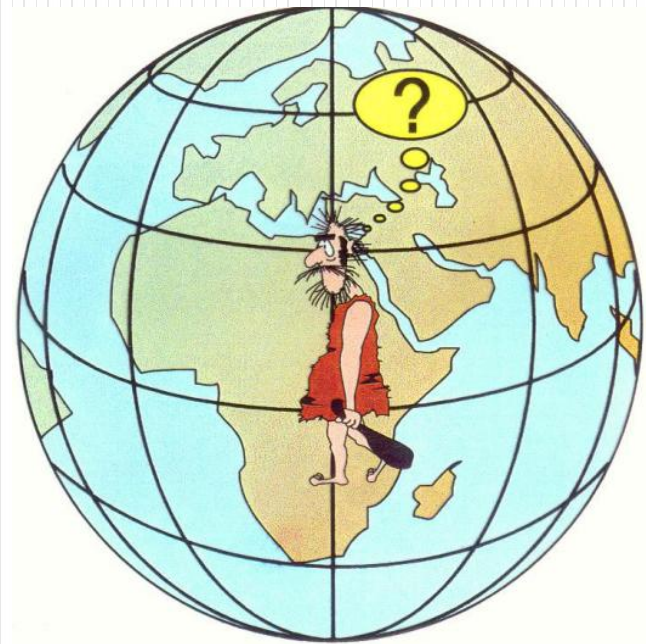


GPS Applications

Ahmed Talabany



- The free, open, and dependable nature of GPS has led to the development of hundreds of applications affecting every aspect of modern life. GPS technology is now in everything from cell phones and wristwatches to bulldozers, shipping containers, and ATM's.
- GPS boosts productivity across a wide swath of the economy, to include farming, construction, mining, surveying, package delivery, and logistical supply chain management. Major communications networks, banking systems, financial markets, and power grids depend heavily on GPS for precise time synchronization. Some wireless services cannot operate without it.
- GPS saves lives by preventing transportation accidents, aiding search and rescue efforts, and speeding the delivery of emergency services and disaster relief. GPS is vital to the Next Generation Air Transportation System (NextGen) that will enhance flight safety while increasing airspace capacity. GPS also advances scientific aims such as weather forecasting, earthquake monitoring, and environmental protection.

Agriculture

- GPS equipment manufacturers have developed several tools to help farmers and agribusinesses become more productive and efficient in their precision farming activities.
- Today, many farmers use GPS-derived products to enhance operations in their farming businesses.
- Location information is collected by GPS receivers for mapping field boundaries, roads, irrigation systems, and problem areas in crops such as weeds or disease.
- The accuracy of GPS allows farmers to create farm maps precisely for field areas, road locations and distances between points of interest. GPS allows farmers to accurately navigate to specific locations in the field, year after year, to collect soil samples or monitor crop conditions.
- Crop advisors use rugged data collection devices with GPS for accurate positioning to map pest, insect, and weed infestations in the field.
- Pest problem areas in crops can be pinpointed and mapped for future management decisions and input recommendations.
- The same field data can also be used by aircraft sprayers, enabling accurate swathing of fields without use of human “flaggers” to guide them.
- Crop dusters equipped with GPS are able to fly accurate swaths over the field, applying chemicals only where needed, minimizing chemical drift, reducing the amount of chemicals needed, thereby benefiting the environment.
- GPS also allows pilots to provide farmers with accurate maps.



