# Report on GNSS Training
# Course ID: T151-40

# Team No: 10


**Team Members:**

Baghel, Triambak

Kerenart, Chayanut

Venkatesha, Praveena

Villanueva, Jara

Widyantoro, Bayu


Training held at GIC/AIT, Thailand
6 – 10 JAN 2020

**Table of Contents**

## Table of Contents

## Table of Figures

# 1. TEAM 10

## 1.1. EXECUTIVE SUMMARY

This five-day GNSS training aims to teach an in-depth understanding of GNSS through conceptual lectures, intensive data collection using both high-cost and low-cost GNSS receivers, and post-processing using various post-processing techniques.

Specifically, we carried out the data collection using high-end receivers and compared them against the results of low-cost GNSS receivers using different post-processing techniques such as SPP (Single Point Positioning), dGPS (Differential Global Positioning System), and RTK (Real Time Kinematic) . RTKLIB, an open source software package developed by Tomoji Takasu, was primarily used in the post-processing procedures. Different settings and parameters were also tested to achieve optimal results. RTK using android was also introduced on the last day of training. RTKDroid, an android app developed by Avinab Malla, features a real time correction of the acquired data. Low-cost GNSS receivers were also used to test the app.

## 1.2. TEAM MEMBERS


*Figure 1. Team 10 Members. From L-R: Bayu Triyogo, Jara Villanueva, Chayanut Kerenart, Triambak Baghel, Praveena Venkatesha*

1. Bayu Triyogo Widyantoro, Center for Geodetic Control Networks and Geodynamics, The Indonesia Geospatial Information Agency (BIG), Cibinong, Indonesia
   *Email: bayu_triyogo@yahoo.co.uk*
2. Chayanut Kerenart, Survey Engineering and Geographic Information Student,Department of Civil Engineering,Kasetsart University,Bangkok,Thailand.
   *E-mail : Chayanut_k@hotmail.com*
3. Jara Villanueva, STAMINA4SPACE Program, University of the Philippines, Diliman, Quezon City
   *Email:jsvillanueva2@up.edu.ph*
4. Praveena Kumara Venkatesha, Research Scholar, Department of Geology, School of Earth Sciences, Central University of Karnataka, Kalaburagi, Karnataka, India
   *Email: praveenakumarav@gmail.com*
5. Triambak Baghel, Ph.D. Student, Water Engineering and Management (WEM), Asian Institute of Technology (AIT) Bangkok, Thailand
   *Email: baghel.triambak21@gmail.com*

## 1.3. INTRODUCTION

This training focuses on the use of GNSS technology in practical applications. Lectures covering GNSS concepts and theory were conducted briefly on the firs few hours of the training, while most of the time were spent on data collection and post-processing.

In order to familiarize the team with the data collection method, hardware and software used, and the processing techniques needed for a wide range of GNSS applications, the team conducted conducted three main tasks: data collection and post-processing using RTKLib and comparison of SPP and RTK method, data post-processing of data obtained from high-cost and low-cost GNSS receivers using SPP, dGPS, and RTK post-processing techniques in RTKLib, and data collection and post-processing using RTKDroid. The following items discuss in details the three main tasks conducted during the entire duration of the training.

### 1.3.1. Data Collection and Post-Processing Using RTKLib: Comparison of SPP and RTK


*Figure 2. Fieldwork set-up for data collection (Static)*

For the static set-up, u-blox M8T was used and observed for 25 minutes. The data was plotted and analyzed using RTKLib. Results of the SPP and RTK post-processing is shown below, with hundred percent of the SPP is in Q5 or Single Solution and RTK is in a hundred percent Q2 or float solution.

