**Performance Evaluation Amongst Static, RTK, and PPK Survey in DGNSS**

**Abstract:**

The Differential Global Positioning System (DGNSS), have three types of observations like Static, Post processed Kinematics (PPK) and Real-Time Kinematic (RTK). In "time-based survey methodology" in GNSS applications , particularly focusing on accuracy and efficiency for India/ In DGNSS surveying methods that rely on the timing of satellite signals and observations achieve high positional accuracy which is time dependent. To confirm the most accurate methods, DGNSS observations were taken using the three methods by fixing a base station, Rover station. Also, the different time of observation is considered focussing on accuracy and efficiency. It has been inferred for all the GNSS surveying procedures, the correction of all skills, that help to accomplish high positional accuracy. Static surveying is time consuming but of high performance, whereas PPK rectifies errors after data collection, RTK smears positional improvements in real-time.

**Keywords: DGNSS, performance evaluation, positional accuracy, Static, PPK, RTK**

**Introduction**

Capturing 3D geospatial information, the foundation data should befast, accurate, comprehensive, reliable, cost-effective etc. The large scale (1:1,000 or 1:500) topographic data is presently widely used for cadastral or town planning survey. For 3-D formation, the Digital Elevation Model (DEM) data (50cmX50cm grid with 10cm vertical accuracy) can be used. Contours having interval 1cm, Orthophotos at 5-10cm ground sampling distance (GSD) and GIS layers considered as per Amrut of 290layers.The present practice of capturing data is redundant, dissimilar, disconnected, done in silos, dissimilar , poor in scale, coverage and incomplete so for one data multiple surveys are conducted. It is pertinent to have one survey that should be unanimously applied and should be realistic and good. The orthodox method of data capturing is done by using total station, GNSS, Satellite imageries and drone photograph but are unsuitable as cannot be applicable in inaccessible terrain, remote areas, erroneous, inaccurate, Time consuming, uneconomical and, inaccurate etc. da. Silva et al., 2025[1].

There are numerous Satellite Navigation (SATNAV) systems operating around the world. Some are global and others only provide service within a certain region. The term Global Navigation Satellite System (GNSS) is defined as the collection of all SATNAV systems and their augmentations. The various SATNAV systems are the U.S. Global Positioning System (GPS), the European Galileo system, the Russian Federation Global Navigation Satellite System (GLONASS), the Chinese BeiDou Navigation Sato stellation elite System (BDS), India’s Navigation with Indian Constellation (NavIC), and Japan’s Quasi-Zenith Satellite System (QZSS).Each system operates at enhanced accuracy and reliability. By triangulating signals from multiple satellites, GNSS receivers can have better coordinate within meters or centimetres accuracy (Walkar et al, 2020[2], Nanda et al, 2023[3], Ramiro et al, 2025[4]).

  
**Fig 1: Drone image of the study area (Centurion Univ. of Tech. & Management).**

These satellite-based systems provide accurate positioning, navigation, and timing to users around the globe, enabling a wide array of applications across various sectors. Originally developed for military purposes, GNSS has become integral to civilian life, influencing everything from everyday navigation in vehicles to precision agriculture, aviation, and disaster response. Other benefits received from GNSS as it is having accurate navigation (10-20cm), weather independent, worldwide coverage, no line of sight needed, high geodetic Accuracy, 24hours operational, quick and economic, common co-ordinate system, wide range of application, competitively priced, and accessible for both civilian and military (Shi et al, 2020[5],Nanda et al, 2024[6], Popove et al, 2025[7] The comparison of the 3-survey methods Static, PPK and RTK along with drone image of the area of CUTM (Atik et al. 2025[8] is applied which is given in Table-1.

**GNSS:**

Hence GNSS as an innovation technique in modern survey as location tracking, enhances safety in transportation, supports emergency services, like autonomous vehicles and drone operations.

