Vehicle Tracking System

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Introduction

Vehicle tracking system

A vehicle tracking system combines the installation of an electronic device in a vehicle, or fleet of vehicles, with purpose-designed computer software at least at one operational base to enable the owner or a third party to track the vehicle's location, collecting data in the process from the field and deliver it to the base of operation. 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. VETRAC is a wireless enabled vehicle tracking system, implemented by Net Research Labs for Indian urban city scenario.

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 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 safety net for the staff member and the vehicle.

Vehicle tracking system consist of following

1. Components
2. Flashing
3. HRC
4. Installation
5. Connection with multimedia car system
6. S/W Upgrading
7. Versions

Components

There are following components

1. GPS Unit
2. GSM Modem
3. Tracking chip

GPS Unit

It is the unit which deals with GPS i.e. global positioning system.

The **Global Positioning System** (**GPS**) is a space-based global navigation satellite system (GNSS) that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver with some technical limitations which are only removed for military users.

Basic concept of GPS

A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include

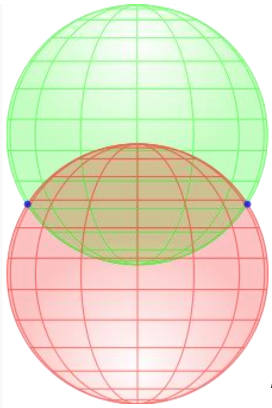
- the time the message was transmitted
- precise orbital information (the ephemeris)
- The general system health and rough orbits of all GPS satellites (the almanac).

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite. These distances along with the satellites' locations are used with the possible aid of trilateration, depending on which algorithm is used, to compute the position of the receiver. This position is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes.

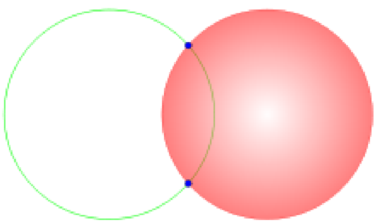
Three satellites might seem enough to solve for position since space has three dimensions and a position near the Earth's surface can be assumed. However, even a very small clock error multiplied by the very large speed of light[31] — the speed at which satellite signals propagate — results in a large positional error. Therefore receivers use four or more satellites to solve for the receiver's location and time. The very accurately computed time is effectively hidden by most GPS applications, which use only the location. A few specialized GPS applications do however use the time; these include time transfer, traffic signal timing, and synchronization of cell phone base stations.

Although four satellites are required for normal operation, fewer apply in special cases. If one variable is already known, a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation. Some GPS receivers may use additional clues or assumptions (such as reusing the last known altitude, dead reckoning, inertial navigation, or including information from the vehicle computer) to give a less accurate (degraded) position when fewer than four satellites are visible.

Position calculation introduction



Two sphere surfaces intersecting in a circle



Surface of sphere intersecting a circle (not a solid disk) at two points

To provide an introductory description of how a GPS receiver works, error effects are deferred to a later section. Using messages received from a minimum of four visible satellites, a GPS receiver is able to determine the times sent and then the satellite positions corresponding to these times sent. The x, y, and z components of position, and the time sent, are designated as $[x_i, y_i, z_i, t_i]$ where the subscript is the satellite number and has the value 1, 2, 3, or 4. Knowing the indicated time the message was received t_r, the GPS receiver can compute the transit time of the message as $(t_r - t_i)$. Assuming the message traveled at the speed of light, *c*, the distance traveled or pseudo range p_i can be computed as $(t_r - t_i)c$.

A satellite's position and pseudo range define a sphere, centered on the satellite, with radius equal to the pseudo range. The position of the receiver is somewhere on the surface of this sphere. Thus with four satellites, the indicated position of the GPS receiver is at or near the intersection of the surfaces of four spheres. In the ideal case of no errors, the GPS receiver would be at a precise intersection of the four surfaces.

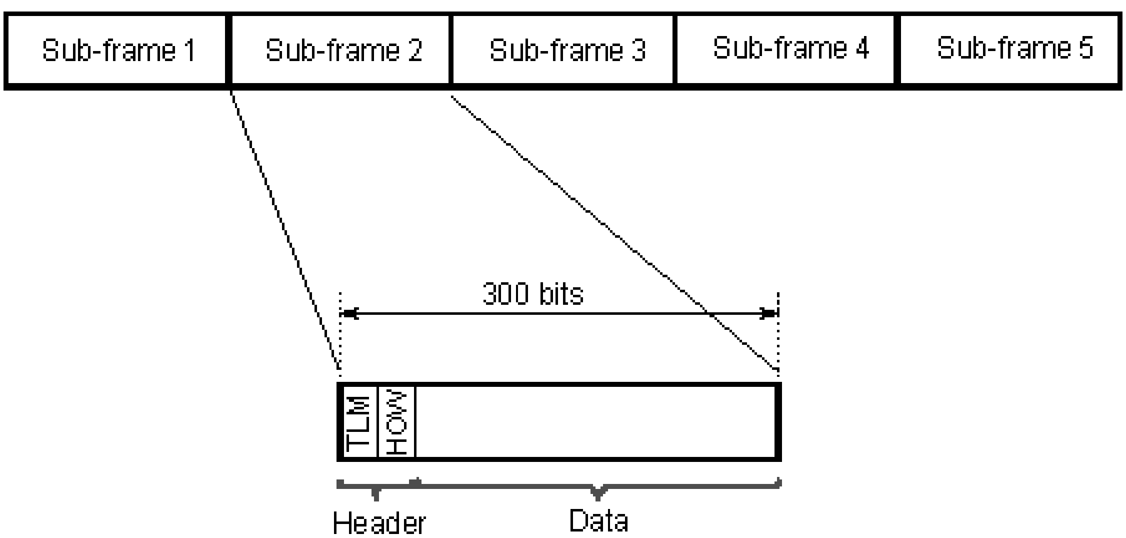
If the surfaces of two spheres intersect at more than one point, they intersect in a circle. The article trilateration shows this mathematically. A figure, *Two Sphere Surfaces Intersecting in a Circle*, is shown below. Two points where the surfaces of the spheres intersect are clearly shown in the figure. The distance between these two points is the diameter of the circle of intersection. The intersection of a third spherical surface with the first two will be its intersection with that circle; in most cases of practical interest, this means they intersect at two points. Another figure, *Surface of Sphere Intersecting a Circle (not a solid disk) at Two Points*, illustrates the intersection. The two intersections are marked with dots. Again the article trilateration clearly shows this mathematically.

For automobiles and other near-earth vehicles, the correct position of the GPS receiver is the intersection closest to the Earth's surface. For space vehicles, the intersection farthest from Earth may be the correct one.

The correct position for the GPS receiver is also the intersection closest to the surface of the sphere corresponding to the fourth satellite.

Structure of GPS

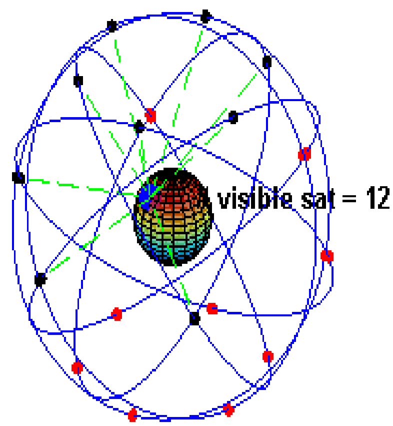
The current GPS consists of three major segments. These are the space segment (SS), a control segment (CS), and a user segment (U.S.). The U.S. Air Force develops, maintains, and operates the space and control segments. GPS satellites broadcast signals from space, and each GPS receiver uses these signals to calculate its three-dimensional location (latitude, longitude, and altitude) and the current time.



data frame structure

The space segment is composed of 24 to 32 satellites in medium Earth orbit and also includes the payload adapters to the boosters required to launch them into orbit. The control segment is composed of a master control station, an alternate master control station, and a host of dedicated and shared ground antennas and monitor stations. The user segment is composed of hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service and tens of millions of civil, commercial, and scientific users of the Standard Positioning Service (see GPS navigation devices).

- **Space segment**



A visual example of the GPS constellation in motion with the Earth rotating. Notice how the number of satellites in view from a given point on the Earth's surface, in this example at 45°N, changes with time.

The space segment (SS) is composed of the orbiting GPS satellites or Space Vehicles (SV) in GPS parlance. The GPS design originally called for 24 SVs, eight each in three approximately circular orbits, but this was modified to six orbital planes with four satellites each. The orbits are centered on the Earth, not rotating with the Earth, but instead fixed with respect to the distant stars. The six orbit planes have approximately 55° inclination (tilt relative to Earth's equator) and are separated by 60° right ascension of the ascending node (angle along the equator from a reference point to the orbit's intersection). The orbits are arranged so that at least six satellites are always within line of sight from almost everywhere on Earth's surface. The result of this objective is that the four satellites are not evenly spaced (90 degrees) apart within each orbit. In general terms, the angular difference between satellites in each orbit is 30, 105, 120, and 105 degrees apart which, of course, sum to 360 degrees.

