Precise Point Positioning (PPP) Technique versus Network-RTK GNSS

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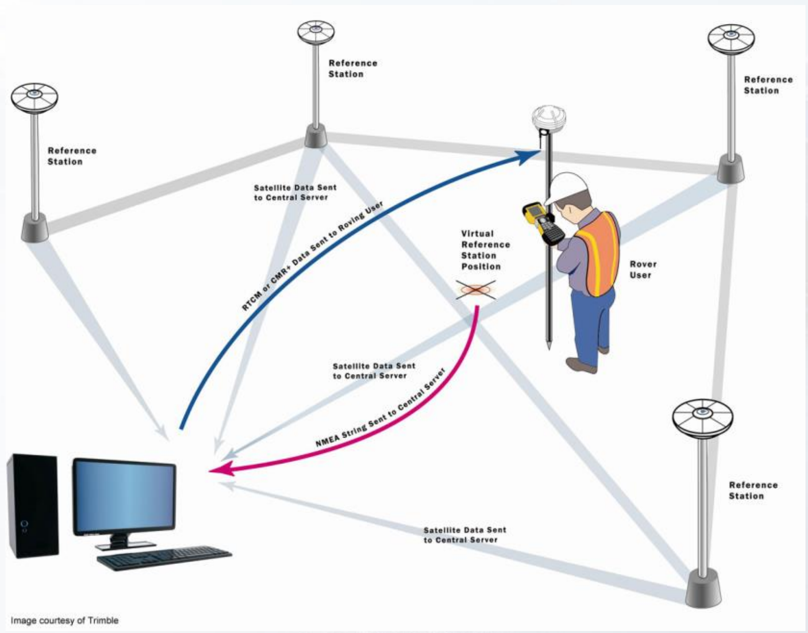
Introduction

Major developments in the world of informatics have led to the development of different solutions with various algorithms, and major changes in numerous professional fields as well as in satellite-based positioning.

Although; in the 1990’s, it was necessary to obtain positioning with Global Positioning Systems (GPS) using **at least two receivers**; nowadays an accuracy of within a centimetre level of positioning has become possible using a single receiver data with advanced techniques.

One of which is **Network-RTK** used extensively in the world, producing economical and rapid solutions for the users 7/24/365.



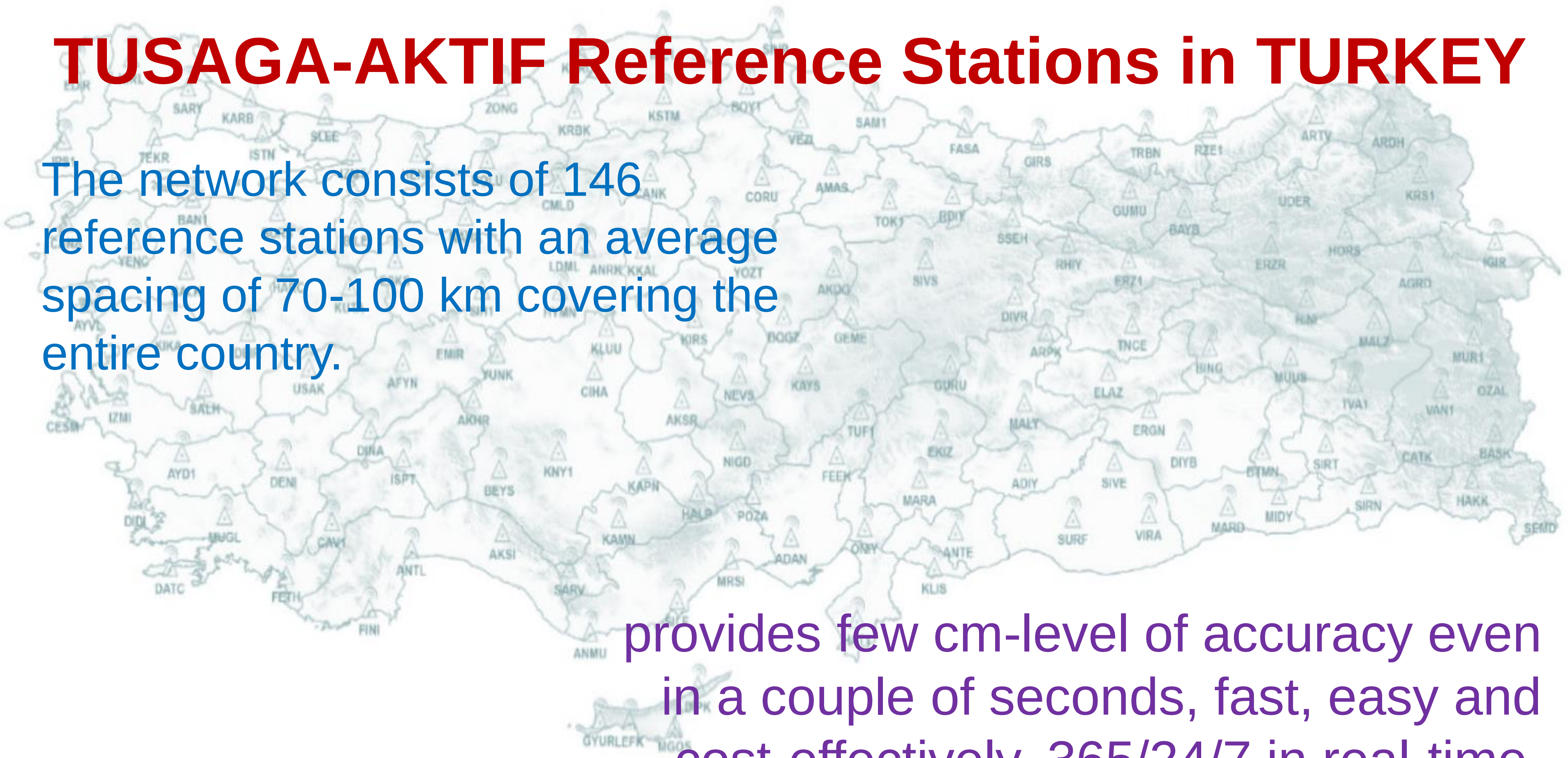
According to the results obtained the Network-RTK has been used quite widely all over the world due to it many advantages like;