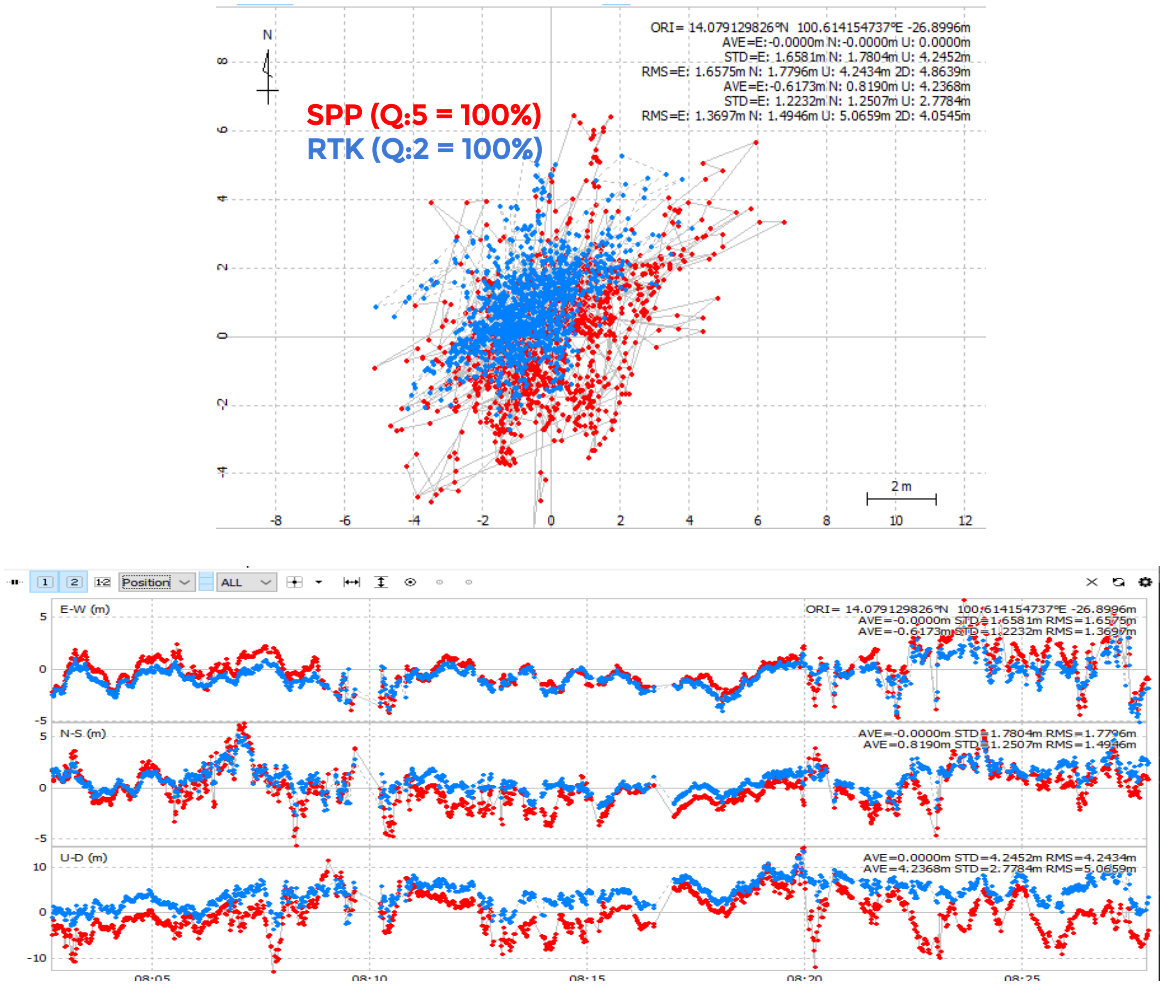


*Figure 3. (Top) Grnd Trk Plot for static data collection using M8T while (Bottom) shows the Position Plot of the data*

For the second half, the team also tried to collect data by moving the receiver through a straight path.

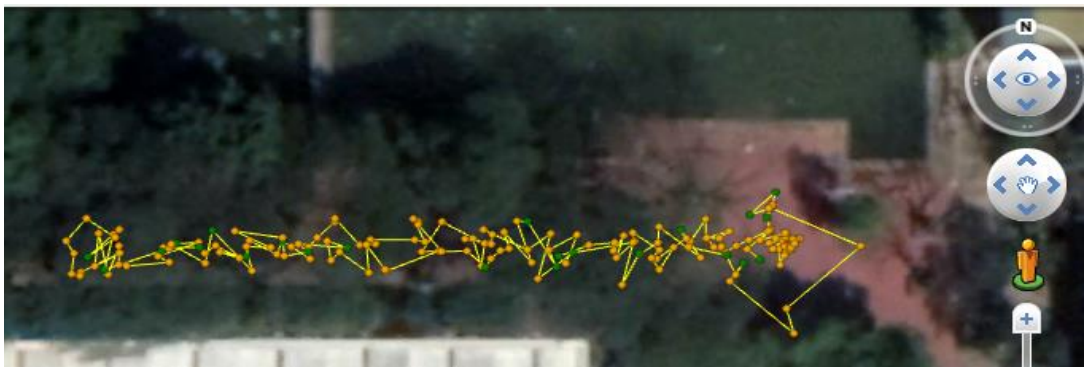

*Figure 4. Google Earth View of the path taken observed with M8T*

Similar to the previous one, the data was also processed using SPP and RTK. Results are shown below with the a hundred percent of the SPP in Q5: Single solution and for RTK, 13.5 % is fixed and 86.5% is float.