Orbiting at an altitude of approximately 20,200 km (12,600 mi); orbital radius of approximately 26,600 km (16,500 mi), each SV makes two complete orbits each sidereal, repeating the same ground track each day. This was very helpful during development because even with only four satellites, correct alignment means all four are visible from one spot for a few hours each day. For military operations, the ground track repeat can be used to ensure good coverage in combat zones.

- **Control segment**

Ground monitor station used from 1984 to 2007, on display at the Air Force Space & Missile Museum

The control segment is composed of

1. a master control station (MCS),
2. an alternate master control station,
3. four dedicated ground antennas and
4. six dedicated monitor stations

The MCS can also access U.S. Air Force Satellite Control Network (AFSCN) ground antennas (for additional command and control capability) and NGA (National Geospatial-Intelligence Agency) monitor stations. The flight paths of the satellites are tracked by dedicated U.S. Air Force monitoring stations in Hawaii, Kwajalein, Ascension, Diego Garcia, Colorado Springs, Colorado and Cape Canaveral, along with shared NGA monitor stations operated in England, Argentina, Ecuador, Bahrain, Australia and Washington DC. The tracking information is sent to the Air Force Space Command's MCS at Schriever Air Force Base 25 km (16 miles) ESE of Colorado Springs, which is operated by the 2nd Space Operations Squadron (2 SOPS) of the U.S. Air Force. Then 2 SOPS contacts each GPS satellite regularly with a navigational update using dedicated or shared (AFSCN) ground antennas (GPS dedicated ground antennas are located at Kwajalein, Ascension Island, Diego Garcia, and Cape Canaveral). These updates synchronize the atomic clocks on board the satellites to within a few nanoseconds of each other, and adjust the ephemeris of each satellite's internal orbital model. The updates are created by a Kalman filter that uses inputs from the ground monitoring stations, weather information, and various other inputs.

Satellite maneuvers are not precise by GPS standards. So to change the orbit of a satellite, the satellite must be marked *unhealthy*, so receivers will not use it in their calculation. Then the maneuver can be carried out, and the resulting orbit tracked from the ground. Then the new ephemeris is uploaded and the satellite marked healthy again.

- **User segment**

GPS receivers come in a variety of formats, from devices integrated into cars, phones, and watches, to dedicated devices such as those shown here from manufacturers Trimble, Garmin and Leica (left to right).

The user segment is composed of hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service, and tens of millions of civil, commercial and scientific users of the Standard Positioning Service. In general, GPS receivers are composed of an antenna, tuned to the frequencies transmitted by the satellites, receiver-processors, and a highly stable clock (often a crystal oscillator). They may also include a display for providing location and speed information to the user. A receiver is often described by its number of channels: this signifies how many satellites it can monitor simultaneously. Originally limited to four or five, this has progressively increased over the years so that, as of 2007, receivers typically have between 12 and 20 channels.

A typical OEM GPS receiver module measuring 15×17 mm

GPS receivers may include an input for differential corrections, using the RTCM SC-104 format. This is typically in the form of an RS-232 port at 4,800 bit/s speed. Data is actually sent at a much lower rate, which limits the accuracy of the signal sent using RTCM. Receivers with internal DGPS receivers can outperform those using external RTCM data. As of 2006, even low-cost units commonly include Wide Area Augmentation System (WAAS) receivers.

Many GPS receivers can relay position data to a PC or other device using the NMEA 0183 protocol. Although this protocol is officially defined by the National Marine Electronics Association (NMEA), references to this protocol have been compiled from public records, allowing open source tools like gpsd to read the protocol without violating intellectual property laws. Other proprietary protocols exist as well, such as the SiRF and MTK protocols. Receivers can interface with other devices using methods including a serial connection, USB, or Bluetooth.

Satellite frequencies

GPS frequency overview		
Band	**Frequency**	**Description**
L1	1575.42 MHz	Coarse-acquisition (C/A) and encrypted precision P(Y) codes, plus the L1 civilian (L1C) and military (M) codes on future Block III satellites.
L2	1227.60 MHz	P(Y) code, plus the L2C and military codes on the Block IIR-M and newer satellites.
L3	1381.05 MHz	Used for nuclear detonation (NUDET) detection.
L4	1379.913 MHz	Being studied for additional ionosphere correction.
L5	1176.45 MHz	Proposed for use as a civilian safety-of-life (Sol) signal.

GSM Modem

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

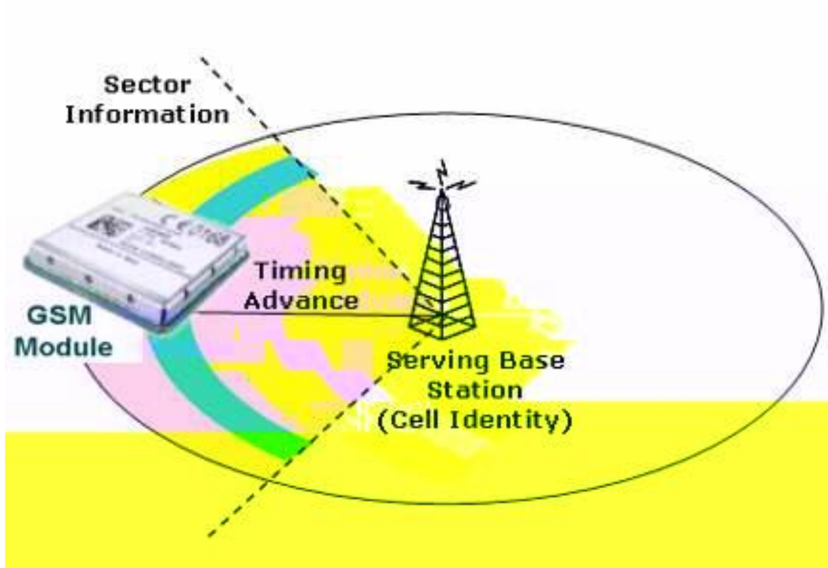
A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer, a GSM modem requires a SIM card from a wireless carrier in order to operate.

Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards.

A GPRS modem is a GSM modem that additionally supports the GPRS technology for data transmission. GPRS stands for General Packet Radio Service. It is a packet-switched technology that is an extension of GSM. (GSM is a circuit-switched technology.) A key advantage of GPRS over GSM is that GPRS has a higher data transmission speed.

GPRS can be used as the bearer of SMS. If SMS over GPRS is used, an SMS transmission speed of about 30 SMS messages per minute may be achieved. This is much faster than using the ordinary SMS over GSM, whose SMS transmission speed is about 6 to 10 SMS messages per minute. A GPRS modem is needed to send and receive SMS over GPRS. Note that some wireless carriers do not support the sending and receiving of SMS over GPRS. If you need to send or receive MMS messages, a GPRS modem is typically needed.

A **GSM modem** is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.



When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

GSM Modem Connectivity

If you plan to send and receive fewer than 15 000 SMS messages per day, you can use a suitable GSM device (phone or modem) attached to your computer with a phone-to-PC data cable. For information about suitable phones, check out the Supported Phones page. The GSM device has to be equipped with a SIM card that charges (preferably) low rates for SMS messages.

With this setup you can use a computer program such as Ozeki NG - SMS Gateway to send and receive SMS messages. In this case, the software uses the attached device to communicate with the GSM network. If a message is sent out by the gateway running on the computer, it is first sent to the attached GSM device. Then the GSM device transmits it to the SMS Center (SMSC) of the GSM service provider, using a wireless link (Figure).

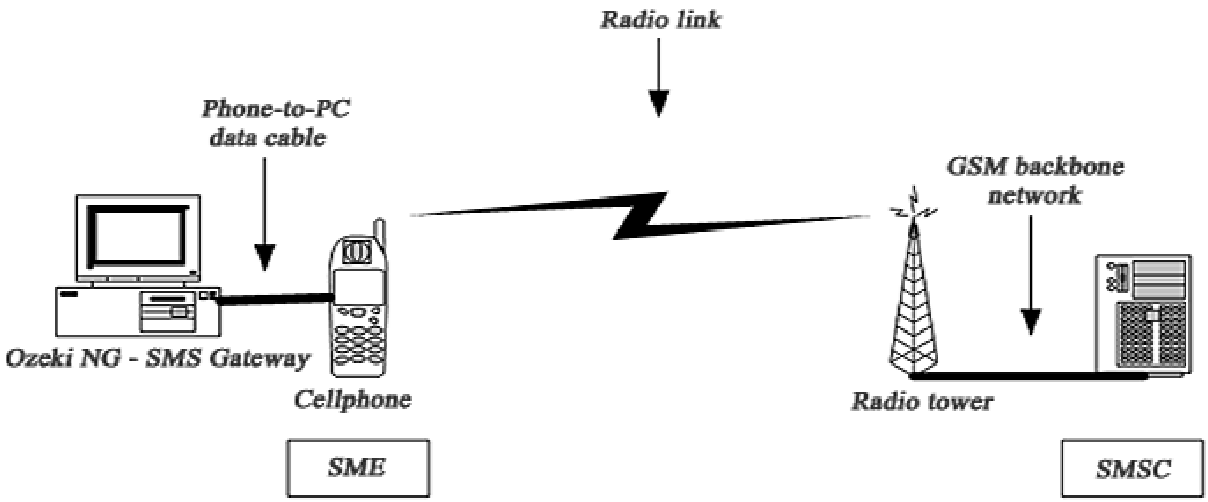


Figure - GSM modem connectivity for SMS messaging

When a message is received, the GSM device stores the message in its memory or on the SIM card, and sends a notification to Ozeki NG - SMS Gateway. When the program receives this notification, it retrieves (reads) the message from the respective memory cell, and then deletes the message from the device to make room for the next incoming message.