Aviation

- Space-based position and navigation enables three-dimensional position determination for all phases of flight from departure, en route, and arrival, to airport surface navigation.
- The trend toward an Aerial Navigation concept means a greater role for GPS. Area Navigation allows aircraft to fly user-preferred routes from waypoint to waypoint, where waypoints do not depend on ground infrastructure.
- Procedures have been expanded to use GPS and augmented services for all phases of flight. This has been especially true in areas that lack suitable ground based navigation aids or surveillance equipment.
- New and more efficient air routes made possible by GPS are continuing to expand. Vast savings in time and money are being realized.
- In many cases, aircraft flying over areas such as oceans have been able to safely reduce their separation between one another, allowing more aircraft to fly more favourable and efficient routes, saving time, fuel, and increasing cargo revenue



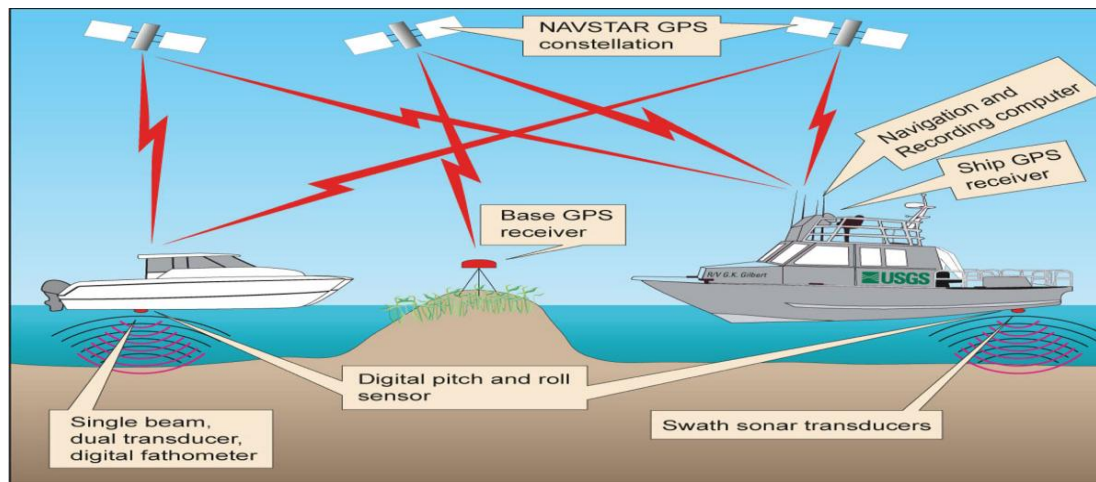
Environment

- Data collection systems provide decision makers with descriptive information and accurate positional data about items that are spread across many kilometres of terrain.
- By connecting position information with other types of data, it is possible to analyze many environmental problems from a new perspective.
- Position data collected through GPS can be imported into geographic information system (GIS) software, allowing spatial aspects to be analyzed with other information to create a far more complete understanding of a particular situation than might be possible through conventional means.
- GPS technology supports efforts to understand and forecast changes in the environment.
- By integrating GPS measurements into operational methods used by meteorologists, the atmosphere's water content can be determined, improving the accuracy of weather forecasts. In addition, the rapid increase in GPS tidal tracking sites, and improvement in estimating the vertical component of a site's position from GPS measurements, present a unique opportunity to directly observe the effects of ocean tides.

