the vehicle's movements.[7]
- Transit tracking: temporary tracking of assets or cargoes from one point to another. Users will ensure that the assets do not stop on route or do a U-Turn in order to ensure the security of the assets.
- Fuel Monitoring: monitor the fuel through tracking device (with help of fuel sensor connected to the device).
- Distance Calculation: calculate the distance travelled by the fleet.
- OBD II – Plug and play interface which provides most engine diagnostics information.

Vehicle tracking systems are widely used worldwide. Components come in various shapes and forms but most use GPS technology and GSM services. Newer Vehicle tracking systems also use the latest NB-IoT technology that can provide low power consumption and optimized data transmission rates. Additionally, these systems may also feature short range data communication systems such as WiFi. While most will offer real-time tracking, others record real time data and store it to be read, in a fashion similar to data loggers. Systems like these track and record and allow reports after certain points have been solved

Vehicle OBD tracking systems

Vehicle OBD tracking systems make use of OBD GPS trackers that plug into the onboard diagnostic (OBD) port of light, medium, or heavy-duty vehicle. A cellular OBD GPS tracker directly communicates with the cell tower for sending the location and other vehicle performance data to the server over the cellular wireless network. Usually, the tracker device draws power from the OBD port itself and contains a built-in antenna along with a GPS module for receiving the GPS signal. In addition, OBD trackers communicate with the different vehicle subsystems for receiving vehicle diagnostic and fuel consumption related data. Users can

view the information using standalone software or web browser from a desktop/laptop computer or using smartphone apps.

Fleet management tracking

Aside from theft-prevention, the most common use of vehicle tracking is in logistics and transport. These systems make use of GPS and GSM technology to provide precise and constant location telematics to an individual fleet manager. These systems are typically equipped with features to monitor statistics such as; fuel consumption, average speed, current driver time and location. There has been a recent increase in demand for this technology as EU regulations place increased restrictions on the hours driver are allowed to work in a given day. It is currently limited to 9 hours per day.[8] Companies are legally obligated to install a tachograph in any vehicle that is expected to carry goods. This obligation has led many to attempt to cauterize this potentially onerous obligation, instead turning it into a benefit. Fleet management systems use GPS & GSM technology. Much like other forms of trackers, although due to their nature they are equipped with more thorough diagnostic features.

Other uses such as *Trailer Tracking, Fuel Monitoring, Distance Calculation, Asset Tracking,* and *Field Sales* can all be incorporated into a fleet management solution.[9]

Unconventional uses

Industries not traditionally known to use vehicle tracking systems (logistics and transportation industries are the ones that have traditionally incorporated vehicle tracking system into their operations) have started to use it in creative ways to improve their processes or businesses.

The hospitality industry has caught on to this technology to improve customer service. For example, a luxury hotel in Singapore has installed vehicle tracking systems in their limousines to ensure they can welcome their VIPs when they reach the hotel.

Vehicle tracking systems used in food delivery vans may alert if the temperature of the refrigerated compartment moves outside of the range of safe food storage temperatures. Car rental companies are also using it to monitor their rental fleets.

simultaneous GPS

Simultaneous GPS or **S-GPS** is a method to allow a GPS reception and CDMA communications to operate simultaneously in a mobile phone.

Ordinarily, cellular geolocation and a built-in GPS receiver is used to determine the location of an E911 call made from CDMA phones. By using a time-multiplexed scheme called **TM-GPS**, the reception of the telephone call and the GPS signal are alternated one after the other, requiring only one radio receiver.

Simultaneous GPS allows a cellphone to receive both GPS and voice data at the same time, which improves sensitivity and allows service providers to offer location-based services.[1] The use of two radios with a single antenna imparts new design challenges, such as leakage of the voice transmitter signal into the GPS receiver circuitry.[2] The commercial availability of S-GPS chipsets from manufacturers such as Qualcomm, has led to adoption of the method in newer handsets.

Mobile computing

Global Positioning System (**GPS**) is a navigation system based on satellite. It has created the revolution in navigation and position location. It is mainly used in positioning, navigation, monitoring and surveying applications. ... At any time, the **GPS** receivers will get the signals from at least four satellites.

