Gps Essay, Research Paper

The Department of Defense (DOD) initiated the Navigation System with Timing And Ranging (NAVSTAR) Global Positioning System (GPS) in 1973. The DOD developed it because at a cost of over twelve billion dollars the government had the monetary resources to achieve idealistic goals of national defense. The GPS Master Control Station controls NAVSTAR GPS, which is at Falcon Air Force Base outside Colorado Springs, Colorado. This satellite system is used to determine the speed and position of an object anywhere in the world within one hundred meters to mere millimeters depending on the size and quality of user equipment (GPS Joint Program Office). GPS achieves this accuracy by using twenty-seven satellites that are launched into six specific orbits that are 20,200 kilometers above the Earth to cover the whole globe. GPS uses ground tracking stations around the world to compute distances by finding the difference between the time a signal is sent and the time it is received (Kaplan).

The NAVSTAR GPS was first designed to aid the military for tracking and navigation of ground, sea, and air forces. The United States Army s original purpose for GPS was for hyper-accurate missile targeting. (Loy) Since that time it has grown from one satellite used strictly by the military to twenty-seven satellites that can be used by civilians and private corporations also. Presently, access to the GPS satellite system is available to anyone with a GPS receiver; is this ethical? At its inception, GPS technology was available to the civilian public, but the signals sent to civilian GPS receivers were purposefully distorted to make sure that civilians around the world were not able to achieve militaristic goals. This was dubbed Selective Availability (SA). SA was put in place so that not everyone could have access to a hyper-accurate satellite system. As of May 2000, the government adjusted the GPS satellites so that a civilian can have GPS readings that are as accurate as military readings. In simpler terms, the government has discontinued the use of SA. Was this a good step on behalf of the United States Government? GPS has become one of the most reliable methods of data collection from satellites around the world. In many of these cases, the satellites are used to deliver very crucial data to the world. An example is the TOPEX/Poseidon satellite.

GPS is now used in almost every satellite for precise orbit determination and accurate location coordinates. The Topography Experiment for Ocean Circulation (TOPEX)/Poseidon mission is the first space mission specifically designed and conducted for studying the circulation of the world s oceans. This is a joint mission between the United States National Aeronautics and Space Administration (NASA) and France s Centre National d Etudes Spatiales (CNES). The Jet Propulsion Laboratory (JPL) controls TOPEX/Poseidon, which is located at the California Institute of Technology in Pasadena, California, USA. The raw data from the satellite instruments are extracted and sent daily to the French ground data system (SSDP), at CNES in Toulouse, France. The TOPEX/Poseidon satellite was launched on August 10, 1992 from the European Space Agency s Guiana Space Center in French Guiana. The United States and France have made a joint effort to fund and operate this mission, and have succeeded for eight years. This satellite system is equipped with a highly accurate and precise GPS receiver. TOPEX/Poseidon is an example where ethical questions arise. Mostly taxpayers in the United States funded TOPEX/Poseidon and the GPS receiver located on TOPEX/Poseidon.

The TOPEX/Poseidon satellite is equipped with a state-of-the-art radar altimetry system. There are two altimeters on board TOPEX/Poseidon, one that is provided by NASA and the other, which is known as Poseidon, is provided by CNES. This radar altimetry system is used to measure the height of the sea level, from which data is retrieved. Every ten days a global map of the ocean topography is made; it is accurate up to 4 centimeters. The data retrieved from the mission will help the understanding of the ocean tides, geodesy and geodynamics, ocean wave height and wind speed. The major goal of the mission is to improve the knowledge of the global ocean circulation to an extent that will ultimately lead to improved understanding of the ocean s role in global climate change. A follow-up mission, Jason-1, is a more advanced satellite system and will be able to take more precise measurements.

The most important data that is produced by TOPEX/Poseidon is the altimeter readings. The altimeter is essentially a very powerful radar. It determines the sea surface topography by measuring the length of time for a radar pulse to travel from the satellite to the sea and back. Two frequencies are used to make measurements to reduce errors that are caused by ionospheric interference. The TOPEX microwave radiometer (TMR) is another important instrument used to measure the water vapor content in the atmosphere. Another instrument, the Laser Retroreflector Array (LRA), is a satellite-tracking instrument used by JPL for precision orbit determination (POD) and calibration of the radar altimeter. TOPEX/Poseidon is also equipped with other, more precise and accurate tracking systems.