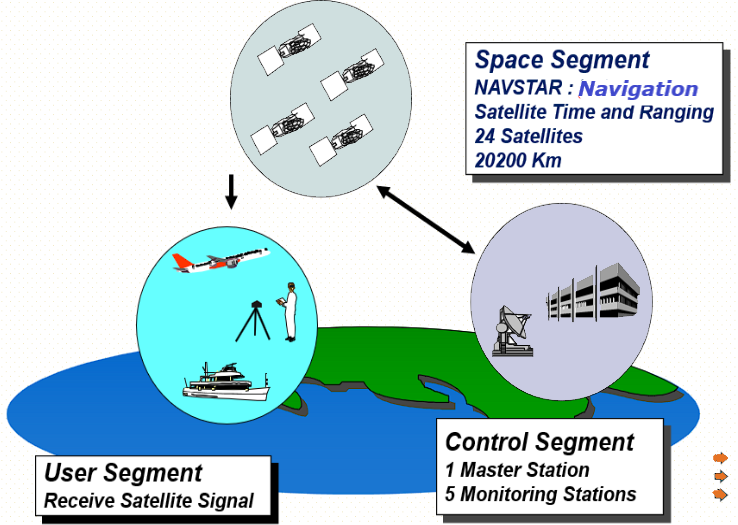


**Fig 2: Differential geographic positioning system (Base, Rover Station & Controller)**

Furthermore, GNSS plays a crucial role in scientific research, environmental monitoring, and tele-communications. Whether navigating city streets or conducting complex scientific measurements, GNSS remain at the forefront of modern navigation solutions (Vetrella et al, 2016, Li et al., 2025, Weng et al, 2025).

**Geographical** **Positioning System: (GPS)**

GNSS is an aligning arrangement of a network of satellites that uninterruptedly transmit coded information. The transmitted information is received by receivers to exactly recognize locations on earth by measuring distances from the satellites(Kim et al, 2017[9], Gao et al, 2023[10].



**Fig 3: Various Global Positioning Segments (Space, User and control segment)**

The Global Positioning System (GPS) is a U.S. maintained usefulness that provides users for positioning, navigation, and timing (PNT) services. The GPS is composed of three main segments: the Space Segment, the Control Segment, and the User Segment. The Space Segment consists of GPS satellites orbiting Earth, the Control Segment manages and monitors those satellites, and the User Segment comprises GPS receivers that receive signals from the satellites to determine location

GPS has many advantages over Traditional Terrestrial Surveying Techniques which rely on line of sight between the survey instrument and a target with high geodetic accuracy, indiscriminate reception place, three dimensional and free. On existence of obstructions the survey work can be carried by traverse method. GPS is widely used for navigation, mapping, and tracking, but it does have few limitations i.e. Signal obstruction (urban canopy, Dense Forests and Tunnels, Indoor), heavy rain, solar storms, Electronic Interference, Jamming and Spoofing. GPS adds to advanced frame work in blockchain, internet of things ( IoT) and in artificial intelligence (AI), in emergency handling and public safety arrangements, Mekik et al, 2009[11], Majumdar et al, 2025[12]

**Sources of error in GNSS:**

The errors incorporated in GNSS system are Satellite errors (orbit uncertainty and satellite clock model), Receiver errors (Receiver clock and noise), observation errors (Ionospheric delay and Tropospheric delay) and station error(station co-ordinates, Signals effect error and multipath). To avoid these large cumulative errors, the Differential GPS/GNSS is incorporated (IIRS – E book- 2023[13]).

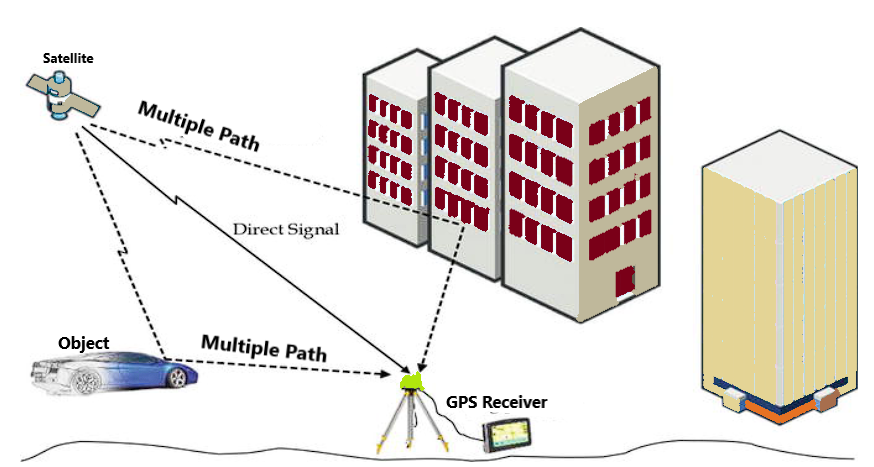
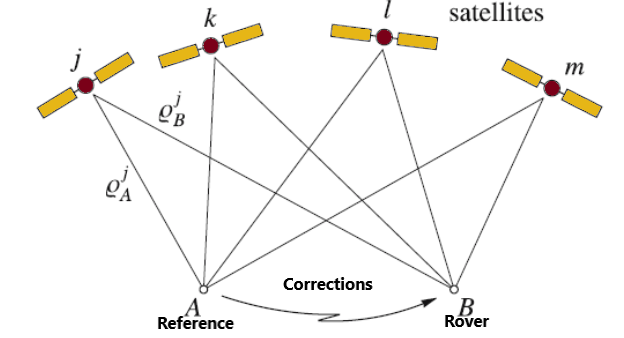
a.b.