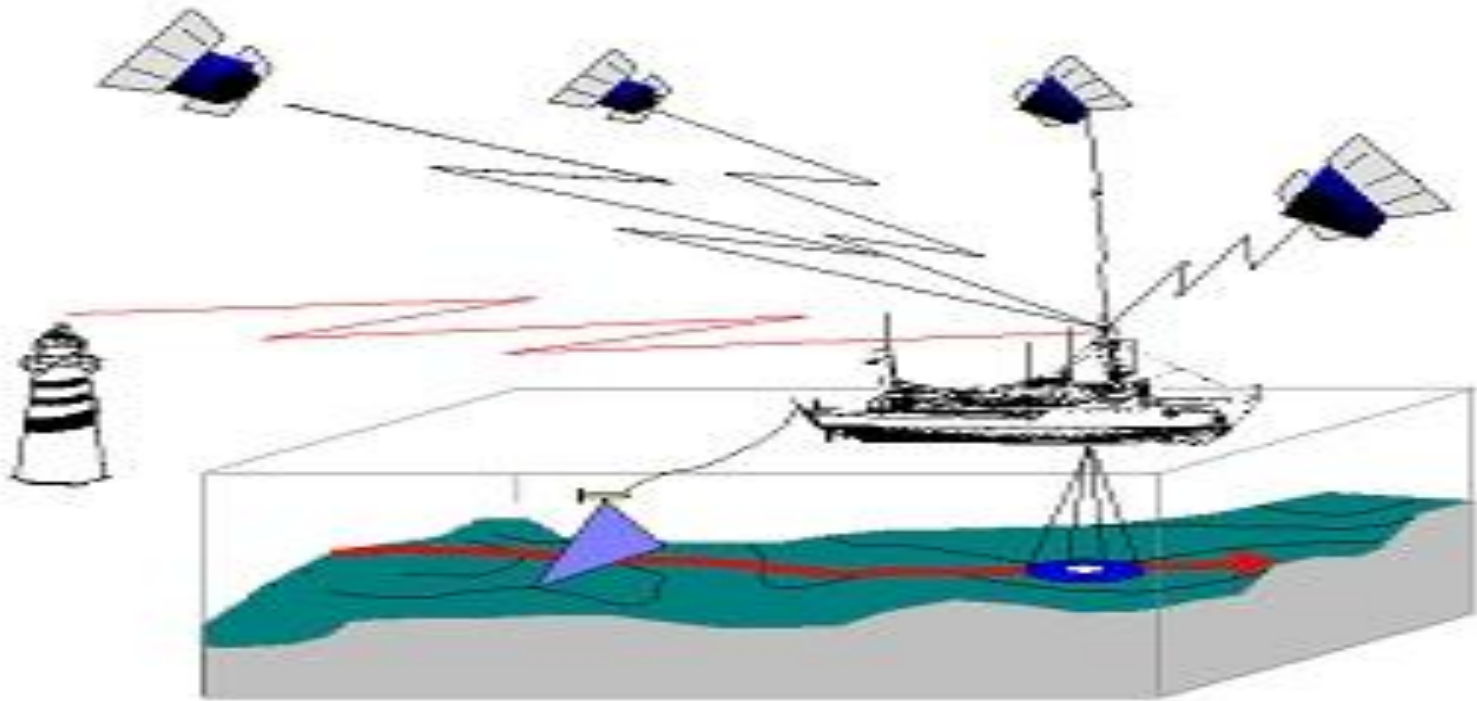


Marine

- Global Positioning System (GPS) has changed the way the world operates. This is especially true for marine operations, including search and rescue.
- GPS provides the fastest and most accurate method for mariners to navigate, measure speed, and determine location. This enables increased levels of safety and efficiency for mariners worldwide.
- It is important in marine navigation for the ship's officer to know the vessel's position while in open sea and also in congested harbours and waterways.
- While at sea, accurate position, speed, and heading are needed to ensure the vessel reaches its destination in the safest, most economical and timely fashion that conditions will permit.
- The need for accurate position information becomes even more critical as the vessel departs from or arrives in port. Vessel traffic and other waterway hazards make manoeuvring more difficult, and the risk of accidents becomes greater.



- Mariners and oceanographers are increasingly using GPS data for underwater surveying, buoy placement, and navigational hazard location and mapping.
- Commercial fishing fleets use GPS to navigate to optimum fishing locations, track fish migrations, and ensure compliance with regulations