- *accurate and fast positioning,*
- *easily be used by one person,*
- *cost-effective*.

On the other hand, it has some restrictions and this limits its usage in some cases and remote places.

The most important restriction is; this technique, *similar to all of the differential techniques*, needs additional data, i.e. correction, from at least one reference station and the distance between the rover and its reference station is not un-limited (should be about 50-100 km).

TUSAGA-AKTIF Reference Stations in TURKEY



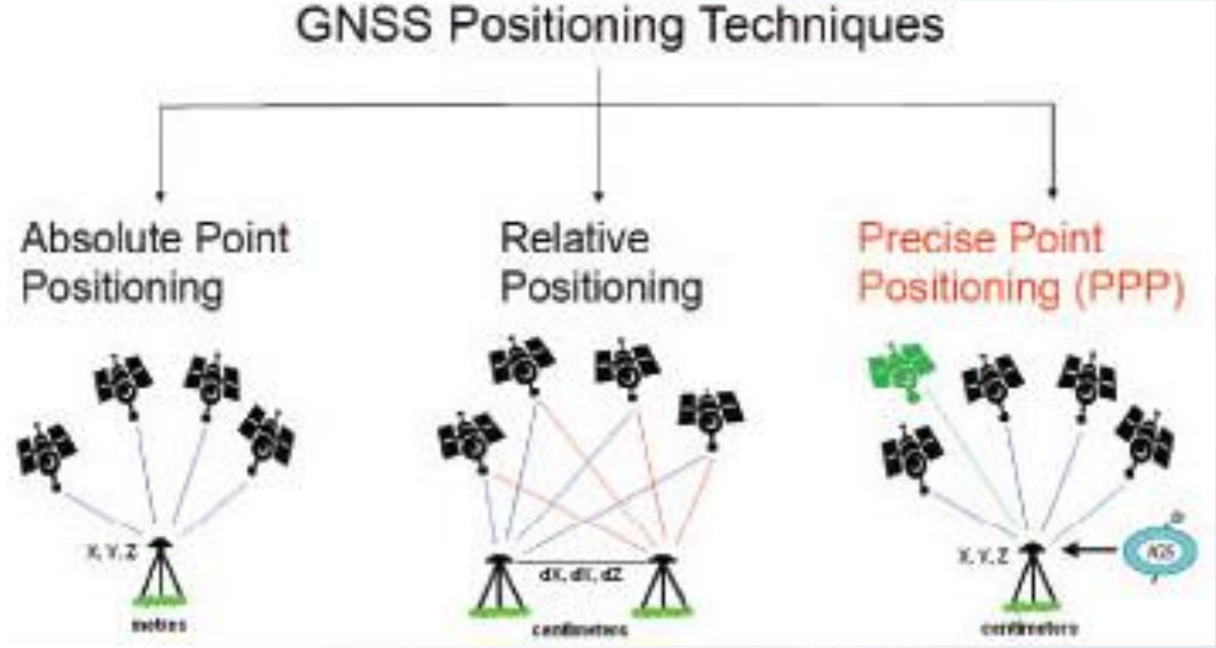
The network consists of 146 reference stations with an average spacing of 70-100 km covering the entire country.