Fig 4 (a-b): (a) Various corrections in satellite installation in GNSS like multipath etc.

**DGNSS:**

The GNSS is available globally and free to use by civilian, without any cost. Some errors incorporate to the information by single point positioning due to satellite clock error, orbital error, ionospheric delay, tropospheric delay, receiver clock error and partially multipath error. These errors can be purged by Differential Global Navigation Satellite System (DGNSS). DGNSS is an enhancement of standard GNSS, which has improved accuracy, integrity, and reliability by using a network of fixed ground-based reference stations.

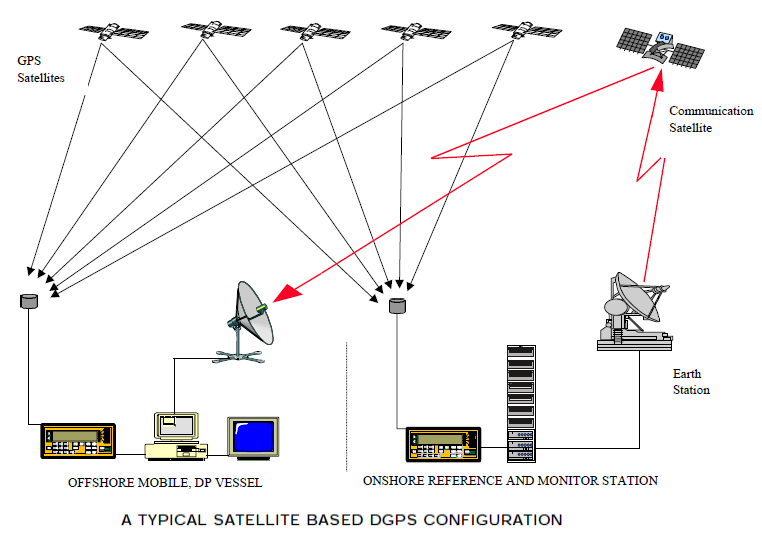


Fig 5: A typical satellite based DGNSS with onshore/ offshore stations.

GNSS addresses the drawbacks by using ground-based reference stations, also known as base stations, and that broadcast corrections to GNSS signals with position accuracy (Krasuski et al, 2021[14], Bakul et al, 2022[15], Spchet, 2023[16]

These reference stations are positioned at precisely known locations. They monitor uninterruptedly the GNSS received signals and calculate the errors present in those signals. The error information is then transmitted to DGNSS-enabled rover receivers in the field. DGNSS.

These instruments often consist of a GNSS receiver, a data processing unit to apply the corrections, and a communication link to receive the correction data from the reference station (Table 1).

**Advantages/disadvantages of DGNSS:**

The advantages of DGNSS are increased positioning Accuracy, offering centimetre-level precision, popular and , wide availability, Real-time Positioning: Many DGNSS systems provide real-time corrections, high-accuracy positioning for time-sensitive applications, Enhanced Reliability in data positioning data and versatile applications (Preety et al, 2022[18], Chilab et al, 2023[19]). The disadvantages of DGNSS are Requires Correction Signal, unavailable in remote or obstructed areas, increased initial equipment Cost, potential for signal interference, limited range, and complex (Biswas et al, 2022[20]). The GNSS survey includes testing different positioning survey can be of two types static and Kinematic in GNSS (Dardanelli et al, 2021[21], Alkan et al, 2025)[22].

**Time-Based Surveying with DGNSS:**

The time of the extent is the receiver time of the acknowledged signals. The accuracy in receiving satellite information the timing is critical. They should maintain correct time called real time and differential correction is to be incorporated to get the most processioned information. The surged accuracy improves to 1-3cm from 15m in case of Single point positioning by GNSS is 3-5m. and can have application in case of land surveys, geodetic and hydrographic surveys. They can also be used for structural health monitoring, precession farming and disaster monitoring like earth quakes, Volcanic eruption, and landslides, etc (SOI 2009).