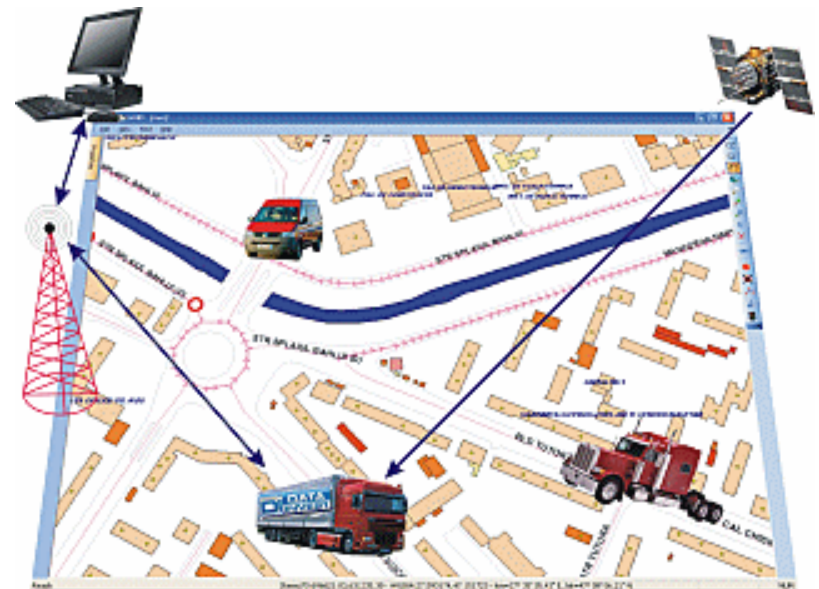
Public Safety & Disaster Relief

- Critical component of any successful rescue operation is time. Knowing the precise location of landmarks, streets, buildings, emergency service resources, and disaster relief sites reduces that time -- and saves lives.
- This information is critical to disaster relief teams and public safety personnel in order to protect life and reduce property loss. The Global Positioning System (GPS) serves as a facilitating technology in addressing these needs.
- GPS has played a vital role in relief efforts for global disasters such as the tsunami that struck in the Indian Ocean region in 2004, Hurricanes Katrina and Rita that wreaked havoc in the Gulf of Mexico in 2005, and the Pakistan-India earthquake in 2005. Search and rescue teams used GPS, geographic information system (GIS), and remote sensing technology to create maps of the disaster areas for rescue and aid operations, as well as to assess damage.
- As the international industry positioning standard for use by emergency and other specialty vehicle fleets, GPS has given managers a quantum leap forward in efficient operation of their emergency response teams.
- The ability to effectively identify and view the location of police, fire, rescue, and individual vehicles or boats, and how their location relates to an entire network of transportation systems in a geographic area, has resulted in a whole new way of doing business.
- Location information provided by GPS, coupled with automation, reduces delay in the dispatch of emergency services. Incorporation of GPS in mobile phones places an emergency

Roads & Highways

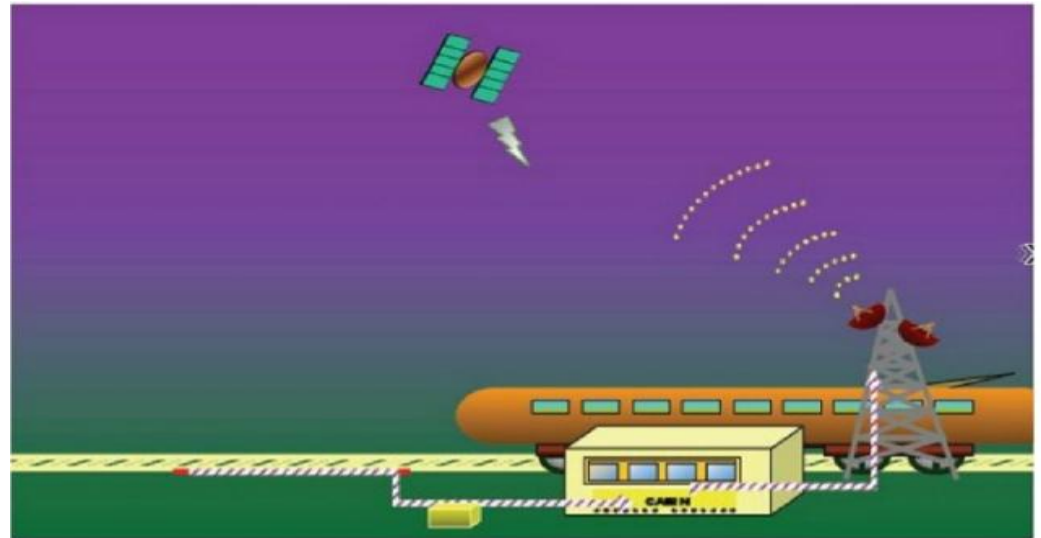
- It is estimated that delays from congestion on highways, streets, and transit systems throughout the world result in productivity losses in the hundreds of billions of dollars annually. Other negative effects of congestion include property damage, personal injuries, increased air pollution, and inefficient fuel consumption.
- The availability and accuracy of the Global Positioning System (GPS) offers increased efficiencies and safety for vehicles using highways, streets, and mass transit systems. Many of the problems associated with the routing and dispatch of commercial vehicles is significantly reduced or eliminated with the help of GPS. This is also true for the management of mass transit systems, road maintenance crews, and emergency vehicles.
- Using GPS technology to help track and forecast the movement of freight has made a logistical revolution, including an application known as time-definite delivery. In time-definite delivery, trucking companies use GPS for tracking to guarantee delivery and pickup at the time promised, whether over short distances or across time zones. When an order comes in, a dispatcher punches a computer function, and a list of trucks appears on the screen, displaying a full array of detailed information on the status of each of them. If a truck is running late or strays off route, an alert is sent to the dispatcher.