The advantage of using a cellular modem is that you do not need Internet connection for SMS messaging. Sending an SMS message using a cellphone takes about 5-6 seconds. Receiving takes about the same time. Good software, such as Ozeki NG - SMS Gateway allows you to attach more than one device to your PC and to use them simultaneously to increase capacity.

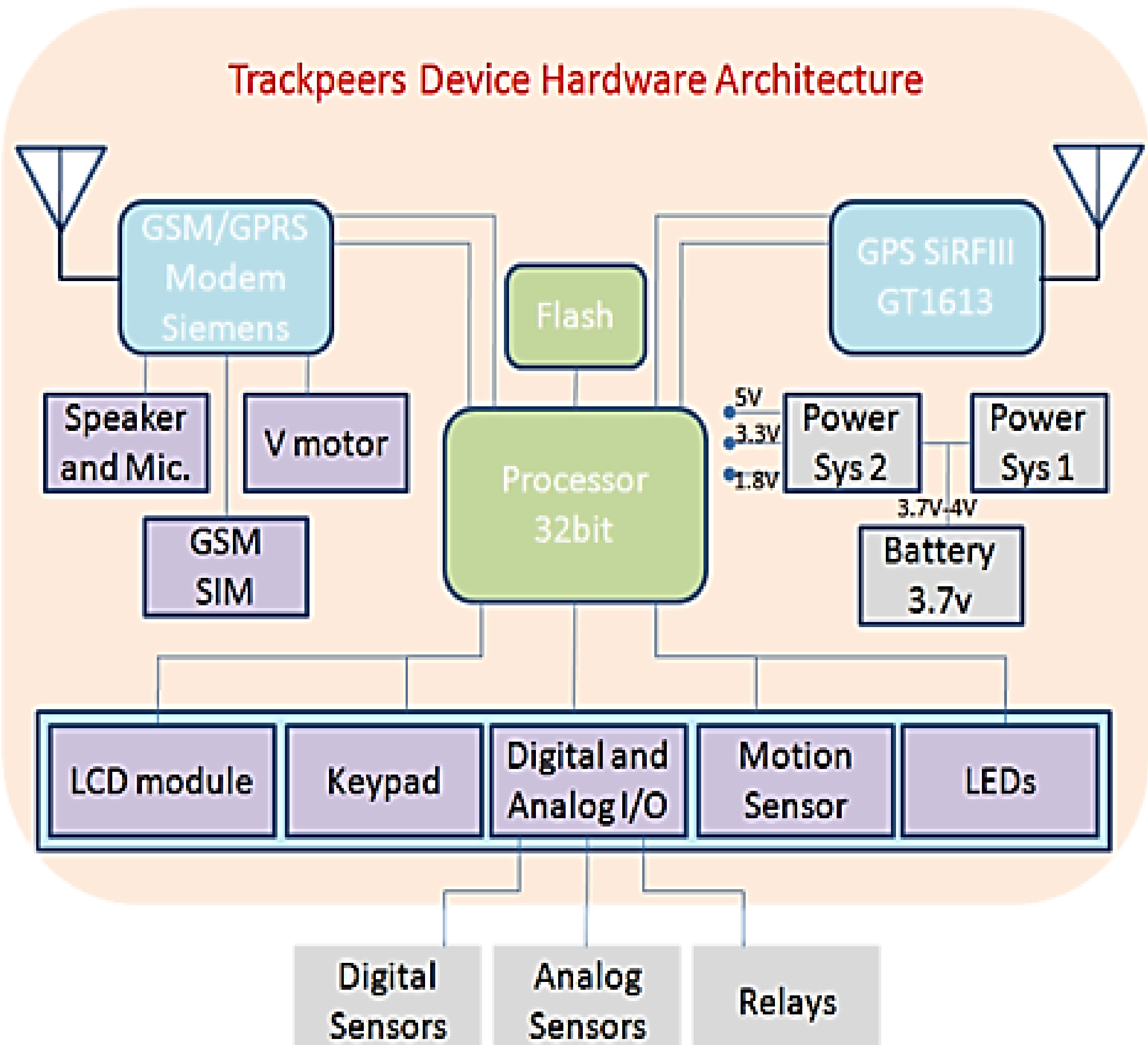
The best option to connect a phone to the PC is to use a standard RS232 serial cable. To find out more about it, check out the RS232 Serial Cable and Industrial Modems page. USB cables, InfraRed and BlueTooth connections are not as reliable. For information about attaching the GSM device with a USB cable.

Tracking chip

A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a vehicle, person, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular (GPRS or SMS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real time or when analyzing the track later, using GPS tracking software.

Tracker architecture

A GPS tracker essentially contains GPS module to receive the GPS signal and calculate the coordinates. For data loggers it contains large memory to store the coordinates, data pushers additionally contains the GSM/GPRS modem to transmit this information to a central computer either via SMS or via GPRS in form of IP packets. The diagram depicts hardware architecture of an advanced GPS tracker.



Types of tracker

Usually, a GPS tracker will fall into one of these three categories:

1. Data logger
2. Data pusher
3. Data puller

Data loggers

Typical GPS logger

A GPS logger simply logs the position of the device at regular intervals in its internal memory. Modern GPS loggers have either a memory card slot, or internal flash memory and a USB port. Some act as a USB flash drive. This allows downloading of the track log data for further analyzing in a computer. The track list or interest list may be in GPX, KML, NMEA or other format.

Most digital cameras save the time a photo was taken. Provided the camera clock was reasonably accurate, or the GPS was used as a time source, this time can be correlated with GPS log data, to provide an accurate location. This can be added to the Exif metadata in the picture file, thus geo tagging it.

In some Private Investigation cases, these data loggers are used to keep track of the vehicle or the fleet vehicle. The reason for using this device is so that a PI will not have to follow the target so closely and always has a backup source of data.

Data pushers

Data pusher is the most common type of GPS tracking unit, used for asset tracking, personal tracking and Vehicle tracking system.

Also known as a GPS beacon, this kind of device pushes (i.e. "sends") the position of the device as well as other information like speed or altitude at regular intervals, to a determined server, that can store and instantly analyze the data.

A GPS receiver and a mobile phone sit side-by-side in the same box, powered by the same battery. At regular intervals, the phone sends a text message via SMS or GPRS, containing the data from the GPS receiver. Newer GPS-integrated smartphones running GPS tracking software can turn the phone into a data pusher (or logger) device; as of 2009 open source and proprietary applications are available for common Java enabled phones, iPhone , Android, Windows Mobile, and Symbian.

Most of the modern GPS trackers provide data "push" technology, enabling sophisticated GPS tracking in business environments, specifically organizations that employ a mobile workforce, such as a commercial fleet. Typical GPS tracking systems used in commercial fleets have two core parts: location hardware (or tracking device) and tracking software. This combination is often referred to as an Automatic Vehicle Location system. The tracking device is most often hardwire installed in the vehicle; connected to the CAN-bus, Ignition system switch, battery. It allows collection of extra data, which later get transferred to the tracking server, where it is available for viewing, in most cases via a website accessed over the internet, where fleet activity can be viewed live or historically using digital maps and reports.

GPS tracking systems used in commercial fleets are often configured to transmit location and telemetry input data at a set update rate or when an event (door open/close, auxiliary equipment on/off, geo fence border cross) triggers the unit to transmit data. Live GPS Tracking used in commercial fleets, generally refers to systems which update regularly at 1 minute, 2 minute or 5 minute intervals, whilst the ignition status is on. Some tracking systems combine timed updates with heading change triggered updates.

The applications of these kinds of trackers include:

Personal tracking

- **Law enforcement**: An arrested criminal out on bail may have to wear a GPS tracker, usually on the ankle, as a bail condition.
- **Race control**: In some sports, such as gliding, participants are required to carry a tracker. This allows, among other applications, for race officials to know if the participants are cheating, taking unexpected shortcuts or how far apart they are. This use has been featured in the movie Rat Race.
- **Espionage/surveillance**: When put on a person, or on his personal vehicle, it allows the person monitoring the tracking to know his/her habits. This application is used by private investigators.
- These devices are also used by some parents to track their children. The supporters claim that if cleverly used, this actually allows children more independence.
- GPS personal tracking devices are being used increasingly to assist in the care of the elderly and vulnerable. Devices allow users to call for assistance and optionally allow designated carers to locate the user's position, typically within 5 to 10 meters. Their use helps promote independent living and social inclusion for the elderly. Devices often incorporate either 1-way or 2-way voice communication which is activated by pressing a button or sliding a switch. Some devices also allow the user to call several phone numbers using pre-programmed speed dial buttons. Trials using GPS personal tracking devices are also underway in several countries for use with early stage dementia and Alzheimer's sufferers.
- **Internet Fun:** Some Web 2.0 pioneers have created their own personal web pages that show their position constantly, and in real-time, on a map within their website. These usually use data push from a GPS enabled cell phone or a personal GPS tracker.