Table 1: Budgeting of GNSS error in the atmosphere in meters

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Error | Ionosphere | At. Clock | Ephemeris | Troposphere | Receiver | Multipath | Total |
| Value (m) | 4.0m | 2.1m | 2.1m | 0.7m | 0.5m | 1.0m | 10.4m |

Source: Maj Gen. R C Padhi; https://orsac.odisha.gov.in/pdf/GNSS-and-DGNSS.pdf

**Pseudo Range (PR):** The PR (in meters) is the distance between the receiver antenna and the satellite antenna together with receiver and satellite clock offsets including atmospheric delays. Mathematically; o that the PR reflects the real-time (stored in m) behaviour of the receiver and satellite clocks. Where, the measured range between the satellite and receiver. D**istance**: True geometric distance between the satellite and the receiver, Velocity ( C ) is the Speed of light (299,792,458 meters per second (m/s), Receiver clock offset (error in receiver's time). Satellite clock offset (error in satellite's time). The **other biases**: Includes ionospheric delay,tropospheric delay, multipath errors, hardware delays, etc.

**PARTS OF DGNSS:**

For DGNSS survey we need minimum two receiver antenna, one is for Base Station and one or more Rover Station. The various components are GNSS Satellites (A constellation of satellites orbiting Earth, transmitting signals for location determination), Base Station (Reference Station), Rover Receiver (A mobile GNSS receiver used in the field to control position, receiving satellite signals and correction data) (Fig 3). Communication Link, and Data Processing Unit: Hardware or software in the rover that applies the corrections received from the base station to improve the accuracy of its position. Antennas, power supplies, soft wares for all station/rovers, data storage and mounting equipment’s used for fixing.

**Why DGNSS:** The absolute position determination with GNSS is less accurate than relative positioning between two stations. Error sources in GNSS location includes the strata in atmosphere, satellite problems, and in the receiver also. These errors can introduce delay and distortion GNSS signals, that affect the accuracy and efficiency. These acting errors (biases) where the error occur are of three categories:

1. *Errors related with distance* : mainly ephemeris and propagation errors, are nearly the same for neighbouring stations, as long as they are sufficiently close, and hence disappear in the differences.
2. *Errors related with time* : are coped with by synchronized or nearly simultaneous observations.
3. *Uncorrelated errors*: affect both participating stations and need a calibration

**Corrections in DGNSS:** The reference station commonly calculates pseudo range corrections (PRC) and range rate corrections (RRC) which are transmitted to the remote receiver in real time. The remote receiver applies the corrections to the measured pseudo ranges and performs point positioning with the corrected pseudo ranges. The use of the corrected pseudo ranges improves the position accuracy with respect to the base station.

**The Applications OF DGNSS**  are precision agriculture (Guiding tractors for precise planting, spraying, and harvesting, optimizing crop yields and reducing resource waste), construction surveying (for accurate positioning for construction layout, ensuring buildings and infrastructure are built according to design specifications, Hydrographic Surveying: Marine Navigation, Aviation, Mapping underwater ( navigation, dredging, and coastal zone management). The other applications are geographic Information Systems (GIS): Autonomous Vehicle Navigation, etc. Gleason et al., 1996[22

**Objectives:**

There exist three types of DGNSS survey. The objective of the work is to find out

1. The Basic ideas about DGNSS (Differential global navigation satellite system)
2. To find out the accuracy of three types of survey(Static, PPK and RTK)
3. To find the accuracy obtained based on timing of observations.

**Methodology**

Data Collection & Processing Timing Requires long observation times (minutes to hours, depending on baseline length and required accuracy) and all data processing happens in the post-processing stage. The receiver remains stationary for the entire observation. Provides real-time centimetre-level accuracy by static and PPK method of survey. Collects raw GNSS data at both the base station and rover. No real-time communication is involved during the observation phase. The base station data is downloaded later for post-processing. All data processing occurs post-mission using specialized software. The rover receives corrections from a base station via a radio link and calculates its position on-the-fly, during the data collection process in RTK. May or may not require static initialization, depending on the specific RTK approach. RTK requires a continuous, reliable radio/cellular data link to transmit corrections from the base station to the rover in real-time for **base station communication**.

***Methodology For Static Survey:***  Static GNSS (Global Navigation Satellite System) surveying is a precise technique used in geodesy, engineering, and cadastral applications to determine accurate positions by collecting data over long observation periods. It involves Set up for Site Selection includes a location with a clear, unobstructed view of the sky for optimal satellite signal reception. Avoid areas near tall buildings, under tree canopies or foliage, inside buildings or under roofs, under the power lines for better accuracy of points. The survey is started with Trimble access being connected with base and rover station. After completion of survey all information/ data are backed up for later processing by Trimble Business Center. (TA: Trimble Access’ software and Trimble Business Centre (23)) .

