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**Benefits of GPS over other measuring equipments**

**Benefits of GPS in surveying:**

1. **Vertical control network**:GPS uses the World Geodetic System(WGS84) ellipsoid as the optimal mathematical model describing the shape of the earth on an ellipsoid of relation. There is no direct mathematical relation between heights obtained from GPS and orthometric elevations obtained from conventional spirit levelling. However a model can be determined from benchmark data and corresponding GPS data. This model can be used to derive the unknown orthometric heights of stations occupied during a GPS observation period to intensify supplemental small-scale topographic mapping.
2. **Geodetic control network**: GPS can be used for a wide area high-order geodetic control network. GPS provides very precise point positioning (when used in relative mode), producing baseline results of the order of 5-10ppm under average conditions
3. **Project control network**: Establishing project control with GPS is often cost-effective, faster, more accurate and more reliable than conventional survey methods. The quality control statistics and large number of redundant measurements in GPS networks help to ensure reliable results. Field operations to perform a GPS survey are relatively easy and can generally be performed by one person per receiver. GPS is particularly attractive for control networks as compared with conventional surveys because intervisibility is not required between adjacent stations.

**Some general benefits of GPS include:**

**1. Navigation**

Perhaps the most common use for GPS is in navigation systems. Combined with map technology, it becomes a powerful tool for road vehicles and boats. GPS can pinpoint a device's location with accuracy and by comparing coordinates, the statistics can be used to calculate a device's direction of movement and speed. This information can be used to provide step-by-step directions from Point A to Point B in real time.

## **2. Low Cost**

The satellites behind GPS are paid for, maintained and upgraded by the US Department of Defense. That means that the system is essentially free, although you may have to pay for a device and software to utilize it. Smartphone apps, such as Google Maps, that use GPS are also usually free.

## **3. Easy to Use**

## Navigation using GPS is generally very easy and requires minimal skill or effort, certainly when compared to traditional methods and technologies, such as map-reading. In most cases, the user just has to input the destination and the device will do the rest. GPS is also an easier and more efficient technology to use for tasks like surveying and the study of the movement of tectonic plates (see below).

## **4. Traffic and Weather Alerts**

One of the nice things about GPS is that it is all happening in real time. That means that you can be notified if there is a traffic accident or other hold-up ahead, or if you are approaching an area where there is a severe weather event occurring. Not only can this shorten your journey time, but also improve safety.

**Types of errors associated with absolute GPS positioning mode**

Some of the errors include:

1. Clock Stability
2. Multi-path
3. Ephemeris errors and orbit perturbations
4. Tropospheric delays
5. Anti spoofing
6. Receiver noise
7. Ionospheric delays
8. Satellite and receiver clock errors
9. Selective Availability(S/A)
10. **Clock Stability**: GPS depends on accurate time measurements. GPS satellites carry rubidium and cesium time standards that are usually to 1 part in 10^12 and 1 part in 10^13 respectively, while most receiver clocks are accurate by quartz standard accuracy or 1 part in 10^8. A time offset is the difference between the time recorded by the satellite clock and that recorded by the receiver range errors observed by the user as a result if the time offset between the satellite and receiver clock has a linear relationship.
11. **Signal multipath:** Multipath describes an error affecting positioning that occurs when the signal arrives at the receiver from more than one path. This occurs when the GPS receiver is positioned close to a large reflecting surface such as a lake, a big rock or a building. In this case the satellite signal does not travel directly to the antenna but hits the nearby object first and is reflected into the receiver's antenna creating a false measurement. This increases the travel time of the signal and causes error.
12. **Ephemeris errors and orbit perturbations**: Satellite ephemeris errors are errors in the prediction of a satellite position which may then be transmitted to the user in the satellite data message. Ephemeris errors are satellite dependent and very difficult to correct and compensate while modelling the orbit of a satellite because many forces acting on the predicted orbit of a satellite are difficult to measure directly. Ephemeris errors produce equal error shifts in the calculated absolute point positions.
13. **Tropospheric delays**: The troposphere is that part of the atmosphere which is the closest to the earth. It extends from the surface of the earth to about 9km over the poles and 16km over the equator. But as far as GPS is concerned, the troposphere is combined with the stratosphere and taken to be at a height of 50km above the surface of earth. The tropospheric delay adds a slight distance to the range the receiver measures between itself and the satellite. The troposphere is an electrically neutral layer of the earth's atmosphere, Hence it is neither ionized nor dispersive.
14. **Anti spoofing(A/S)**: This is similar to selective availability(s/a). It is intended to deny civilian access to the P-code part of the GPS signal, thereby forcing the user to use the C/A code which has selective availability applied to it (A/S) encrypts the P-code into a signal called the Y-code. Only uses with military GPS receivers can decrypt the Y-code.
15. **Selective availability(S/A):** Selective availability is a process applied by the U,S department of defence to the GPS signal. This is intended to deny civilian and hostile foreign powers from getting full accuracy of GPS by subjecting the satellite clocks to a process known as dithering, which alters their time slightly.
16. **Ionospheric delays**: GPS signals are electromagnetic signals and such are non-linearly dispersed and refracted when transmitted through a highly charged environment like the ionosphere. Dispersion and refraction of the GPS signal is referred to as the ionospheric range effect because it results in an error in the GPS range calculation as the velocity of the radio-signals from the satellite is affected. The ionospheric range effects are frequency dependent and are not constant.
17. **Satellite and receiver clock errors**: Even though the clocks in the satellite are very accurate to about 3 nanoseconds, they do sometimes drift slightly and cause small errors, affecting the accuracy of the position. The satellite clocks are independent of each other.