Asset tracking

- **Solar Powered**: The advantage of some solar powered units is that they have much more power over their lifetime than battery powered units. This gives them the advantage to report their position and status much more often than battery units which need to conserve their energy to extend their life. Some wireless solar powered units, such as the Rail Rider can report more than 20,000 times per year and work indefinitely on solar power eliminating the need to change batteries.

- **Animal control:** When put on a wildlife animal (e.g. in a collar), it allows scientists to study its activities and migration patterns. Vaginal implant transmitters mark the location where pregnant females give birth. Animal tracking collars may also be put on domestic animals, to locate them in case they get lost.

Data pullers

GPS data pullers are also known as GPS transponders. Contrary to data pushers, that send the position of the devices at regular intervals (push technology), these devices are always-on and can be queried as often as required (pull technology). This technology is not in widespread use, but an example of this kind of device is a computer connected to the Internet and running gpsd.

These can often be used in the case where the location of the tracker will only need to be known occasionally e.g. placed in property that may be stolen, or that does not have constant source of energy to send data on a regular basis, like freights or containers.

Data Pullers are coming into more common usage in the form of devices containing a GPS receiver and a cell phone which, when sent a special SMS message reply to the message with their location.

HRC (Higher Region Control)

HRC consist of following

- GPS Tracking
- Speed Monitoring
- Stolen vehicle tracking
- Fuel tracking with GPS
- Geocaching tracking
- Road monitoring

GPS Tracking

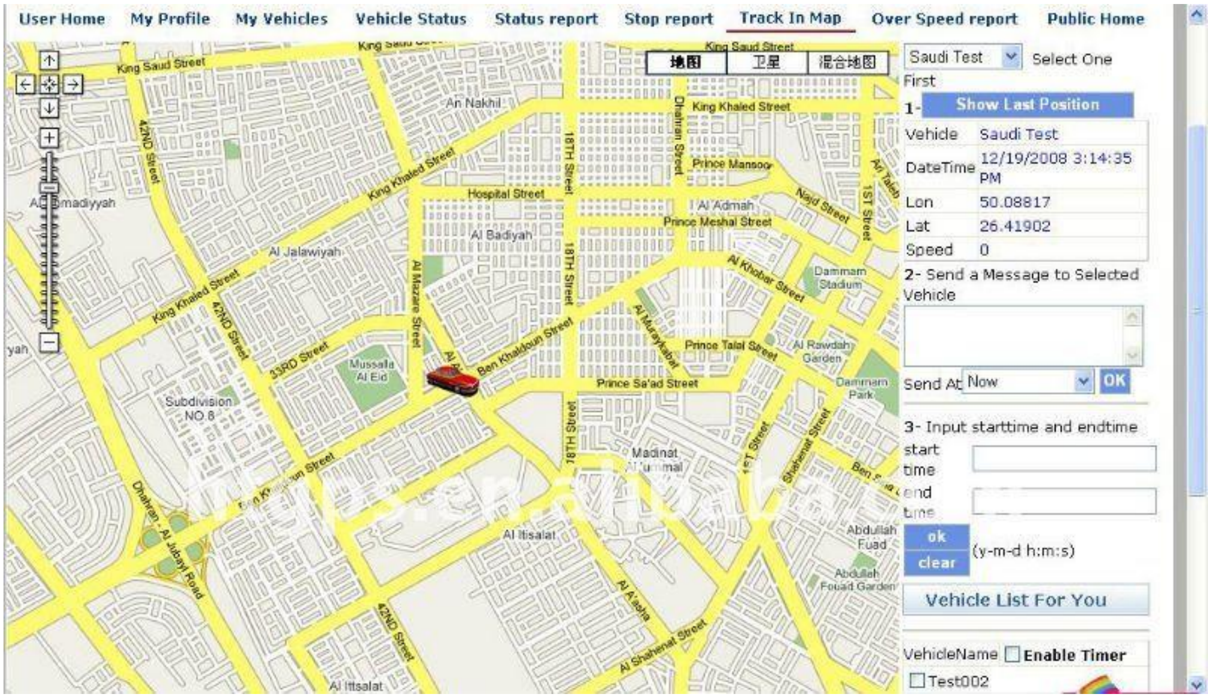
GPS Vehicle Tracking System, uses satellite & GPS technology to provide vehicles' exact location and status reports like Current & historical reports with speed, trip distance, trip duration, mileage, fuel, track, locate, live tracking, alert, land mark, harsh breaking, harsh acceleration, sudden course change, drivers identification, disable & enable function, graphical reports & much more for having ultimate control over your vehicles.

A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a vehicle, person, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular (GPRS or SMS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real time or when analyzing the track later, using GPS tracking software.

Key modules of GPS TRACKING:

- Tracking and Monitoring
- User Administration
- Master Records Maintenance
- Reports Generation
- Display Handset Data
- Activity Log
- Dynamic Status Modules
- Messaging Module
- Geo Fence Modules
- Vehicle Allocation Module
- Driver Module (Optional)

SPEED MONITORING



The speed control rule set of the vehicle object. There are only three possible choices: accelerate one unit, slow down one unit, or keep the present speed level. If more than one rule is fired, the latter rules always overrule the previous ones. The basic idea of the rule system is the following. The vehicle has a basic tendency to accelerate towards its desired speed. This tendency can be overruled by interactions with potential obstacle objects like other vehicles, pedestrians, signal heads, yield signs etc. The effect of an obstacle object depends on in which of the three possible zones the approaching vehicle currently exist. In the outmost "free area" the obstacle has no effect. In the closest "forbidden area" the vehicle has to slow down. In between there is a zone called "stable area" where deceleration is not required, but acceleration is forbidden. The first rule is the default case. It remains true when no other rule is activated. Because the number of update cycles is much higher than the number of actual speed steps, in most decision cycles the speed level remains unchanged. The second rule allows the vehicle to accelerate if speed level has been temporarily lowered. To obtain proper acceleration rate, the time interval T between acc successive steps is specified as a function. In the simplest case Tacc is constant and thus linear acceleration rate is obtained. A more advanced model is achieved by setting Tacc as function of speed. The third rule can cancel the given acceleration permission when vehicle is approaching an obstacle or a slower vehicle. The zone where permission is denied is specified by stable area width. The stable area continues from the forbidden area defined by the minimum safe distance (Smin). The third rule keeps the approaching and car following stable by preventing the activation of rule two. Several obstacles can be in the vehicle's sight at the same time. If any of them activates rules three or four, it cannot be canceled by other objects. The fourth rule forces a vehicle to slow down when approaching a moving or stationary obstacle. The minimum safe distance Smin specifies whether the rule is activated or not. The definition of Smin is not determined by the rule set, thus different\ solutions are possible. However a sort of basic solution chosen into HUTSIM is to define S as a function of the vehicle's own speed and min the speed of the obstacle. Rule four is overruled by the fifth rule if speed is already less than the speed of the obstacle or if the maximum deceleration is exceeded. The sixth rule detects possible collisions. The speed in collision is forced to zero if the obstacle was physical i.e. vehicle or pedestrian. A "collision" with for example red light does not cause speed to go to zero, but can also be detected. A collision can take place if the driver's reaction is delayed or there are conflict points without proper signals or yield signs.

1. **NO SPEED CHANGE**:
   Keep the present speed level (default case).

2. **ACCELERATE IF {vown<vdes} and {t-tlast>Tacc (vown)}** :
   The current speed vown is less than desired speed vdes and the time elapsed from last acceleration tlast is more than Tacc.

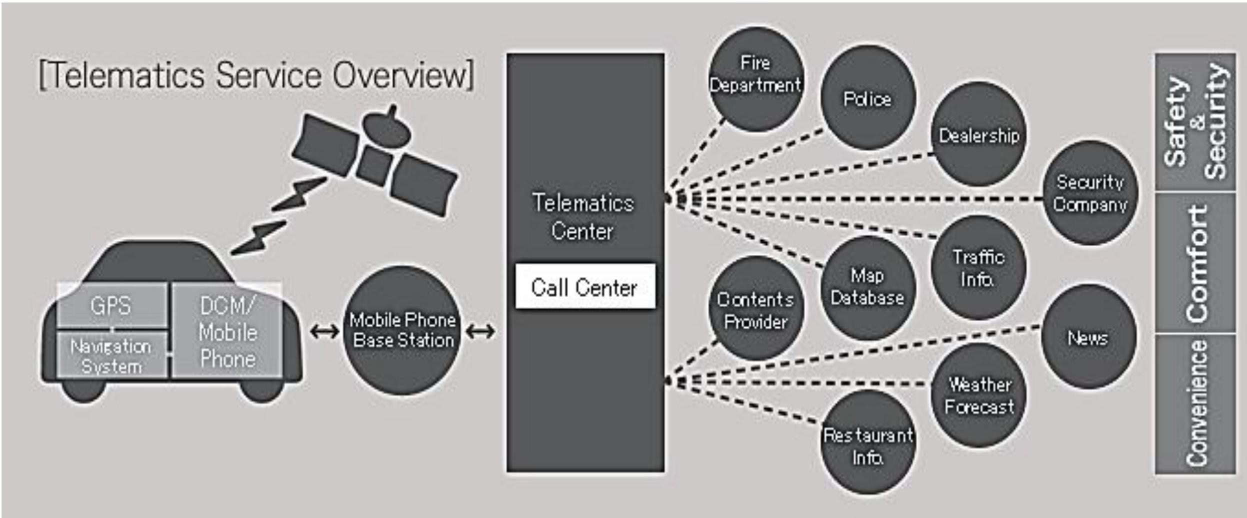
3. **NO ACCELERATION IF {Dobs<Smin (vown,vobs)+Wstab(vown,vobs)}:**
   The distance from obstacle Dobs is less than the minimum safe distance Smin plus the width of stable area Wstab.