provides few cm-level of accuracy even in a couple of seconds, fast, easy and cost-effectively, 365/24/7 in real-time.

Over the past decade, researchers have made studies to develop more economical, convenient, reliable, and worldwide precise positioning solutions, **which do not have the disadvantages that exist in the conventional differential GNSS techniques, including CORS-like**.

In this frame, one of the commonly used methods is **Precise Point Positioning (PPP)**.

PPP provides positioning without the need for a reference station using a stand-alone GNSS receiver **by using precise satellite orbit and clock corrections**.



With this method, it has become possible to reach a cm to dm level of positional accuracy in the **static or kinematic mode**.

The user of this method can obtain his/her position;

- *within a global reference frame,*
- *anywhere in the world easily,*
- *economically,*
- *without any need of a base station data*
- offers great operational flexibility.

The use of PPP has been increased, but it has some drawbacks including **necessity of long occupation time for converge** and **unavailability of PPP processing mode** in common commercial GPS processing software.

Especially long convergence time is limited its use in many situations where rapid GPS surveying is required and surveying efficiency is concerned.

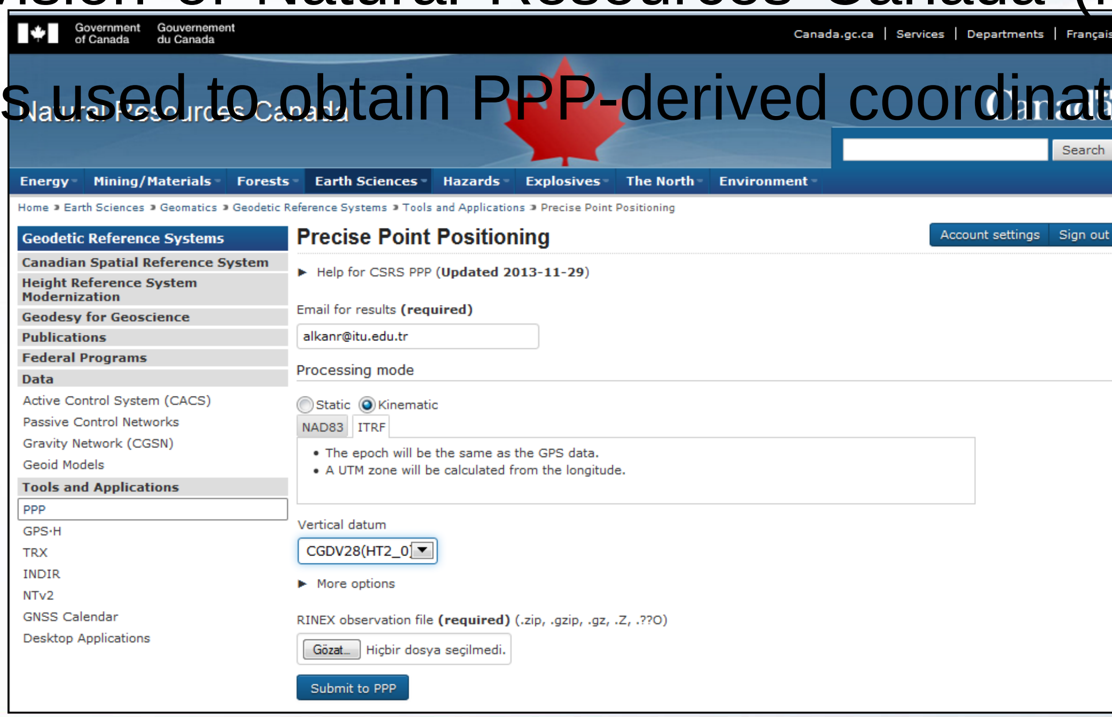
There is a number of software packages to estimate PPP-derived coordinates, i.e.,