***Methodology For PPK Survey***

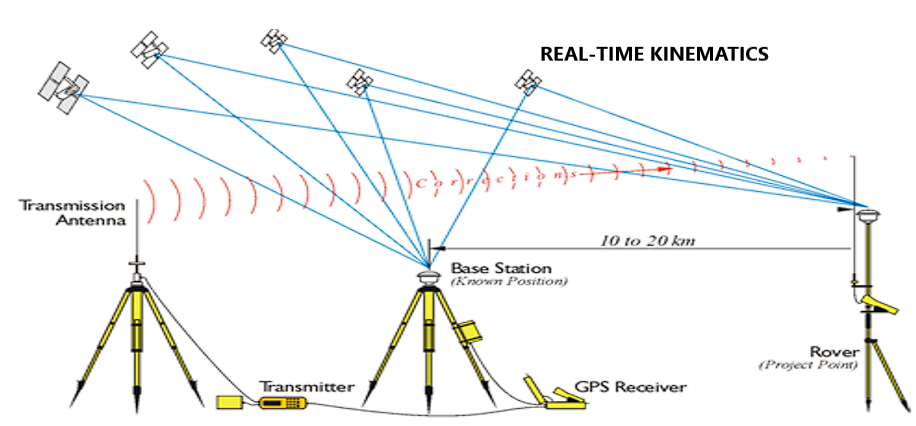
PPK (Post-Processed Kinematic) GNSS surveying is a technique that allows for high-accuracy positioning by recording GNSS data at both a base station and a rover, then correcting the rover's positions after the survey using post-processing software. **Base station** records GNSS data at a known location. **Rover (mobile receiver)** collects data at unknown positions (e.g., UAV flight path or land points). After data collection, the rover’s data is corrected using the base station's data in **post-processing software**, correcting for satellite and atmospheric errors. Unlike RTK, it doesn't require a real-time link. After fieldwork, data from both is processed together to apply differential corrections. PPK is robust against signal interruptions and works over longer distances. Although post-processing is needed, it's ideal for high-precision applications where real-time accuracy isn't critical. This makes it suitable for aerial surveys, mapping, and challenging environments.

There requirement for uninterrupted site selection, proper levelled and stable base station set up, and Rover set up with well-connected receiver, antenna, and data collector. The set up must have proper power connection, data collector system. The completion of survey all information/ data are backed up and start processing (Shao et al. 2015[24], Cirillo et al., 2022[25], Chao et al. 2023[26])

Various applications of PPK survey are Various application of PPK survey are Land and topographical surveys, Construction site layout, Aerial mapping using drones, Pipeline and utility surveys and Monitoring earthworks and infrastructure projects

B. ***RTK SURVEY***: RTK (Real-Time Kinematic) survey is a DGNSS technique providing centimetre-level accuracy in real-time. A base station transmits corrections to a rover, enabling instant, precise positioning. It requires a constant communication link, typically radio, between base and rover. RTK is efficient for surveying and construction needing immediate results. However, its performance depends on signal strength and short distances. Obstructions can degrade accuracy, but its speed and precision are valued for many tasks.

The applications are *Land Surveying* (Boundary mapping, property surveys, and topographical surveys, *Construction:* Site layout, road alignment, and excavation control, *Agriculture:* Precision farming, planting, and irrigation layout, Aerial *Mapping*: Used with drones to geotag images for photogrammetry, and Utilities and Infrastructure: Pipeline and utility alignment surveys.



**Fig 6: The satellite constellation in Real time kinematics (RTK)**

The appraisal among the three methods of DGNSS survey applications by Static, PPK (Post processed kinematics) and RTK (Realtime kinematics) in GNSS Survey is in Table 2.