The second tracking system, the Doppler orbitography and radiopositioning integrated by satellite (DORIS), is a more accurate type of satellite tracking that uses microwave Doppler technology. This system is equipped with meteorological sensors that measure temperature, humidity, and atmospheric pressure. These readings help correct the bias in the data that is transmitted by this instrument. DORIS was designed and developed by CNES.

TOPEX/Poseidon was equipped with two experimental instruments. The first is a low-power, low-weight, test altimeter that was developed by CNES. The second is the Global Positioning System (GPS) demonstration receiver (GPSDR), which was developed by Motorola under NASA supervision. The GPSDR receives signals, from up to six satellites at once, of the satellite s location. The continuous tracking of TOPEX/Poseidon has made POD possible without the need of more sophisticated and time-consuming techniques. The experimental GPSDR has performed well and is now in full use on the TOPEX/Poseidon satellite to retrieve exact and precise data readings. The major goals of the GPS experiment are to (1) evaluate the accuracy and operational potential of GPS for tracking Earth satellites; (2) provide a database that includes the GPS-based orbit solutions, calibration data, and reference frame ties for post experiment use by the project; and (3) provide production GPS POD technology for possible conversion to an operational system (JGR). The GPS data is usually high quality; only 0.01% of the data is reported to be inconsistent and is removed. An economic objective of GPS is the ability of GPS to generate very accurate POD measurements, which can make it a cost-effective alternative to the present form of tracking systems. Because GPS data can be turned around into usable data within three hours, it also may be a time saving alternative as well.

Measurements such as sea surface height (sea surface anomalies), geostrophic velocity vectors, wind speed, and wave height provide useful in many applications. The data retrieved from the satellite altimeter is mainly used in the marine environment. Some applications include: ship routing, offshore industries, and climate forecasting.

Sea surface height is defined as the distance of the surface of the sea above a reference surface. The reference surface, in most cases, is the earth s ellipsoid. The earth s ellipsoid is based on the equatorial radius. Geostrophic velocity vectors are usually superimposed on maps of sea surface height or sea surface height anomalies. Geostrophic velocity vectors are currents that are caused by pressure gradients and the earth s rotations. The altimeter indirectly measures wind speed. The wind speed is measured from the strength of the returned radar signal from the ocean. Although the altimeter does not give the wind direction, a satellite scatterometer can be used to find the direction. The wind speed can be used in climate forecasting because of the long range of time the data is available. Wave height is calculated by the status of its return. If the radar pulse returns to the altimeter with a short, sharply defined pulse after it bounces of the sea surface, the sea is rough with high waves. If the radar pulse returns to the altimeter with a long, stretched pulse, the sea is calm with low waves. Maps of wave height can be useful for ship routing. Each measurement is to be precise and accurate. Since October 1992, altimeter data from TOPEX/Poseidon has been used to create incredibly accurate topography maps of the ocean. This is largely due to the POD processes. At present, the GPSDR on TOPEX/Poseidon is the chief instrument used for POD. GPSDR allows precise tracking and POD of TOPEX/Poseidon. This in turn allows TOPEX/Poseidon s altimeter to take measurements of the ocean at incredible accuracy.

The maps of the sea surface anomalies with the geostrophic velocity vectors are used in commercial shipping and competitive sailing to optimize the route from one destination to another. The data obtained from the altimeter are used to locate the ocean currents and eddies which are related to high currents. Specifically, wave height information is used to ensure the safe sailing in hazardous environments (application). Also, the ocean-current data will help ship captains [to] determine routes (application). Commercial ships use these reports and maps to avoid treacherous situations. For example, when the current flow direction is opposite to the wind direction, dangerously high waves result and could put the entire ship into jeopardy. The GPSDR also aids in this situation. If a less precise instrument were used for satellite location, the resulting data could be distorted and the effect could be hazardous. A ship could travel into the wrong current and have an accident, which may result in financial damage or even loss of life.