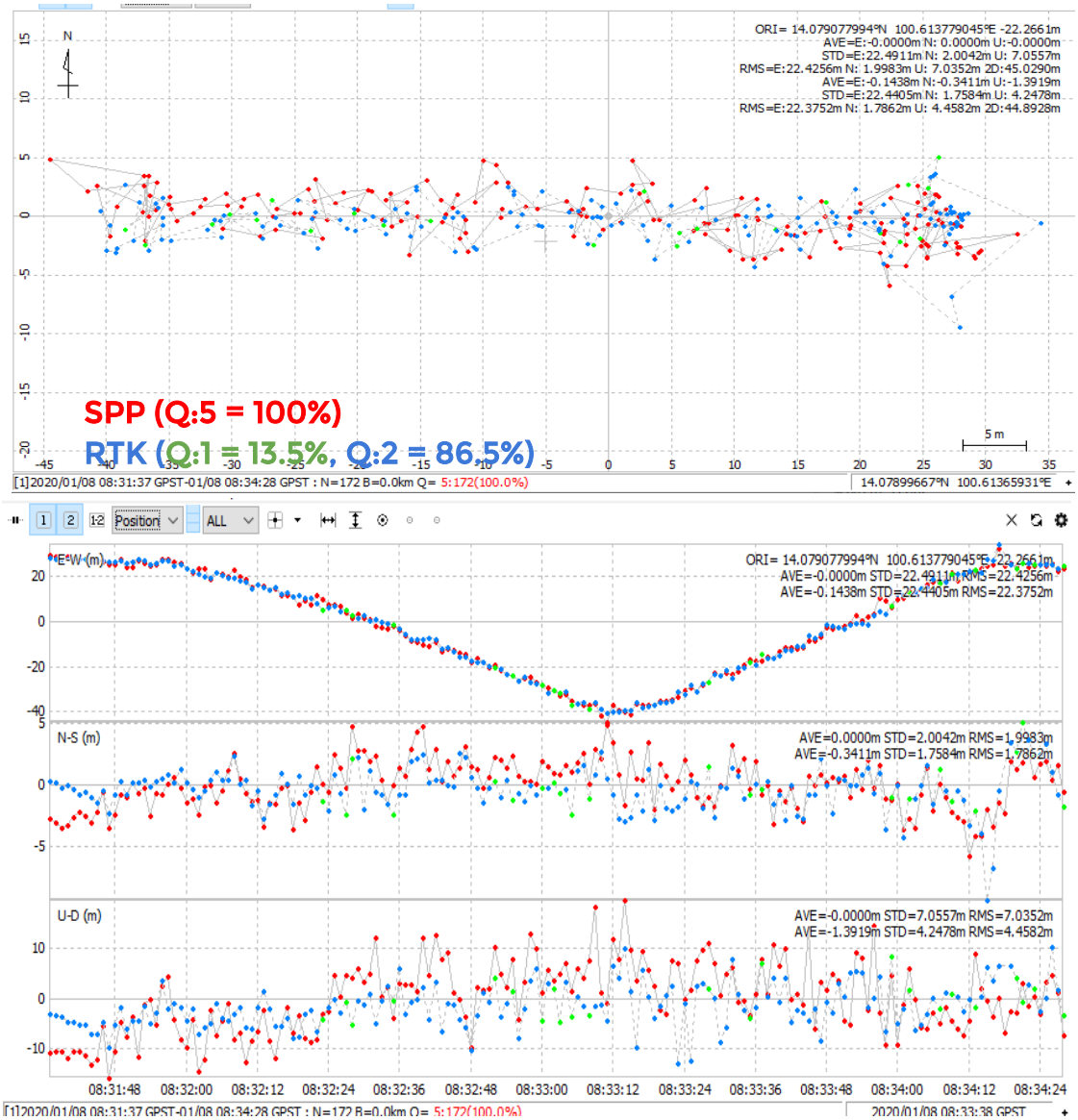


*Figure 5. (Top) Grnd Trk Plot for dynamic data collection using M8T while (Bottom) shows the Position Plot of the data*

### 1.3.2. Data Post-Processing of High-Cost and Low-Cost GNSS Receivers using SPP, dGPS and RTK Techniques

This activity aims to assess the difference between a high-cost and low-cost GNSS receivers and the different post-processing techniques which include SPP, dGPS, and RTK. For high-

cost GNSS receiver, NetR9 data was used while for low-cost GNSS receiver, u-blox M8T data was used. Results are shown below.