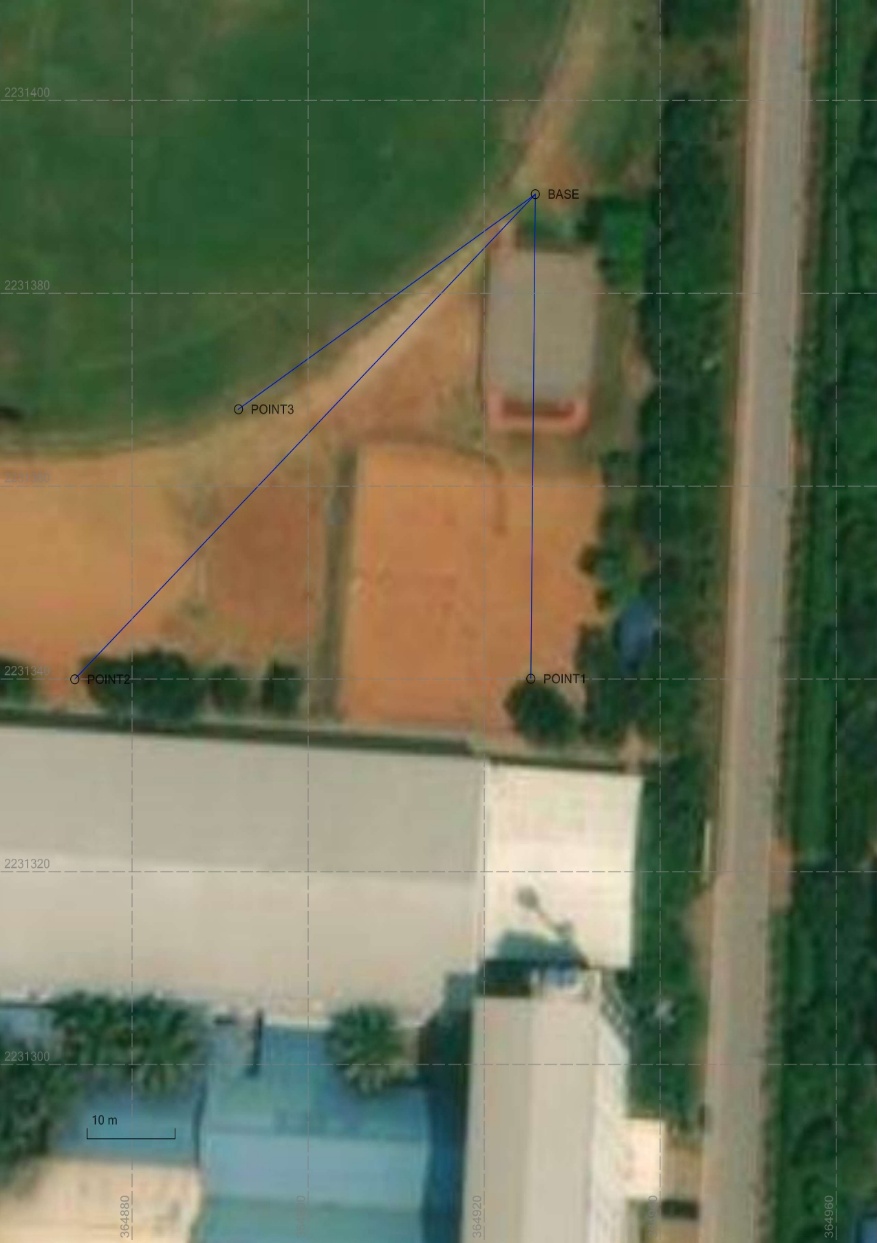
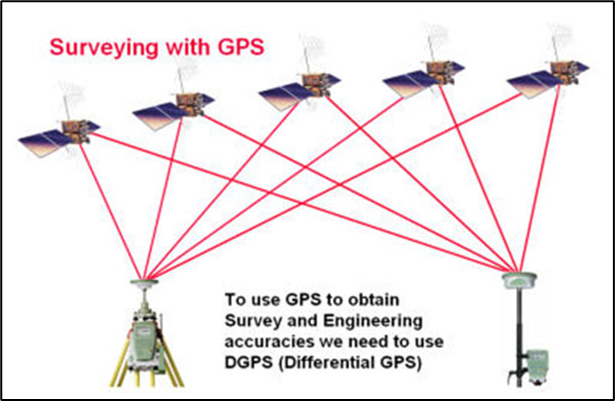
Table 2: Difference Between Various survey methods in GNSS ( STATIC, RTK & PPK)