- Research is underway to provide warnings to drivers of potential critical situations, such as traffic violations or crashes. Additional research is being conducted to examine the potential for minimal vehicle control when there is a clear need for action, such as the pre-deployment of air bags. The position information provided by GPS is an integral part of this research.
- GPS is an essential element in the future of Intelligent Transportation Systems (ITS). ITS encompasses a broad range of communications-based information and electronics technologies. Research is being conducted in the area of advanced driver assistance systems, which include road departure and lane change collision avoidance systems. These systems need to estimate the position of a vehicle relative to lane and road edge with an accuracy of 10 centimetres.



Rail

- Modern railways in several different countries are fielding Positive Train Control (PTC) systems to prevent collisions, derailments, work zone incursions, and passage through switches in the wrong position.
- PTC is the combination of real-time location information with sophisticated command and control systems to monitor and control train movements.
- Rail systems that do not have PTC also gain benefits from GPS technology.
- GPS gives dispatchers and passengers more accurate information on train arrivals. It enables the automation of track surveying and mapping operations.
- GPS also allows the automation of track inspection systems that work much faster and detect more defects than human crews, saving time and money while improving safety.



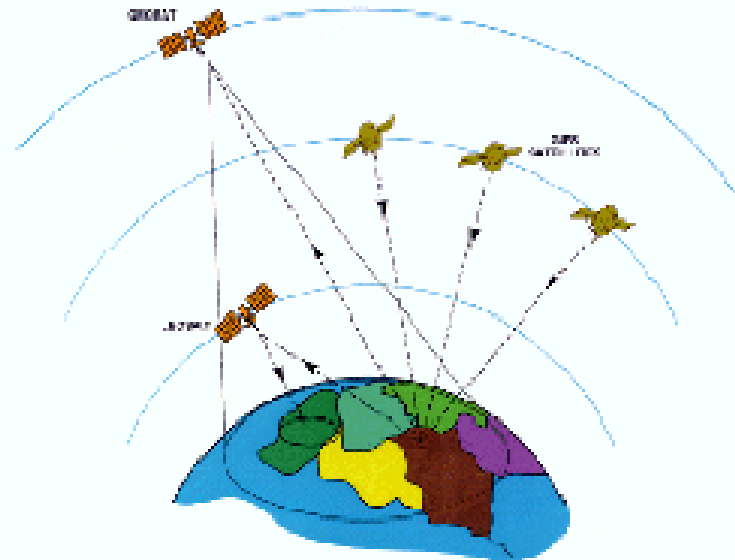
Timing

- In addition to longitude, latitude, and altitude, the Global Positioning System (GPS) provides a critical fourth dimension – time. Each GPS satellite contains multiple atomic clocks that contribute very precise time data to the GPS signals. GPS receivers decode these signals, effectively synchronizing each receiver to the atomic clocks. This enables users to determine the time to within 100 billionths of a second, without the cost of owning and operating atomic clocks.
- Precise time is crucial to a variety of economic activities around the world. Communication systems, electrical power grids, and financial networks all rely on precision timing for synchronization and operational efficiency. The free availability of GPS time has enabled cost savings for companies that depend on precise time and has led to significant advances in capability.