**A. SPP**

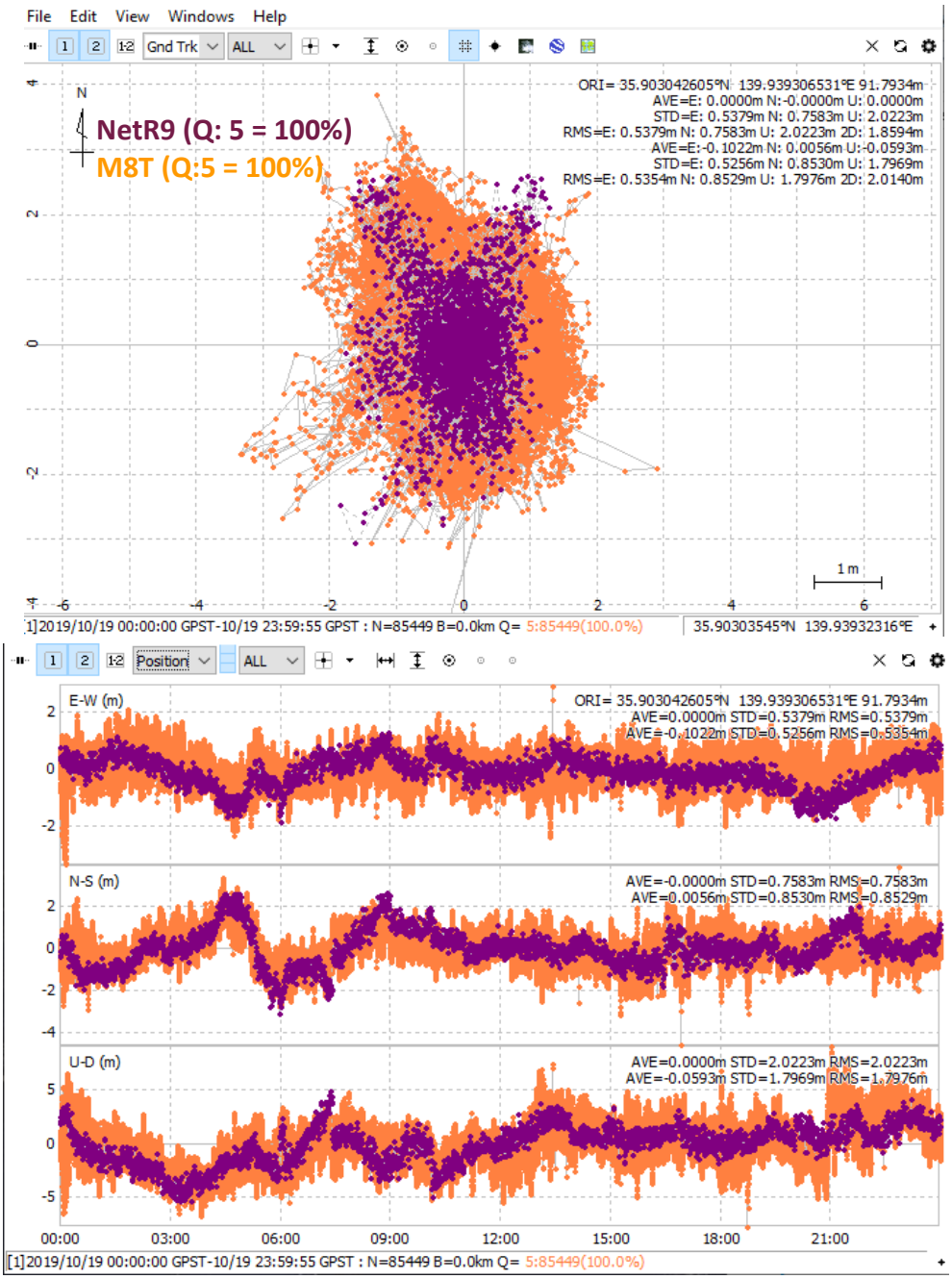


*Figure 6. (Top) Grnd Trk Plot for NetR9 and M8T while (Bottom) shows the Position Plot comparison of both datasets*

While both datasets are a hundred percent in Q5 solution, it can be noticed from the graph that Netr9 data has a more clustered solution which may indicate a higher precision value.