4. **SLOW DOWN IF {Dobs<Smin(vown,vobs)}**:
   The distance from obstacle Dobs is less than the minimum safe distance Smin.

5. **DO NOT SLOW DOWN IF {vown<vobs} or {t-tlast<Tmaxdec}:**
   Own speed is less than obstacle speed or maximum deceleration rate is exceeded.

6. **GOTO ZERO IF {Dobs<0} and {Obstacle=physical}**:
   Distance to physical obstacle is below zero (= collision).

STOLEN VECHILE TRACKING



FOR STOLEN VECHILE CONTROL: RTLS IS USED

Real-time locating systems (RTLS) are a type of local positioning system that allow to track and identify the location of objects in real time. Using simple, inexpensive badges or tags attached to the objects, readers receive wireless signals from these tags to determine their locations. RTLS typically refers to systems that provide passive or active (automatic) collection of location information.

Operation

For RTLS to function, the location of tagged items must be determined either by a central processor or by an embedded mobile computing facility. Locating is generally accomplished in one of the following ways

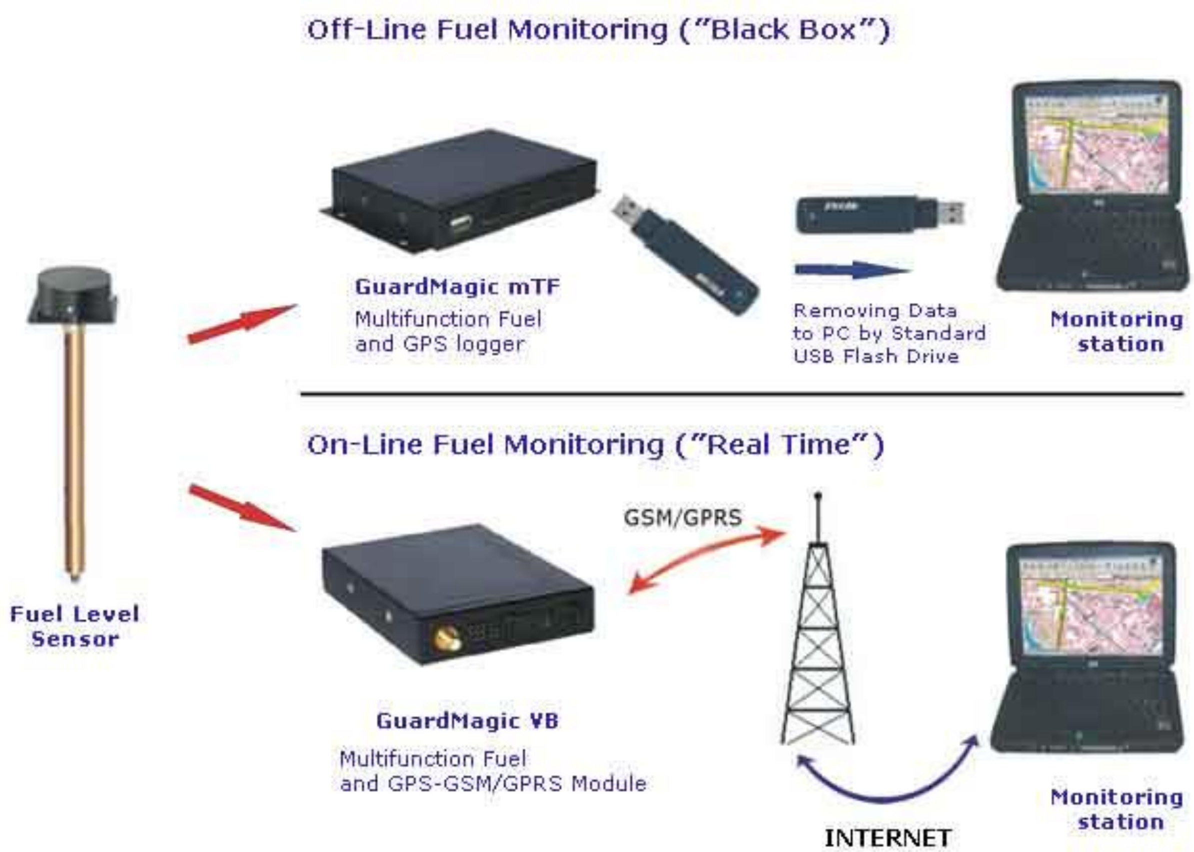
1. ID signals from nodes are identifiable to a single reader in a sensory network thus indicating the coincidence of reader and nodes.
2. ID signals from nodes are picked up by a multiplicity of readers in a sensory network and a position is estimated using one or more locating algorithms
3. Location signals from signposts with identifiers are transmitted to the moving nodes and are then relayed, usually via a second wireless channel, to a location processor.
4. Mobile nodes communicate with each other and perform metering distances.

Examples one (1) and three (3) have much of the same characteristics. They typically require that a node be assigned at a time to a single reader/signpost. Separation from overlapping readers/signposts is roughly provided by RSSI or Physical Space Division (walls/floors/ceilings). Readers/signposts are often associated with highly stable location boundaries (i.e. a room or room division). In these examples, locations are listed as "Current Location" or "Last Known Location."

Example two (2) requires that distances between nodes in the sensory network be determined in order to precisely locate a node. In this instance, the determination of the location is called Localization. The location is calculated through Trilateration or Multi-lateration from the determined distance between the nodes or through Triangulation from the determined angles between nodes. The determination of distances is called Ranging.

FUEL MONITORING WITH GPS

Fueling control gives user of GPS vehicles tracking system to monitor where, when and how much fuel was filled into the tank; it avoids the manipulation of fuel and, consequently, reduces the operating costs of transport.



Information on raising or lowering the level of fuel comes from fuel level sensor, and vehicles tracking system with the help of GPS determines the location and time. The volume of fueling is determined using the calibration table that is either in a terminal of vehicle tracking system, either in the software of vehicles tracking system. It should be noted that the algorithms for identifying of refills and determining their volume are quite complicated; and we are ready to provide the system designer of automobile tracking system of these algorithms to be integrated into terminal or server software.

- **Fuel tank draining control:** Fuel tank draining control is carried out similarly to fueling control. Terminal of vehicle tracking system receives data about changes of fuel level in the tank from fuel level sensor. User of vehicle tracking system knows about the unauthorized fuel draining almost immediately.

- **Measurement of the actual engine fuel consumption**: To solve this problem fuel flow meter, fuel level sensor and/or data, derived from the CAN bus of a vehicle are used.

- **Driver quality control**: With fuel monitoring you can detect violations of technology, such as reduction of burying of plow on a tractor or decreasing of duration of heating burners. Fuel tracking provides exact information about real fuel consumption and prevents fuel draining, fuel fraud and fuel over consumption.

- **Monitoring the technical state of machines**: Knowing the information about the current fuel consumption, the driver can select the most economical way of working. The increase in fuel consumption may be a sign of engine wear.

- **Time control of the engine**: Typically, GPS vehicle tracking systems determine motion time of a vehicle. However, considerable amount of machines, especially special, works without movement. In this case the automobile tracking system may determine the engine by connecting to the sensor of engine speed. However, it is easier to use a fuel flow meter DFM. Flow meter also receives information about fuel consumption, and the time of the engine, because only running engine consumes fuel. Moreover, the magnitude of fuel consumption can also be judged on the regime of load on the engine. Knowing the fuel consumption at idle, average and maximum fuel consumption, automobile tracking system can accurately calculate the time of the engine in a particular mode.

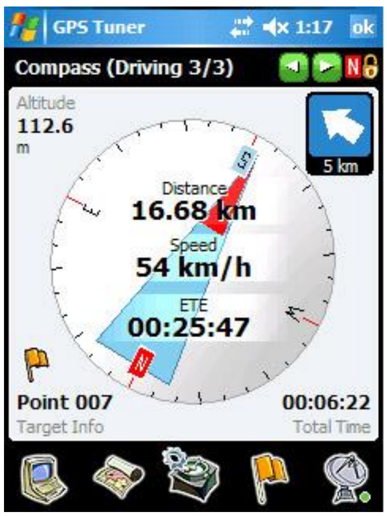
- **Axle load control:** This function is not directly related to fuel monitoring, but ties the fuel information to the load of machine. Thus, user receives separate information about fuel consumption of an empty and loaded car. In addition, GPS vehicles tracking system gets valuable information about the location and time of events of loading and unloading machines, and it is necessary for effective fleet management.