- Instrumentation is another application that requires precise timing. Distributed networks of instruments that must work together to precisely measure common events require timing sources that can guarantee accuracy at several points. GPS-based timing works exceptionally well for any application in which precise timing is required by devices that are dispersed over wide geographic areas. For example, integration of GPS time into seismic monitoring networks enables researchers to quickly locate the epicenters of earthquakes and other seismic events.
- New applications of GPS timing technology appear every day. Hollywood studios are incorporating GPS in their movie slates, allowing for unparalleled control of audio and video data, as well as multi-camera sequencing. The ultimate applications for GPS, like the time it measures, are limitless.

Space

- Navigation solutions -- providing high precision orbit determination, and minimum ground control crews, with existing space-qualified GPS units.
- Attitude solutions -- replacing high cost on-board attitude sensors with low-cost multiple GPS antennae and specialized algorithms.

GPS/GEO/LEO SATELLITE TRACKING CONCEPT



Surveying & Mapping

- Surveying and mapping community was one of the first to take advantage of GPS because it dramatically increased productivity and resulted in more accurate and reliable data. Today, GPS is a vital part of surveying and mapping activities around the world.
- When used by skilled professionals, GPS provides surveying and mapping data of the highest accuracy. GPS-based data collection is much faster than conventional surveying and mapping techniques, reducing the amount of equipment and labor required. A single surveyor can now accomplish in one day what once took an entire team weeks to do.
- GPS is especially useful in surveying coasts and waterways, where there are few land-based reference points. Survey vessels combine GPS positions with sonar depth soundings to make the nautical charts that alert mariners to changing water depths and underwater hazards. Bridge builders and offshore oil rigs also depend on GPS for accurate hydrographic surveys.

Recreation

- 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.

Surveying



Navigation



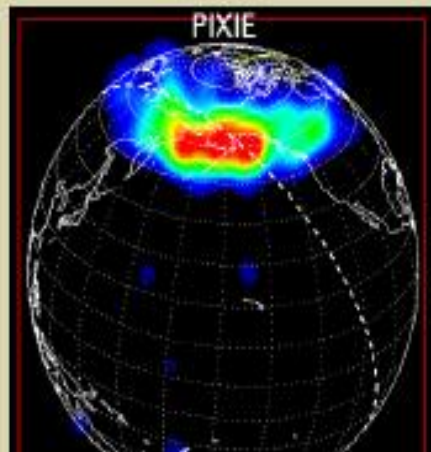
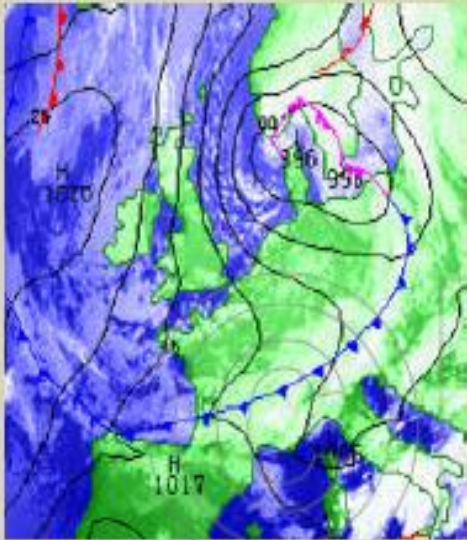
Structural Monitoring







Scientific Applications



Crustal Plate Motion