**B. DGPS**

For the dGPS, the solution was improved to a hundred percent float solution with lower values of standard deviation as shown below.

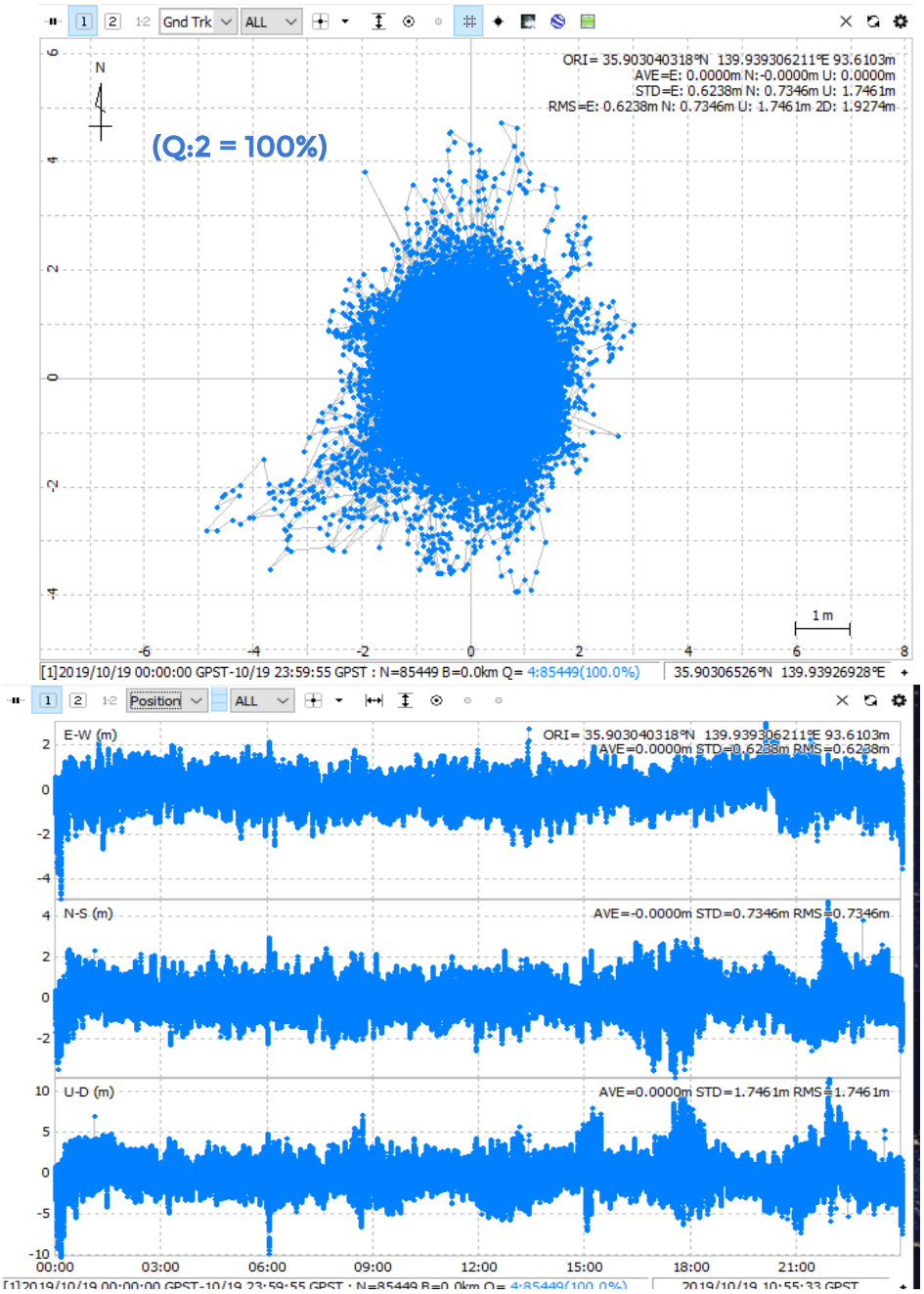


*Figure 7.(Top) Grnd Trk Plot for dGPS solution while (Bottom) shows the Position Plot of the data*

### C. RTK

The third post-processing technique tested is the RTK method. The solution output in this technique yielded a 13.5 % fix solution and 86.5% float solution which is an improvement from the SPP and dGPS methods.