Military applications

Military technology is the **application** of technology for use in warfare. It comprises the kinds of technology that are distinctly **military** in nature and not civilian in **application**, usually because they lack useful or legal civilian **applications**, or are dangerous to use without appropriate **military** training.

The satellite navigation is applied to military missions for navigation purposes in enemy territories, and are especially important in absence of light in night missions. The military forces rely on GNSS over conventional compasses, in order to obtain an accurate positioning of their own units, as well as the enemy's forces positions and the locations of enemy's facilities or installations. These positions coordinates can be acquired and distributed to other units, in order to enhance the ground awareness picture.

Satellite navigation is also used to plan and track the movements of convoys and in operations of search and rescue of injured soldiers, with considerable reduction of response time. Satellite navigation is used by military forces for ground navigation, aviation navigation and maritime navigation. Since military aviation navigation and maritime navigation are similar to their civilian counterparts this article will focus mostly on military ground navigation.

Application Architecture

The GPS was initially developed for military purposes and has proven to be indispensable for several military activities, such as land, air and sea navigation and accurate positioning for a wide range of military applications.[1] The use of GNSS has reduced the search and rescue operations response times, increasing the survival chances of the wounded soldiers.

The military navigation applications in current use, facilitate the following activities:

- Forces location,
- Forces navigation,
- Forces deployment,
- All weather and around the clock operations,
- Communication network timing.

The military applications are considered safety critical applications and in the case of GPS the military use the Precise Positioning Service (GPS PPS), which is a robust and encrypted signal with anti-jamming features.

GPS PPS uses both L1(C/A) and L2(P-code) frequencies while the Standard Positioning Service (SPS) uses only L1. The use L1 and L2 simultaneously allows among other things the removal of ionospheric errors and a more robust positioning. Detailed descriptions of Precise Positioning Service and Standard Positioning Service are available in GPS Services.

Galileo and modernized GPS will support multiple frequency signals for civilian uses and the accuracy difference between military and civilian GPS services will be reduced. Despite this the non-public services of GNSS systems will still have additional security and anti-jamming characteristics.

GPS modernization

An important part of the current GPS modernization program, is the new signal that is designed to improve both the security and prevention jamming properties of military navigation using GPS, the M-code.

The M-code signal provide better jamming resistance than the P(Y)-code signal (that defines the Precise Positioning Service), primarily through enabling transmission at much higher power without interference with C/A-code or P(Y)-code receivers.

The M-code design provides a more robust signal acquisition than is achieved today, while offering better security in terms of exclusivity, authentication, and confidentiality, along with streamlined key distribution. The M-code is designed to be autonomous, and so users will be able to calculate their positions using only the

M-code signal, unlike the existing military P(Y)-code, which also requires use of the C/A-code, providing at least comparable performance to the P(Y)-code signal, and more flexibility than the flexibility offered by P(Y)-code signal.

While providing these benefits, the M-code signal must coexist with current signals on L1 and L2, not interfering with current or future civilian or military user equipment.[2]

Application Characterization

Forces Navigation

Forces location information is fundamental in military procedures. GNSS systems can turn the determination of the location of allied and enemy units into a simple task, with the proper equipments. With GNSS ubiquitous presence in military actions, troops must be constantly moving to avoid interceptions.

The tracking of troops is another useful application, since potential targets, must be tracked and monitored before an attack. This tracking procedures use other techniques such as photo reconnaissance combined with GNSS information, to enhance the awareness and providing guidance information to bombing missions.

Aircraft navigation is a military application, that also used for civil purposes, as it is documented in Aviation Applications article. The Maritime Navigation is also used by military vessels. In Maritime Applications article there are examples of satellite navigation applied to maritime navigation civil domain.

Remotely Operated Vehicles

Nowadays, the Unmanned Aerial Vehicles (UAVs) have a prominent importance in military actions around the world, due to the capabilities of being remotely controlled in military bases, located on a different part of the globe. The UAVs have increased the tracking and insight capabilities of enemy territories, in intelligence, surveillance and reconnaissance activities.

The UAVs used in military application have a GNSS receiver installed, along with the cameras installed in vehicle, allowing pilots to operate the vehicle, away from the conflict region. The GPS tracking systems are very effective in guiding the high-altitude UAVs controller in areas where the installed cameras fail, due to clouds or lower vision.