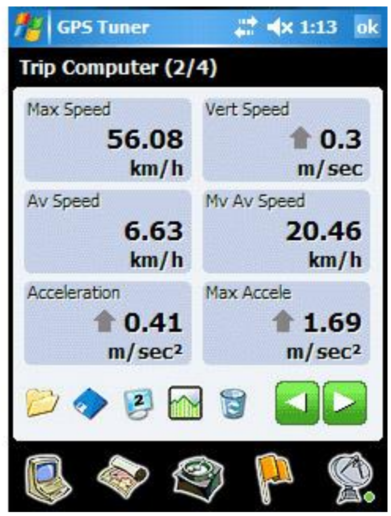
Fuel monitoring sensors for vehicle tracking systems		
Fuel level sensor DUT-E	Designed to measure the fuel volume in tank. There are number of modifications of various length and interfaces. Compatibility requirements: terminal of vehicle tracking system should have one or two analog inputs or RS 232 interface or RS 485 interface or CAN interface.	
Fuel flow meters DFM	Designed to measure the flow in the fuel line of engine. Compatibility requirements: terminal of vehicle tracking system should have one or two frequency inputs.	

GEOCACHING TRACKING

Geocaching is an outdoor sporting activity in which the participants use a Global Positioning System (GPS) receiver or mobile device and other a techniques to hide and seek containers, called "geocaches" or"caches",anywhere in the world. A typical cache is a small waterproof container containing a logbook where the geo cacher enters the date they found it and signs it with their established code name.

Geocaches are currently placed in over 100 countries around the world and on all seven continents, including Antarctica. After 10 years of activity there are over 1.3 million active geocaches published on various websites. There are over 5 million geo cachers worldwide.





Geocaching has become immensely popular in recent years. As a new form of treasure hunting, geocaching can be played in any location around the world. Instead of finding a map in a dusty old bottle tossed to sea just pull out your GPS tracking device and start searching!

The geocaching treasure is called the "cache" and is usually a small waterproof container that holds a logbook and on occasion a small treasure. The finder of the treasure may take the treasure, but it must be replaced with a new trinket. Geo cachers can go online to geocaching dedicated websites to find new treasure locations and participate in large scavenger-hunt types of geocaching games.

Using a GPS tracking device to find the exact longitude and latitude of the treasure as specified on a website, geo cahers then search high and low to find the little piece of treasure their GPS tracker has led them to. Geocaching adventurers may then find themselves climbing meters up a tree or diving into the depths of unknown waters to retrieve their cache.

The best GPS tracking device for geocaching is one that is handheld, waterproof and easily put away in a pocket while you embark on adventure. Your GPS tracker is your treasure map to find the hidden destination of your treasures. Many cache locations can be found online for free, the only thing you need to get started geocaching is a GPS tracking device.

ROAD MONITORING

The primary objective for rural roads networks is to provide basic accessibility Most indicators focus on road condition and do not measure accessibility Road Funds, financing agencies, and other stakeholders need simple, consistent measures of how well rural roads satisfy the needs of users.

Main vehicles are pick-ups, vans and small trucks carrying passengers and goods and traveling at slow speeds. Rupture points or sections of very low speed discourage transporters and reduce accessibility. Rural road users value roads that are transit able, permit reasonable speeds, and have few very slow sections. Roughness or ability to travel at high speeds is of secondary importance.

Requirements for Monitoring

Data collection should be inexpensive, not require specialized skills, based on objective measures, and capable of being implemented independently of the roads agencies to reduce possible conflicts of interest. The indicators should generate simple and easily understood measures of accessibility. The indicators should be measurable at various levels of aggregation (road, class, province, and network) permitting useful comparisons. The results should be consistent and robust.

Install a Real Time GPS Vehicle Tracking System

Procedure

1. **Purchase a real time GPS tracking device**: There are wide assortments of vehicle GPS tracking systems available depending on what your needs are. Some are designed to track one vehicle; others can be used to track hundreds. Two that you might consider are Spark Nano Real-Time GPS Tracking Device, or Livewire Unlimited™ GPS Tracking. You can find a wide variety of systems at BrickHouseSecurity.com or SpyAssociates.com and they generally range in price from $199 to $399 for the unit plus a monthly fee of around $39.95.

2. **Install the GPS tracking device:** Once you've decided on what your needs are and you've purchased a system, you'll need to install it. For some of the devices it's just a matter of placing them on the undercarriage of the car with the built-in magnet and turning it on. Within a minute the device will begin transmitting the data. Others will need to be attached to a live wire and are usually hidden somewhere underneath the dashboard. Other devices are completely self-contained and can fit in the palm of your hand. They just need to be turned on and can be hidden in the trunk of the car, or underneath a seat.

3. **Track your vehicle**: Once installed the device will begin sending data immediately. You just need to log onto the password-protected website that will be provided by the company whose product you purchased. Depending on what your needs are, in addition to the location on the map, the GPS may give you information such as longitude and latitude, altitude, speed, idle time, history and statistics to go along with this data. Location data is uploaded in real time and will be accurate within 15 feet.

Install a GPS Vehicle Tracking System

Procedure

1. Decide whether you want a battery-powered GPS tracking system which uses its own batteries, or one which runs off the vehicle's power source. Some battery-powered systems have motion detectors to prolong battery life, so they only operate when they detect motion. They're easier to install in the vehicle, since no wiring is required. Some are magnetic and can simply be placed wherever they'll stick. GPS tracking systems which run off the vehicle's battery require basic wiring, but never need recharged.

2. Purchase the tracking system, which should include installation instructions to allow it to display tracking information on your computer, as well as a SIM card to communicate with your computer. Some systems are web-based and don't require software, so they can be accessed from any computer. Most systems require an initial fee to purchase the hardware, plus a monthly fee.

3. Install batteries into a battery-powered GPS tracking system, if necessary. Make sure your SIM card isn't PIN protected (check it by testing it in a regular cell phone), and insert the SIM card into the tracking unit. Using the user's manual set the SIM card to send data.

4. Choose a location to install the GPS tracking system in the vehicle. If you're using a covert system and don't want it to be found, choose a hidden location, allowing for the fact that it will work best if it's blocked as little as possible from satellite signals, though many systems don't necessarily need to be completely exposed to the open sky. A battery-powered system is quicker and easier to install, though the battery will need recharged eventually, while one powered off the car's battery will last longer. Install the system, and wire it to the car's battery if necessary.

5. Install the software to receive the GPS information in your computer, following the manufacturer's instructions. Each GPS system is slightly different, so some don't require a software download at all and instead require logging into a website. The instructions with your tracking system will tell you specifically how to finish linking the GPS unit with your computer or mobile device, so you can begin receiving information on the location of the vehicle.

Connectivity of car multimedia system

Producers of installation

I. The first thing you should do when installing a vehicle tracking device is to open the package that it comes in and check to see that you have all the necessary parts. You do this by reading the instructions thoroughly and checking the component list to make sure you're not missing anything.

II. The next step is to decide where you're going to mount the device. The instruction manual will give your ideas of where your particular model should be mounted. Some models can be mounted anywhere on the vehicle while others need to be mounted where they will get better reception.

III. Next you must mount the vehicle tracking device. In some applications were the device will be mounted only for a short period of time, it's advisable to secure the device with semi-permanent fastener such as zip ties. In most applications, where the vehicle tracking device will be installed permanently, the kit will come with some self-taping screws. These screws are designed to both start a hole in the metal and fastened the device to the vehicle. Be sure and choose someplace that will not cause damage to the vehicle. For example you certainly don't want to screw the vehicle tracking device into the gas tank. Once again, refer to the instruction manual for ideas on where to install the tracking device.

IV. After you have found an appropriate spot, using a power drill with a screwdriver bit, securely fastened the device to the vehicle with the self- taping screws.

V. The next step is to connect the tracking device to the vehicles wiring system. The tracking device will likely come with two wires attached to it. One will be red and one will be black. The red wire is connected to either the positive battery terminal or a wire on the vehicle that contains power. You can use the millimeters or test lamp to find a wire that has power. The black wire is either connected to the negative battery terminal or to a solid metal spot on the vehicle.

VI. Finally, all that is left to do is to securely wrap all the wiring connections with the electrical tape to protect them from coming loose. It's also a good idea to use zip ties to fasten the wires someplace where they will not rub on something and either get cut or break. You may want to hide the wires in a special covering called a wire loom. This makes the installation look very professional.

Car tracking devices are often used by concerned parents, business owners, and conscientious vehicle owners. A car tracking device uses a global positioning system to track a vehicle's location and movement. These devices can be used by parents to monitor a child's route, speed, and time spent at specific locations. For business owners, a tracking device is useful in monitoring employees' activities while on company time. Many vehicle owners also install tracking devices to aid in recovery in the event their vehicle is stolen. A car tracking device is an indispensable tool when monitoring a car's location is necessary.

Magnetic Weatherproof Case

1. Purchase a battery powered GPS car tracking device. Tracking devices can be either hardwired into your car or run on batteries. A hardwired device requires professional installation, so a battery operated device is the best choice for quick and simple installation at home. Purchase a magnetic weatherproof case to prevent the tracking device from being exposed to the elements.

2. Select a location for the car tracking device. The strong magnetic case surrounding the device will make it possible to choose among several metal areas in the vehicle. The most common locations for placing a tracking device are in the glove compartment, under the hood, on the metal frame beneath the vehicle, and in the trunk. Select an inconspicuous area that will not be routinely accessed.