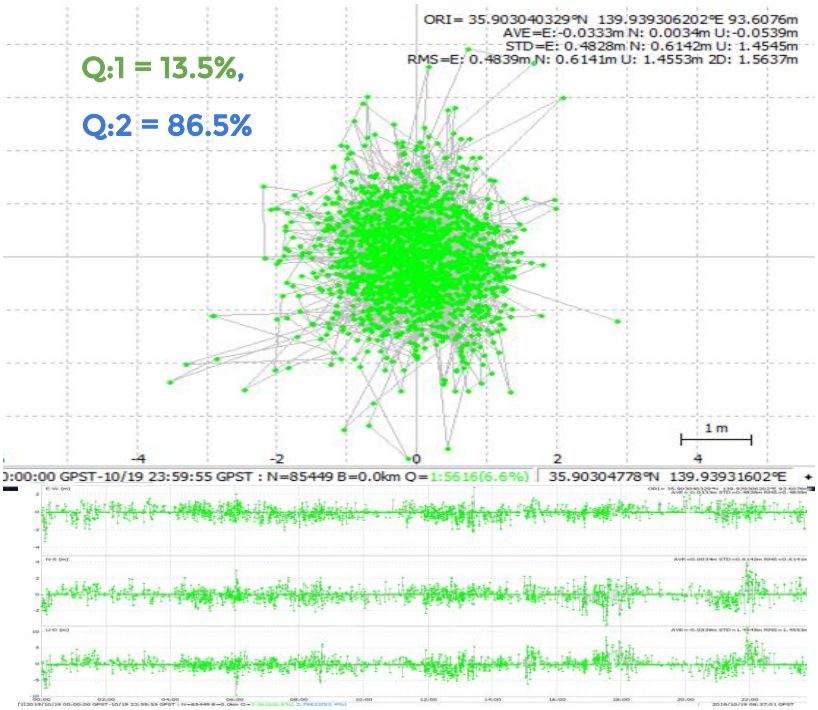


*Figure 8.(Top) Grnd Trk Plot for RTK solution while (Bottom) shows the Position Plot of the data. The graphs only show the Fix solution data*

### 1.3.3. Data Collection and Post-Processing Using RTKDroid


*Figure 9. Fieldwork set up using android in RTK data collection*

The last task was conducting a GNSS data collection using RTKDroid, an android phone app, with the receiver and antenna attached. The use of this tool is relatively easier and more convenient since it already collects and processed the data in real time, with outputs saved in the phone immediately.