Estimates of the ocean s currents are very useful to industries that are involved with offshore activities. These industries use altimeter-derived monitoring tools for working on activities such as ocean cable laying and hydrocarbon exploration. Because telecommunication is an important area in the global economy, underwater communication cables have considerably increased, especially because of the expansion of the Internet. The cost of laying and repairing cable on the ocean floors is greatly reduced by an extremely accurate knowledge of the ocean water circulation. The altimeter data has been used to locate and identify areas of strong currents. This is especially important when thermal imagery is not available because of cloud cover. The offshore hydrocarbon industry (oil-drilling) has also used the near real-time altimeter data (Kantha). This altimeter data has been made of potential use by the offshore oil and gas industry. An important part of the ocean monitoring and forecast system is the integration of near real-time altimeter data into a numerical ocean model, which helps the hydrocarbon industries to determine where strong currents are located in a specific area of the ocean. The altimeter data retrieved from TOPEX/Poseidon is crucial to the development of global telecommunications and the further expansion of the hydrocarbon industry.

Finally, TOPEX/Poseidon altimetry data is also used in climate forecasting. Altimeter data, combined with other data, is used to predict the severity of a hurricane season and to forecast intensity changes of a storm. From the altimetry data, the heat content can be estimated from the sea surface topography. Because heat content plays a role in the development and formation of hurricanes, this information can improve predictions of hurricane forecasting. The altimeter data can be combined with on-site data to predict the severity of a hurricane season as well as forecasting the intensity of a hurricane storm. El Ni o-related climate variations have also been partially predicted using TOPEX/Poseidon s altimeter. El Ni o and La Ni a have often caused widespread and devastating impacts. In the United States alone, business losses from the 1986-87 El Ni o amounted to $10-15 billion. Although El Ni o s effects cannot be prevented, the data from TOPEX/Poseidon could cause businesses to alter strategies to reduce their economic vulnerability (Cheney). Also, the advance notice of inclement weather may help clearing drainage channels in areas likely to flood, or planting drought resistant crops in areas likely to experience drought. The National Oceanic and Atmospheric Administration (NOAA) and National Centers for Environmental Prediction (NCEP) have the mandate to provide forecasts to the nation to reduce loss of life and minimize economic impacts.

TOPEX/Poseidon continually maps the changes of sea level. These observations are valuable because the changes of the sea level show the heat storage in the ocean, which affects the global climate. This information is used to prevent the damage that occurs with extreme weather conditions. TOPEX/Poseidon has also been an enormous aid to the measuring and study of global tides. The path of TOPEX/Poseidon s orbit was chosen also to be helpful in this area. This objective has been reached; tides can now be predicted everywhere in the ocean with an accuracy of two centimeters. Tides are important for navigation in coastal regions. This is all possible because of the POD of TOPEX/Poseidon. The POD largely depends on the GPSDR to provide accurate satellite tracking and position data. In turn, millions of lives and billions of dollars depend on the accuracy of the GPSDR on POD.

The results from this experiment confirm the accuracy of prelaunch GPS. Error studies have been completed for this project and the analysis lends confidence to predictions made by similar studies for future missions (JGR). Evidence shows that the GPSDR on TOPEX/Poseidon obtains an accuracy of three centimeters or better for its orbit. Future missions will take advantage of the GPS system developed for this experiment and should obtain accuracies of five centimeters or better in orbits of a few hundred kilometers (JGR). Although TOPEX/Poseidon has been in operational status since 1992 and has produced precise and accurate readings, it has had its problems.

From 1992, at its inception, to 1999, TOPEX/Poseidon has had a total of 99 (total published) problems. Several of these problems over the eight-year period have lasted for longer than 24 hours. This loss of this data interrupts other processes, applications, and uses that require and depend on the information that is supposed to be retrieved from the satellite instruments. In some uses of TOPEX/Poseidon, the altimeter data must be very accurate

Civilians are not only the ones who can access this technology. Private organizations around the world can gain access to GPS. This presents an important question of ethics that must be addressed while dealing with the use of GPS. The civilians paid for, in tax money, for the NAVSTAR GPS project; should private companies and commercial corporations be able to have access to the GPS technology? Should these private organizations pay a fee or reimburse money to the public to us this technology? Should the technology be available to civilians and organizations around the world? It has been the United States taxpayers who have paid for the NAVSTAR GPS project, and yet the technology is available to any person who is able to gain access to a relatively inexpensive GPS receiver.

