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**QUESTION 1:**

1. **Navigation:** the most common use of gps is in navigation systems. It helps maintain control over assets that are important for moving inventory or customer service. GPS can pinpoint a devices location with accuracy and by comparing coordinates, the statics can be used to calculate the device direction of movement and speed.
2. **Lowcost:** the satellite behind GPS are paid for, maintained and upgraded by the us department of defence. That means that the system is essentially free, although you may have to pay for a device or software to utilize it.
3. **For security purposes:** with the GPS tracking system, you get the power to secure your vehicle from being stolen even it miles away from you. It can be used as a valuable tool to track criminals or terrorist, using devices they attach to the vehicles or through their smartphones.
4. **Easy to use:** several speculations suggesting the complexity of vehicle tracking system have indeed kept many people from availing the benefits. However the modern day GPS tracking systems are smartly engineered and offer the ease of use.
5. **Compatibility with devices:** smart phones and tablets are virally in use these days. One of the most excellent features of the GPS tracking system is that it is compatible to phones and allows access to applications and software’s.

**QUESTION 2**

**TYPE OF ERRORS ASSOCIATED WITH ABSOLUTE GPS POSITIONING MODE**

1. **System errors:** are those errors that will affect every positioning activity regardless of the specific location of a particular receiver. System errors originate from inaccuracies in the positions of the satellites, the GPS signal and the propagation of the signal through the earth’s atmosphere. Most of these errors can be eliminated if GPS positioning is performed in a relative mode and with dual frequency receivers. GPS surveys are always made relative to a known control point, thus, many system errors cancel out. System errors include:
* **Ephemerides Errors** – To compute a position with GPS, it is necessary to know the exact position of each observed satellite. The positions of the satellites derived from the broadcast navigation message (broadcast orbits), are predictions of where the satellites are expected to be. These predictions could have an error of a few meters. For most practical purposes these errors are insignificant in a relative (differential) positioning mode. Precise orbits that have typically sub-decimeter orbital accuracy may be required for specific projects.
* **Satellite Clock** – Precise GPS positioning depends on precise timing devices since one of the GPS observables is time. The double-differencing data processing technique (processing observation data from 2 satellites and 2 receivers simultaneously) can eliminate the impact of this error. In GPS surveying, the standard positioning computation is double-differencing.
* **Tropospheric Delay** – The troposphere is the lower part of the atmosphere extending from the Earth's surface to a height of approximately 15 km. This is an electrically neutral and non-dispersive medium for frequencies as high as about 30 GHz. Within this medium, group and phase velocities of the GPS signal on both L1 and L2 frequencies are equal. The GPS satellites transmit on two L-band frequencies: L1 = 1575.42 MHz and L2 = 1227.6 MHz.
1. **Receiver Dependent Errors**
* **Receiver Clock Error** – As mentioned earlier, precise timing is essential for GPS positioning. High quality clocks are very expensive and even they are subject to errors. Receiver clock errors can be eliminated by utilizing the double differencing computation method.
* **Receiver Noise** – GPS receivers are not perfect devices. Some level of noise always contaminates the observations and produces positioning errors. The “carrier to noise power density ratio C/No” value determines how well the tracking loops in the receiver can track the signal and, hence, the precision of the observation. Nominal GPS receiver C/No values are in the 40 50 dB-Hz range.
* **Antenna Phase Center** – The cross hair of a GPS receiver is the antenna phase center. The position that is determined with GPS is the position of the antenna phase center. Every antenna is calibrated by the vendor to determine the offset between the center of the physical center of the antenna (used to place the antenna directly above a point) and the phase center. Each antenna has a setup orientation mechanism to enable the user to orient all antennas used in a given session to the same (usually north) direction. If this is done and the same type of antenna is used in the session, the antenna phase error can be eliminated. This is one of the reasons why it is not recommended to mix antennas from different manufacturers in a given session, unless this error is known and corrected for.
* **Bulls-Eye Level Bubble Collimation Error** – The integrity of the bulls-eye level bubble on the 2-meter fixed height pole and the rover bi-pod pole must be checked before, after and during the project (if suspect). The findings must be documented in the final survey report. An out of adjustment bubble can cause an antenna centering error of several centimeters.
1. **Errors Due to Point Selection**