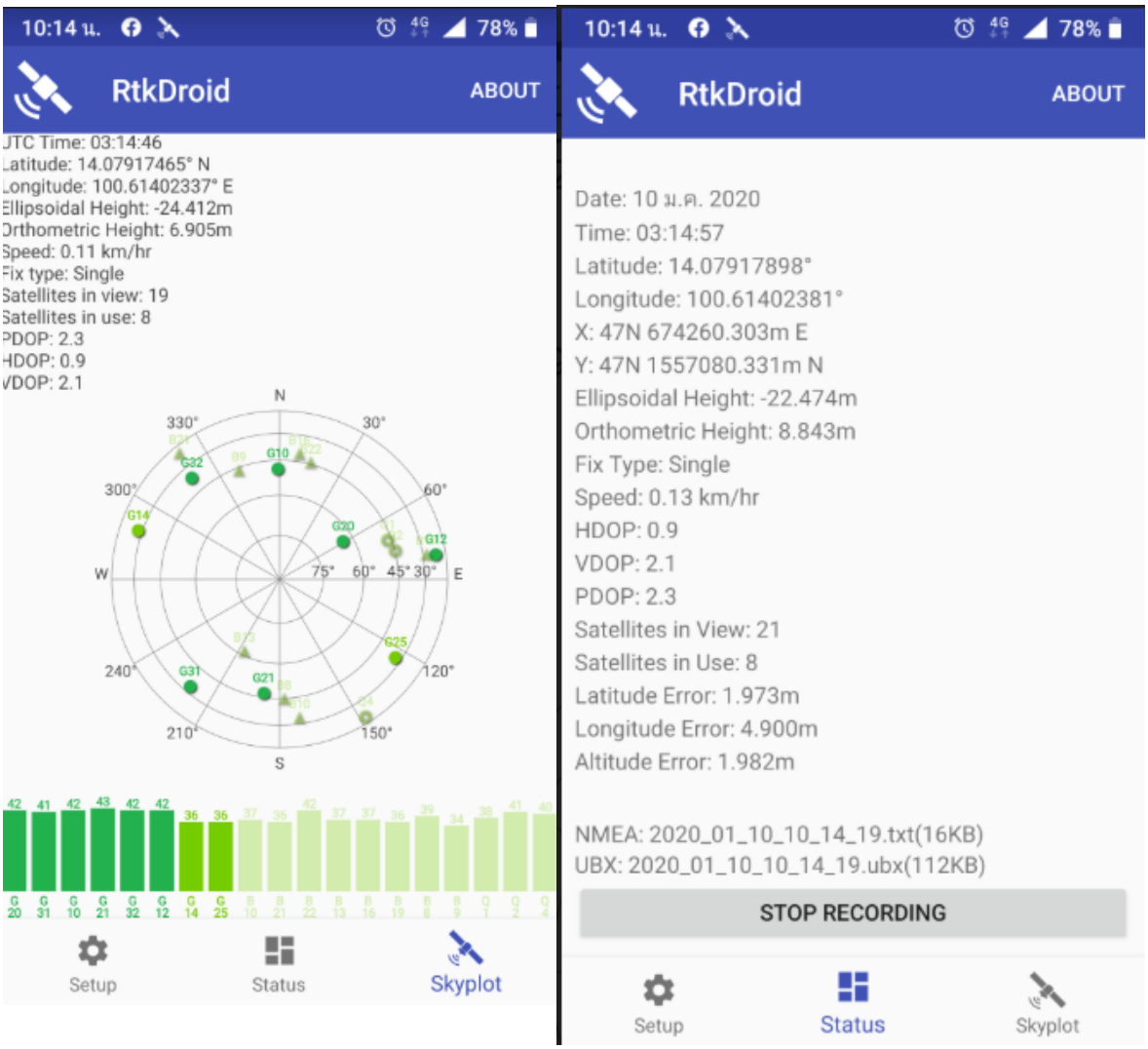


*Figure 10. User Interface of the RTKDroid app*

### 1.4. SUMMARY OF RESULTS FOR COMPARISON OF SPP, DGPS AND RTK POST-PROCESSING TECHNIQUES

To comprehensively analyze and compare the results from the post-processing of NetR9 and M8T data using SPP, dGPS, and RTK techniques, the standard deviation values and CEP (circular error probable) computed from the processed outputs are tabulated and analyzed. Results are shown below.

*Table 1. Summary of results for SPP, dGPS, and RTK post-processing*

| | SPP (M8T) | SPP (NetR9) | DGPS | RTK |
|---|---|---|---|---|
| **σX** | 0.647898 | 0.570189 | 0.392341 | 0.367857 |
| **σY** | 0.505637 | 0.378705 | 0.284688 | 0.266757 |
| **σZ** | 0.516354 | 0.382769 | 0.295145 | 0.275601 |
| **σY/σX >0.3?** | 0.780427 | 0.664175 | 0.725614 | 0.725166 |
| **CEP (0.62*Y+0.56*X)** | 0.676318 | 0.554103 | 0.396217 | 0.371389 |

Based from the results, between M8T and NetR9, the high-cost GNSS receiver NetR9 has a lower standard deviation and CEP values compared to M8t which is a low-cost GNSS receiver. Whereas all in all, amongst the techniques SPP, dGPS, and RTK, the method which gives the lowest standard deviation and CEP values is the RTK for this particular dataset.

### 1.5. RECOMMENDATIONS

The objective of this training emphasized the GNSS data collection and processing. The team fulfilled it by carrying out different data collection procedures and set-ups and analyzing the result using different techniques by optimizing the best settings for the specific data. While best practices during the data collection should be rigorously followed, various data post-processing techniques can also be explored to improve the quality of the data.

Further applications using GNSS technology can be introduced and tested as well in the future trainings, as well as the use of other types of receivers.