3. Insert new batteries into the tracking device. Most tracking devices will run for one month continuously before the batteries will need to be replaced. Turn the device on and verify that it is transmitting information to the system monitoring it.

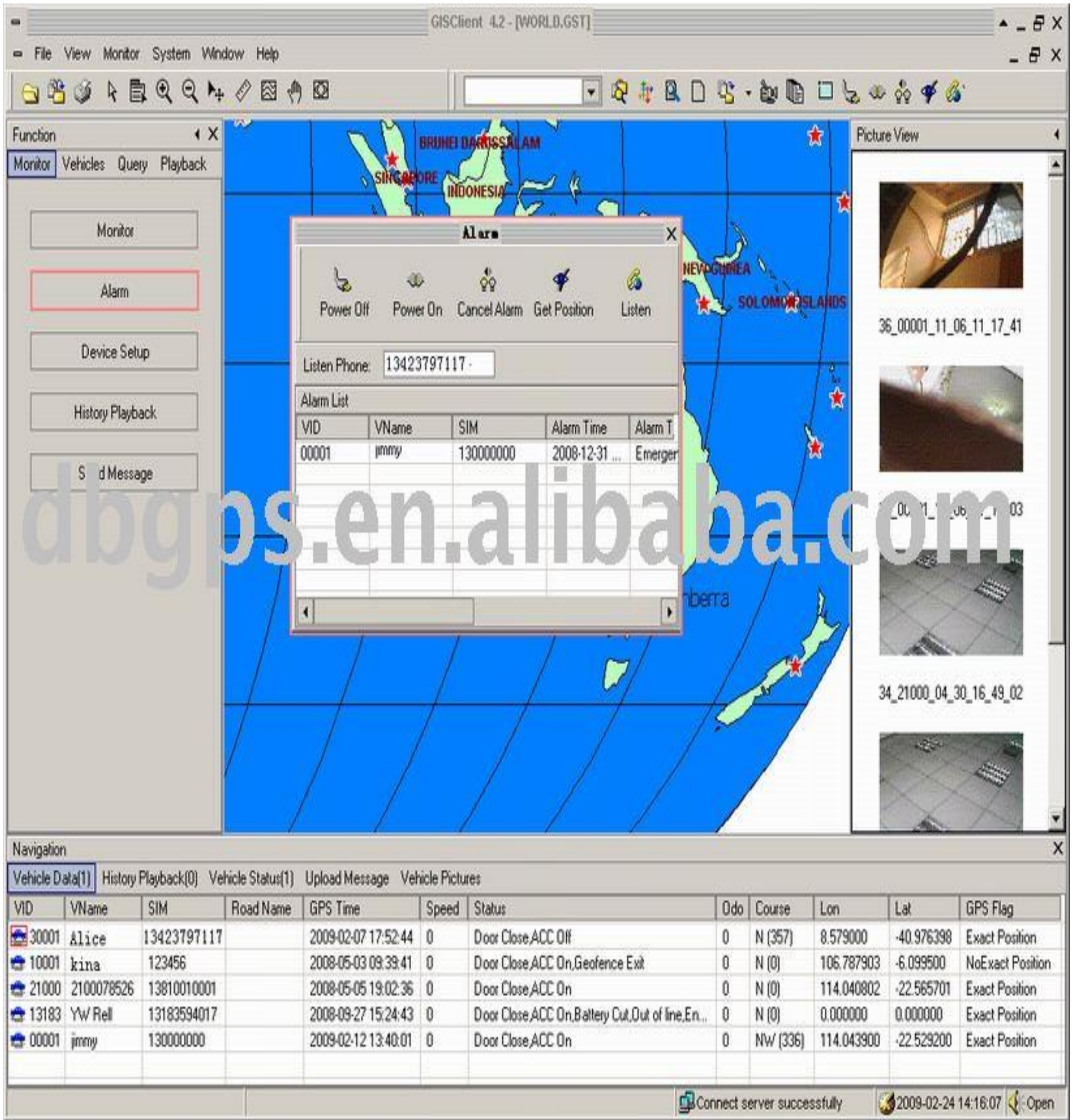
4. Place the car tracking device on the metal area that was previously selected. A strong magnet on the tracking device case will attach to the metal and hold it securely in place. Check that the device is not placed in an area where it can be damaged by moving parts or debris.

5. Does a test drive? With the car tracking device in place, drive the vehicle for a few blocks. Exit the vehicle, and make certain that the tracking device is still securely in place. Log onto the car tracking program, and verify that the information transmitted is accurate. Once the placement and transmission are confirmed, the tracking device may be used until its next battery replacement is due.

Software Update

Procedure

1. **GIS system**


GISClient 4.2 - [WORLD.GST]
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10001 kina 123456 2008-05-03 09:39:41 0 Door Close,ACC On,Geofence Exit 0 N (0) 106.787903 -6.099500 NoExact Position
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13183 YW Rell 13183594017 2008-09-27 15:24:43 0 Door Close,ACC On,Battery Cut,Out of line,En... 0 N (0) 0.000000 0.000000 Exact Position
00001 jimmy 130000000 2009-02-12 13:40:01 0 Door Close,ACC On 0 NW (336) 114.043900 -22.529200 Exact Position
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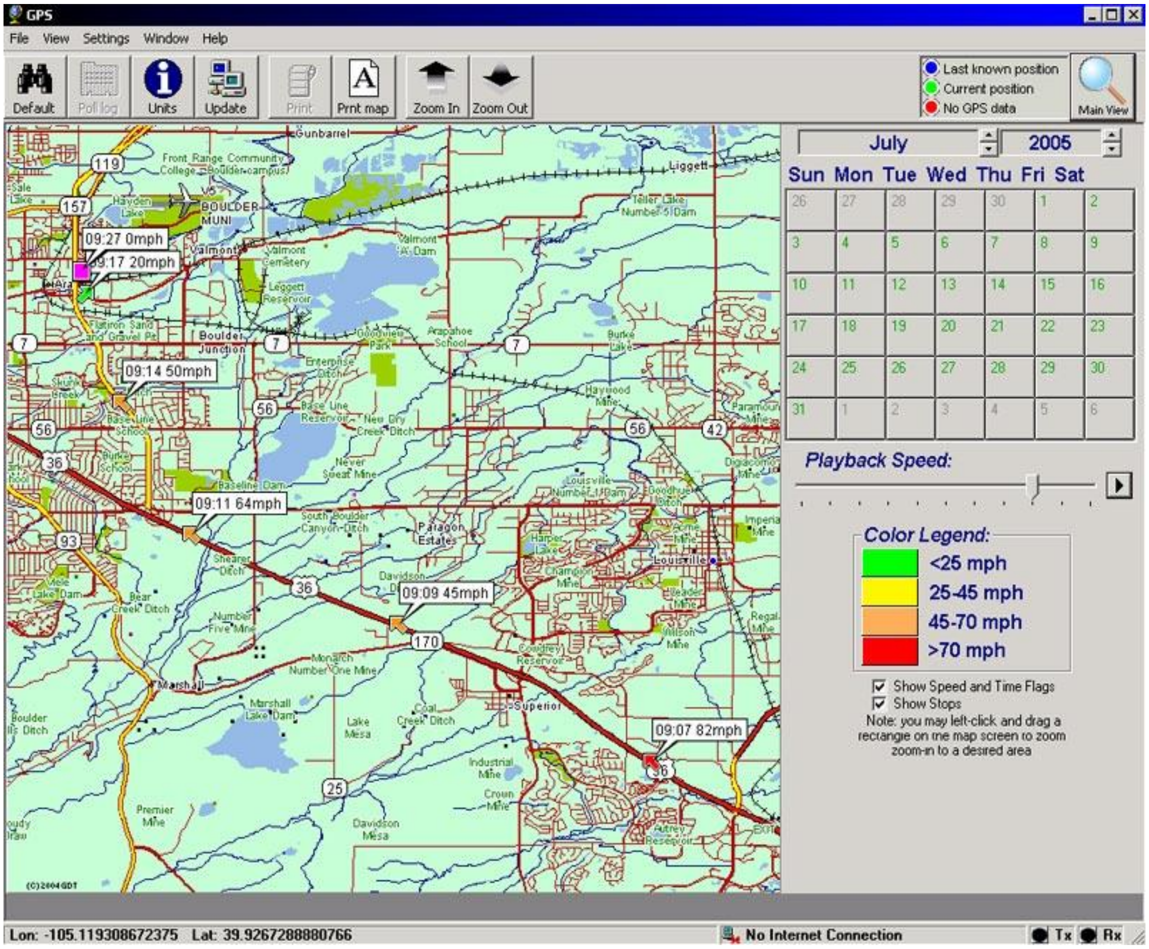
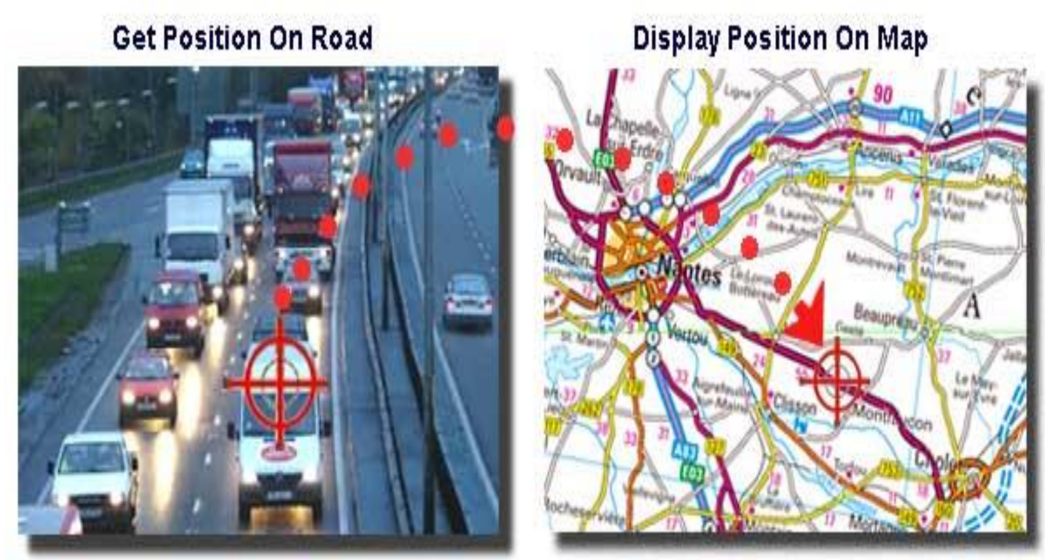
Open