The GNSS receivers can also be useful for Attitude Determination in UAVs.

Signal Jamming

Signal jamming is a major thread to military operations based in GPS. The emergence of GPS jamming devices capable of broadcasting a signal in the same frequency used by satellite navigation to obtain location information, can drive to a disruption of satellite transmissions.

There are some military applications like the GPS Jammer Location (JLOC) designed to monitor for GPS interference threats and provide alerts to military users in the field when a threat is detected.[3]

Application Examples

The military GPS/GNSS devices appear up in many military applications for Force Deployment, Logistical Support and Vehicle Navigation, such as:

- Handheld receivers for soldiers,
- GPS-aided navigational systems for aircraft,
- GPS-aided navigational systems for unmanned aircraft,
- Navigational devices for vehicles, or
- GNSS jammers or anti-jamming applications.

recreational applications

Golfers **use GPS** to measure precise distances within the course and improve their game.
Other **applications** include skiing, as well as **recreational** aviation and boating. **GPS** technology has generated entirely new sports and outdoor activities.
The Global Positioning System (GPS) has eliminated many of the hazards associated with common recreational activities by providing a capability to determine a precise location. GPS receivers have also broadened the scope and enjoyment of outdoor activities by simplifying many of the traditional problems, such as staying on the "correct trail" or returning to the best fishing spot.

Outdoor exploration carries with it many intrinsic dangers, one of the most important of which is the potential for getting lost in unfamiliar or unsafe territory. Hikers, bicyclists, and outdoor adventurers are increasingly relying on GPS instead of traditional paper maps, compasses, or landmarks. Paper maps are often outdated, and compasses and landmarks may not provide the precise location information necessary to avoid venturing into unfamiliar areas. In addition, darkness and adverse weather conditions may also contribute to imprecise navigation results.

GPS technology coupled with electronic mapping has helped to overcome much of the traditional hardships associated with unbounded exploration. GPS handsets allow users to safely traverse trails with the confidence of knowing precisely where they are at all times, as well as how to return to their starting point. One of the benefits is the ability to record and return to waypoints. Similarly, fishermen typically use GPS signals as a means to continually stay apprised of location, heading, bearing, speed, distance-to-go, time-to-go, chart plotting functions, and most importantly, returning to a location where the fish are plentiful.

An advantage in newer GPS receivers is the capability to transfer data to and from a computer. Outdoor enthusiasts can download waypoints from an exciting adventure and share them. An example of this is a web site based in Malaysia dedicated to GPS for mountain biking enthusiasts. Riders post waypoint files marking their favorite rides allowing other riders to try out the trails.

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 GPS technology has generated entirely new sports and outdoor activities. An example of this is geocaching, a sport which rolls a pleasurable day's outing and a treasure hunt into one. Another new sport is geodashing, a cross-country race to a predefined GPS coordinate.

GPS modernization efforts, designed to enhance more serious applications than recreation have provided direct and indirect benefits to the user. Various GPS augmentation systems that were developed in several countries for commerce and transportation are also being widely used by outdoor enthusiasts for recreational purposes. Modernization plans for GPS will result in even greater reliability and availability for all users, such as under a denser forest cover -- just the environment in which many adventurers most need this capability.

Note: The main text of this page has not been updated since 2006.

Benefits

- Highly accurate all-weather positioning information using GPS receivers helps outdoor adventurers with safer exploration anywhere in the world.
- Ability to return to favorite fishing spots, trails, campsites or other locations with precision year after year, despite changing terrain conditions.
- New and interesting activities (based solely on the capabilities of GPS) are developed every day by outdoor enthusiasts and shared with others.
- Relatively small, portable, and affordable handsets can be used for multiple types of recreation activities.

"GPS has speeded up play on the golf course. For those in the rough, it tells them how far away they are from the trap rather than the sprinkler heads and they don't have to agonize as much over club selection if they know exactly how far they have to go. The unfortunate part is that it tells you the brutal truth of exactly how far you hit your driver. Most people think they hit it 20 or 30 yards farther than they actually do, but GPS doesn't lie."