The selection of points to be measured with GPS is not a trivial matter. The rules of point selection in traditional surveying, mainly maintaining line of sight, do not apply in GPS surveys. Since the direct line of sight has to be with the satellites, points have to be selected in such a way that the clearest signal is received at that point. The following are errors that can impact the results of GPS surveys:

* **Multipath** – Multipath is receiver-satellite geometry dependent, hence the effect of the multipath error on positioning will generally repeat on a daily basis for the same baseline. A signal can arrive at a receiver directly from the satellite, but also from a nearby reflective surface. The reflected signal travels a longer path than the direct one, which results in an observation error. The point to be GPS occupied must be selected in such a way that it is not adjacent to a reflective surface. If possible, avoid locations of stations near large flat surfaces such as buildings and large signs.

For this reason, the vehicle used during the survey should not be parked near the GPS antenna, or the antenna should be mounted higher than the vehicle. Longer observation times can help “average out” multi-path error.

.  Multipath Example

* **Obstructions** – There are two types of obstructions that may interfere with GPS signals. The first is a solid obstruction that completely blocks the antenna from the incoming signal. This will cause fewer actual observations to fewer satellites than planned and a weaker positioning solution. Every point to be GPS surveyed must be inspected for such obstructions and the obstructions must be properly mapped. The observation planning software should be updated with these obstructions to provide better session planning and, eventually, better results. Generally, some GPS obstructions can be tolerated to the north of the station due to the orientation of the satellite orbital planes coming into view in the south.
The second types of obstructions are those that do not completely block the signal but may hamper integer fixing, such as tree canopy. If the location of the point cannot be altered, longer observation sessions are required to assure quality results.
* **Interference** – Electromagnetic signal interference can cause lower C/No values and less reliable observations. Areas with very high wireless communication traffic or nearby high voltage power lines should be avoided. Longer sessions could overcome some of the effect of the interference.
1. **Operation Errors**
* **Satellite Geometry** – There are several satellite geometry factors to be considered when planning a GPS survey. These factors influence the geometry of the satellites in space at the time of observations is an important factor of GPS positioning accuracy. These factors include the number of satellites available, the minimum elevation angle for the satellites (elevation mask), obstructions that limit satellite visibility, and the various locations of each satellite with respect to the receiver. The best geometry is when the satellites are evenly distributed around the horizon and at least one satellite is at the zenith. The worst geometry is when all the satellites are bunched together in a small region of the sky.
1. **Data Processing Errors**

Data processing errors are those errors which can be identified only when the field work has been completed. During the processing of the field data certain “poor” observations have to be filtered while others can be corrected with the software.

* **Loop Closures** – Closed loops of baselines are used for the quality control of the measurements and their respective errors in a similar way as used in traversing and leveling. A loop is defined as a series of at least three independent, connecting baselines, which start and end at the same station. Each loop shall contain baselines collected from a minimum of two independent sessions. The acceptable closure for a given survey task should be specified at its planning stage. Survey tasks that require higher accuracies will have more stringent acceptable closures and vice versa.
* **Ambiguity Resolution Error** – The ambiguity in GPS surveys is an integer number of full carrier wave cycles between the receiver and the satellite. An inaccurate ambiguity determination results in a position error because the computed distance between the receiver and the satellite is incorrect. This value cannot be measured directly, but must be computed (resolved) using sophisticated algorithms. Longer sessions and low GDOP values will reduce the potential for ambiguity resolution errors.

**Cycle Slip** – A cycle slip is a discontinuity in GPS carrier phase observations caused by signal loss, usually due to obstructions. If a GPS receiver loses a signal temporarily, when the signal is reacquired there may be a jump in integer number of full carrier phase cycles (ambiguity). This jump must be identified and corrected; otherwise the position determination may be in error. Most GPS software have cycle slip repair tool to correct short