2. Ranger



3. Technology



Track stick

Find out how to cut back on gas or improve your company's delivery time with the Track stick Pro. Emergency services can examine response times and driving avenues to better help in saving lives. It's the perfect solution for companies and individuals looking for a way to record and validate vehicle, shipping, or trucking routes. Visualize ground and air transportation, times and speed with the help of satellite mapped waypoints and Google Earth's 3D model of the planet.

Unlike the portable Track stick models, the Track stick Pro is conveniently powered by an included cigarette-lighter plug, and can even be hard-wired to any vehicle. With 4Mb of memory, the Track stick Pro can log weeks or even months of route histories. User-selectable features allow the record time to be changed from a recording interval of every 5 seconds, or from 1 minute up to every hour. A "first in, first out" memory cache will keep on recording new routes while erasing the oldest ones first.

The Track stick Pro can be permanently mounted on a vehicle in plain sight, covertly installed, or removed from the cradle and placed on the dashboard. An internal software alarm will time-stamp any power interruptions and can

Be viewed when the data is downloaded. The weatherproof case allows Track stick Pro to be mounted almost anywhere inside or out via the detachable cradle and screw pads. Do it in style, as the Track stick Pro comes in a variety of colors to better match the aesthetic of your entire fleet service.

Track stick's technology enables a continuously updated record history of the exact route, stop times, speed and direction. All information can easily be downloaded to your computer via the included USB cable and quickly viewed on Google Earth's 3D model of the planet. No monthly fees are required and all software needed to use Track stick Pro is included.

Configuration

- 2 1/2" X 2" X 3/4" 2.5 Meter Accuracy Built in USB 2.0 port Weatherproof case and detachable cradle.
- Firmware alarm notifies of any power interruptions.
- 4Mb flash memory records months of location histories.
- Runs on 5 – 24 volts DC with less than 6mA during normal operation.
- Built in temperature recorder -10°C / +14°F to +60°C/140°F +/- 1°C can be powered by the onboard USB port and plugged into any computer.
- "Live Track" maps its actual location in real time. (not for remote viewing over the internet, local use only) Integrates directly into Google Earth for worldwide use.
- Fully compatible with all versions of Track stick Manager Software, Microsoft Streets and Trips and other off the shelf programs via CSV file format.
- Requires Windows XP or 2000 compatible computer with USB1.1/2.0 port for mapping and data retrieval.

Track stick

The Super Track stick is an obvious choice for government agencies and intelligence personnel. The weatherproof case and removable magnetic mount allow for covert installation. Features like this make Super Track stick best suited for police or homeland security personnel.

The Super Track stick is conveniently powered by two (2) AAA batteries. With the built in vibration detector and proprietary low power GPS technology, the Super Track stick will run for over a month with average use. The 4Mb of flash memory ensures that the Super Track stick will log weeks or even months of travel histories. User selectable features allow the record time to be changed from an interval of every 5 seconds or from 1 minute to every 15 minutes. Like all Track stick devices, Super Track stick will work anywhere on the planet. Using the latest in GPS mapping technologies from Google Earth, its exact location can be shown on satellite-based maps and 3D geographical terrain.

The Super Track stick comes equipped with the highest technological features available on the market today. With the detachable magnetic mount and belt clip, Super Track stick can be carried on a belt, in a bag or covertly installed and placed on anything that moves. Track stick's technology enables a continuously updated record of the exact route, stop times, speed and direction and other valuable information.

The Super Track stick even has its own built in temperature recorder to monitor and record its environment. All of Super Track stick's information can easily be downloaded to your computer via the USB port and quickly viewed on Google Earth's 3D model of the planet. No monthly fees are required and all software needed to run Super Track stick's technology is included.

Configuration

- 4 1/2" X 1 1/4" X 3/4" 2.5 meter horizontal accuracy Integrated USB 2.0 connector Weatherproof case, detachable magnetic mount and belt clip.
- Integrated directly into Google Earth for worldwide use.
- 4Mb flash memory records months of location histories.
- Vibration Detector for ultra-long battery life. (4 weeks typical)
- Built in temperature recorder -10°C / +14°F to +60°C/140°F +/- 1°C
- Runs on two (2) AAA batteries.
- Requires Windows computer with USB1.1/2.0 port.

<u>Versions of vehicle tracker</u>

There are four versions of vehicle tracker

1. GPS Vehicle tracker M528 S
2. GPS Vehicle Tracker M528
3. GPS Vehicle tracker M518
4. GPS Vehicle tracker M508

GPS Vehicle tracker M528 S

Description

Applications: Location-based services and vehicle tracking, vehicle security/anti- theft. Fleet management: Position, monitoring, command & scheduling management of vehicle, Car, Taxi, Bus, Truck, Van, Motorcycle and etc. Function: Accurate GPS positioning, dynamic positioning deviation is less than 5 m and authorized tapping, the mute function. Protection from high or low level voltage and the data resend from signal dead zone. Speeding alarm, the power-off alarm; high/under-voltage alarm. Parking alarm, fatigue driving alarm. Mileage statistics; Geo-fence alarm; 3Analog Inputs.

Main Function

- SMS and GPRS TCP/UDP Communication
- Track by Time Interval and call roll
- SMS of mobile and gprs
- Mileage function
- Remotely monitor by authorization

- Record data logging function
- Remotely lock vehicle
- SOS alarm
- Cut power alarm
- Over speed alarm
- Parking alarm
- Internal flash memory 16MB : When the M528 is disconnected to the system (for example, the GPRS signal is weak), the position data will be storing in the flash, and then it will upload again after it reconnect to the system (the GPRS signal is ok).
- Fatigue driving alarm remotely update

GPS Vehicle Tracker M528

Product Description

- SMS and GPRS TCP/UDP Communication
- Track by Time Interval and call roll
- SMS of mobile and GPRS
- Mileage function
- Remotely monitor by authorization
- Record data logging function
- Remotely lock vehicle
- SOS alarm
- Cut power alarm

- Over speed alarm
- Parking alarm
- Internal flash memory 16MB: When the M528 is disconnected to the system (for example, the GPRS signal is weak), the position data will be storing in the flash, and then it will upload again after it reconnect to the system (the GPRS signal is ok)
- Fatigue driving alarm
- Remotely update.

GPS Vehicle tracker M518

Product Description

- Small size, easy to install
- Accurate GPS positioning, dynamic positioning deviation is less than 5m
- Support GSM voice and SMS functions, UDP / TCP protocol
- communications in GPRS mode
- Support the GPS data uploading at intervals and location
- Support the two way voice communication function
- Support two way SMS communication via Mobile and PC software
- Support authorized tapping function
- Support protection from high or low level voltage function
- Support the data resend from signal dead zone function
- Support remotely locking vehicle function
- Support watching vehicle function
- Support emergency alarm function
- Support the power-off alarm function

- Support over speed alarm function
- Support parking alarm function
- Support illegal door-open, illegal engine-start alarm function
- Support fuel consumption detection
- Support fuel changing alarm
- Support mileage statistics
- Support Geo-fence alarm
- Support fatigue driving alarm
- Support camera
- Support temperature detection
- Support remote update

GPS Vehicle tracker M508

Product Description

- SMS and GPRS TCP/UDP Communication
- Track by Time Interval and call roll
- SMS of mobile and GPRS
- Mileage function
- Remotely monitor by authorization
- Record data logging function
- Remotely lock vehicle
- SOS alarm
- Cut power alarm
- Over speed alarm

- Parking alarm
- Internal flash memory 16MB: When the M528 is disconnected to the system (for example, the GPRS signal is weak), the position data will be storing in the flash, and then it will upload again after it reconnect to the system (the GPRS signal is ok).
- Fatigue driving alarm
- Remotely update.

Technical use of vehicle tracking system

- Traffic monitoring
- Routing
- on-board information and security
- real-time information

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