|  |  |  |  |
| --- | --- | --- | --- |
| **Aspect** | **STATIC** | **RTK** | **PPK** |
| Accuracy/ reliability | Highest (mm- Sub-cm) | Very High | High (cm level) based on signal/data link quality) |
| Horizontal/Vertical Accuracy | ± 2–5 mm + 0.5 ppm /± 5–10 mm + 1 ppm | ± 2–5 mm + 0.5 ppm/  ± 5–10 mm + 1 ppm | NA |
| Obsn. Time needed | Long observation time (15 min or more | Real-time (instant) | Continuous/ record in fly, OT -Short (sec-min) |
| Processing time | Hours (post-processing needed) | Minutes to hours (post-processing) | Instant |
| Need Set up (GNSS) Receiver/ base station need, Link Communiqué | Base and Rover stn. for a long period; BS needed; No communication link | Need; operating reference stn (CORS). (radio, NTRIP,), communiqué linked; | continuous Operating reference stn. (CORS). Rover moves with data reception, No link |
| GNSS Receiver | Dual frequency (DF) | DF + RTK-enabled | DF + Onboard Logging |
| Data processing | Postprocessed | Real Time | Faster post-processing |
| Advantages (Pros) | Geodetic/ tectonic monitoring; Highest accuracy; great for long baselines. | High accuracy; no need for real-time data link. | Drone mapping, Topographic survey; Real-time results; fast and efficient |
| Disadvantages | More Time, needs post-processing | Post-processing need; setup complex | Requires communication link; range-limited |
| Distance Cover  a. Baseline range  b. Suitability for remote area | a. 10-100s km  b. Excellent | a. <20km(more with RTK network)  b. Limited (if no communication link) | a.<40kmcan be longer with good data  b. Excellent |
| Ambiguity Resolution | Longer observation times, grow success rate/ reliable in doubt resolution. | Initialization time is needed to solve ambiguity. | Post-processing, and longer processing times for better accuracy/ reliability, even with short observation times. |
| Movement & Dynamics | The rover receiver must remain stationary over each point for the entire observation period. | Used in kinematic model, continuous positioning while the rover is in motion requiring Static initialisation. | Best for kinematic applications, provide accurate positioning even when the rover that require Static initialisation . |
| Typical Applications | Creating control networks, warp monitoring, high-accuracy geodetic surveys where high accuracy is needed, and time isn't a major constraint. | Stakeout, topographic surveys, construction layout, and other applications where real-time positioning is essential. | Aerial/ drone mapping), mobile mapping, areas with poor communication coverage, situations for high accuracy but real-time processing is not required. |
| Best for | Long baselines, long observations | Real-time stakeouts, topo surveys | UAV, dynamic surveys without real-time corrections |
| Min: Minute ; Hrs: Hours; CP’s: Control points, BS: Base station RS: Rover Station | | | |

Source of information : SOI manual published from time to time [21]

**FIELD WORK:**

Four locations were practical work. We measure these four points with DGNSS in STATIC mode one-hour, STATIC mode 30 minutes, RTK mode 10 minutes, PPK mode 10 minutes. Then we process the data in TBC (Trimble Business Centre). We put the known co-ordinate in Base Station co-ordinate then process the baseline accompanying others processing and print the map.

a.b.

c.d.

**Fig 7 : The field observations at the field of CUTM (a) with fixing rover with bipod**

**RESULTS:**

*List 1 : TIME BASED COMPARISION*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **1 HOUR OBSERVATION** | | **30 MINUTES OBSERVATION** | |
| **POINT NAME** | **LATITUDE** | **LONGITUDE** | **LATITUDE** | **LONGITUDE** |
| BASE | N20°10'30.57900" | E85°42'26.54327" | N20°10'30.44993" | E85°42'26.57772" |
| POINT1 | N20°10'28.94265" | E85°42'26.53903" | N20°10'28.81324" | E85°42'26.57431" |
| POINT2 | N20°10'28.92774" | E85°42'24.75236" | N20°10'28.81169" | E85°42'24.89789" |
| POINT3 | N20°10'29.84439" | E85°42'25.38622" | N20°10'29.71527" | E85°42'25.42130" |

**List 2 : COMPARISION BETWEEN STATIC, RTK & PPK**

***STATIC***

|  |  |  |
| --- | --- | --- |
| POINT NAME | LATITUDE | LONGITUDE |
| BASE | N20°10'30.44993" | E85°42'26.57772" |
| POINT1 | N20°10'28.81324" | E85°42'26.57431" |
| POINT2 | N20°10'28.81169" | E85°42'24.89789" |
| POINT3 | N20°10'29.71527" | E85°42'25.42130" |

***RTK***

|  |  |  |
| --- | --- | --- |
| **POINT NAME** | **LATITUDE** | **LONGITUDE** |
| BASE | N20°10'30.44546" | E85°42'26.57997" |
| POINT1 | N20°10'28.81055" | E85°42'26.57578" |
| POINT2 | N20°10'28.79340" | E85°42'24.78890" |
| POINT3 | N20°10'29.71043" | E85°42'25.42411" |

***PPK***

|  |  |  |
| --- | --- | --- |
| **POINT NAME** | **LATITUDE** | **LONGITUDE** |
| BASE | N20°10'30.63007" | E85°42'26.53351" |
| POINT1 | N20°10'28.99480" | E85°42'26.52866" |
| POINT2 | N20°10'28.97888" | E85°42'24.74370" |
| POINT3 | N20°10'29.89545" | E85°42'25.37753" |