Corporate use of GPS is an ethical issue that must be dealt with. There is an example of this commercial use in India. GPS is being used with wireless communications to enable commercial truck (lorry) owners to located their vehicles. Private owners are also able to locate their vehicles in cases of emergency or theft (GPS Exchange). In this case private owners have the ability to use the United States GPS for their benefit. The United States taxpayers funded the project from its start. Just in February 2000, the [United States ] President Requests $617 Million in FY [Fiscal Year] 2001 for GPS Sustainment and Modernization (http://www.igeb.gov). The taxpayers are still paying for GPS technology to be maintained and improved. The government, at no cost, allows a private corporation to use GPS. It has been stated in the May 2000 Presidential Release, about GPS, that the United States Government has the ability to prevent access to GPS by region or receiver signal. For example SA was used with civilians in the past and could be used to completely cut private companies and organizations access to the satellite system. An issue now arises from this statement. If the government is able to single out signals to the satellite and deny them, then if the government wanted to, it could easily single out the signals from the private companies and charge a fee. Although civilians paid for the technology, it is available to businesses that have not funded for it by means of taxes. I believe that these specific signals should be singled out and the private firms should be charged a nominal fee as a tax on the technology. The government would then obtain a greater amount of money through taxes. Then, possibly, corporate use of the GPS technology would not be an ethical issue.

A second ethical concern arises from GPS technology. GPS satellites can be accessed by anyone around the world. Even if the issue with the corporate use of GPS were solved, a second issue still exists with any individual outside the United States. Many around the world can access a simple GPS receiver and be able to gain access to very precise and accurate tracking and directional information. The increased performance is also expected to accelerate its acceptance and use by businesses, governments, and private individuals in the U.S. around the world that will enjoy increases in productivity, efficiency, safety, scientific knowledge and quality of life (Presidential Press Release). From this statement it seems as though the government does not plan to impose any type of taxes or fees to corporate individuals or private individuals in the United States or even around the world. President Clinton states that his decision will make GPS more responsive to civil and commercial users worldwide (Clinton). This statement makes it clear that he does not plan to collect any compensation from any individuals, domestic or worldwide. The issue may work out itself as some countries have started to develop their own version of the GPS technology, emulating the United States. But this initiative is taken only by a small percentage of the world. But most still take advantage of the United States GPS technology. Again, it was stated in the May 2000 Presidential Press Release that the United States Army has the ability to prevent a specific region to gain access to precise tracking from the GPS.

As mentioned above, simply limiting the use of GPS can solve both ethical matters. The United States Government has the capacity to prevent the rights to use GPS by region or by individuals. The United States Government could easily apply a fee or tax to the use of the GPS satellites. Applying a tax to GPS technology could result in two outcomes. First, private and/or foreign individuals would decide that they are not able to afford the technology and therefore find another source of precise and accurate tracking and locating data. Second, the private and foreign individuals will find that they need the GPS technology and decide to pay the extra cost. The government uses the reasoning that by leaving GPS as a public service to the world, global productivity and technology will grow. In this sense it may be beneficial to the world but the issue still remains; the foreign world as well as the corporate individuals are using GPS technology at the expense of the United States taxpayers.

Since its launch, GPS has been used for a variety of applications and purposes. It was first used for hyper-accurate missile targeting. Overtime, it has progressed from these militaristic ideals to civilian and corporate functions. GPS has become one of the most versatile technologies available to the general public. TOPEX/Poseidon is one example where GPS is used by the government and benefits the world. TOPEX/Poseidon is a prime example of where this governmental technology aids civilian and corporate tasks. An ethical question of GPS use on TOPEX/Poseidon for the foreign global society and commercial users arises with discussion about the funding of the entire project. I believe that the individuals in commercial agencies or in foreign agencies should pay some form of a tax or fee for the use of GPS. This extra income for the government could result in some tax relief for the current United States taxpayers. It is not practical to allow private companies and foreign individuals access to a technology that they did not pay for. There is also the contradicting criticism that explains GPS as a promoting tool for technological and economic growth. This is the view taken by the United States Government, and is stated in the May 2000 Whitehouse Press Release. GPS is a technology, which increases in productivity, efficiency, safety, scientific knowledge and quality of life, but it is at the expense of the taxpayers. GPS, a widespread technology, is used by the global society, which brings up many ethical questions. These questions cannot be easily solved and they will not disappear overtime.

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