**Discussion:**

*The difference between the coordinates of those points is:*

1. The coordinates of Base station in one hour observation are N20°10'30.57900" Lat. & E85°42'26.54327" Long. and in 30 minutes observation is N20°10'30.44993" Lat. & E85°42'26.57772" Long. The difference between two Latitude is 00°00’00.12907” second and Longitude -00°00’00 .3445”. The difference is very minimal.
2. The coordinates of Point1 in one hour observation is N20°10'28.94265" Lat. & E85°42'26.53903" Long. And in 30 minutes observation is N20°10'28.81324" Lat. & E85°42'26.57431" Long. The difference between two Latitude is 00°00’00.12941” second and Longitude -00°00’00.3528”. The difference is very minimal.
3. The coordinates of Point2 in one hour observation is N20°10'28.92774" Lat. & E85°42'24.75236" Long. And in 30 minutes observation is N20°10'28.81169" Lat. & E85°42'24.89789" Long. The difference between two Latitude is 00°00’00.11605” second and Longitude -00°00’00.14553”. The difference is very minimal.
4. The coordinates of Point3 in one hour observation is N20°10'29.84439" Lat. & E85°42'25.38622" Long. And in 30 minutes observation is N20°10'29.71527" Lat. & E85°42'25.42130" Long. The difference between two Latitude is 00°00’00.12912” second and Longitude -00°00’00.3508”. The difference is very minimal.

The difference in the co-ordinates in latitude and longitude is minimal in fractions of a second which can be neglected.

*The difference between the coordinates of these three points in STSTIC RTK & PPK mode are*

1. The coordinates of Base station in STATIC observation is N20°10'30.44993" Lat. & E85°42'26.57772" Long. And in RTK observation is N20°10'30.44546" Lat. & E85°42'26.57997" Long. And in PPK observation is N20°10'30.63007" Lat. & E85°42'26.53351". The difference is very minimal.
2. The coordinates of Point1 station in STATIC observation is N20°10'28.81324" Lat. & E85°42'26.57431" Long. And in RTK observation is N20°10'28.81055" Lat. & E85°42'26.57578" Long. And in PPK observation is N20°10'28.99480" Lat. & E85°42'26.52866". The difference is very minimal.
3. The coordinates of Point1 station in STATIC observation is N20°10'28.81169" Lat. & E85°42'24.89789" Long. And in RTK observation is N20°10'28.79340" Lat. & E85°42'24.78890" Long. And in PPK observation is N20°10'28.97888" Lat. & E85°42'24.74370". The difference is very minimal.
4. The coordinates of Point1 station in STATIC observation is N20°10'29.71527" Lat. & E85°42'25.42130" Long. And in RTK observation is N20°10'29.71043" Lat. & E85°42'25.42411" Long. And in PPK observation is N20°10'29.89545" Lat. & E85°42'25.37753". The difference is very minimal.

The comparison of DGNSS static survey coordinates with one-hour versus 30-minute observation times reveals minimal discrepancies. Latitude differences range from 0.116" to 0.129", while longitude differences span -0.146" to -0.353". This consistency suggests that reducing the observation time to 30 minutes may be viable in similar conditions without significant loss of accuracy. However, this depends on factors like satellite geometry, atmospheric conditions, equipment, and the desired accuracy. Further investigation is advised to confirm this finding for broader applicability. A shorter duration will save on field time and resources Mc, Mohan et al 2021[29], Zhang et al. 2024[30].

Coordinate comparisons between Static, RTK, and PPK DGNSS methods reveal "very minimal" differences. While all provide reasonable consistency, the choice depends on project needs. Static offers highest accuracy, RTK balances speed and precision, and PPK suits environments lacking real-time links. Variations reflect method-specific error characteristics and factors like atmospheric conditions. Project tolerances must guide method selection. Acknowledging these minimal differences remains crucial in ensuring appropriate application and data reliability. Analysis preprints highlighting the different problems and challenges allied with the GNSS receivers. Its appropriate use and best combination to receive accurate and exact data Diouf et al. 2024[31].

**Conclusion:**

In summary, DGNSS observation time tests (30 vs. 60 minutes) showed minimal coordinate differences, suggesting reduced times may be viable. Comparing Static, RTK, and PPK methods also revealed "very minimal" differences, yet method selection depends on project needs. Static offers the highest accuracy, RTK balances speed and precision, and PPK is suited to environments lacking real-time communication links. Key factors influencing accuracy include atmospheric conditions, satellite geometry, and equipment. Acknowledging and understanding method-specific error characteristics remains crucial for reliable data.

In DGNSS survey more time can provide more accuracy in STATIC mode. And STATIC, RTK & PPK mode has different usages and different advantages.The results in case of various methods of DGNSS Survey are:

• Static: Best for high-precision control over long distances and non-time-sensitive applications.

• PPK: Ideal for mobile mapping or UAV surveys where real-time corrections are not available.

• RTK: Best for real-time applications in short-to-medium range, such as construction, Topo surveys, and precision farming.

**Disclaimer** (Artificial intelligence): Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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