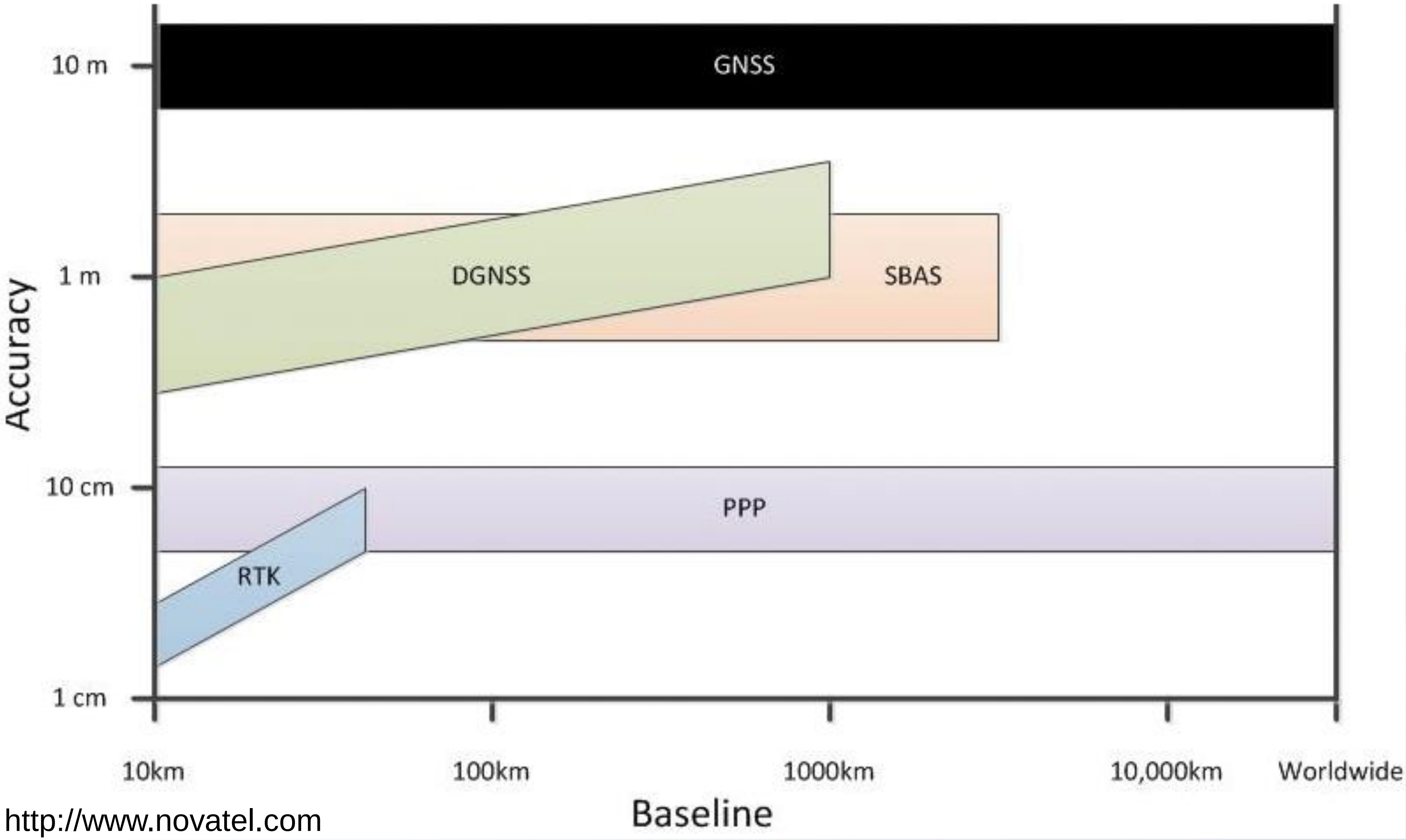
- *individuals at universities or research organizations,*
- *scientific GPS processing software and,*
- *in recent years, web-based on-line processing services*.

The use of the processing services has become widely popular because of their ease of use, being free of charge (or requiring low cost fee) and no requirement of a license and knowledge of a GPS processing software.

In these services, users can upload/send their GPS observation file(s) which will be processed automatically and estimate the coordinates (or trajectory).

In this study **Canadian Spatial Reference System-Precise Point Positioning Service (CSRS-PPP)** operated by Geodetic Survey Division of Natural Resources Canada (NRCan) online service was used to obtain PPP-derived coordinates.





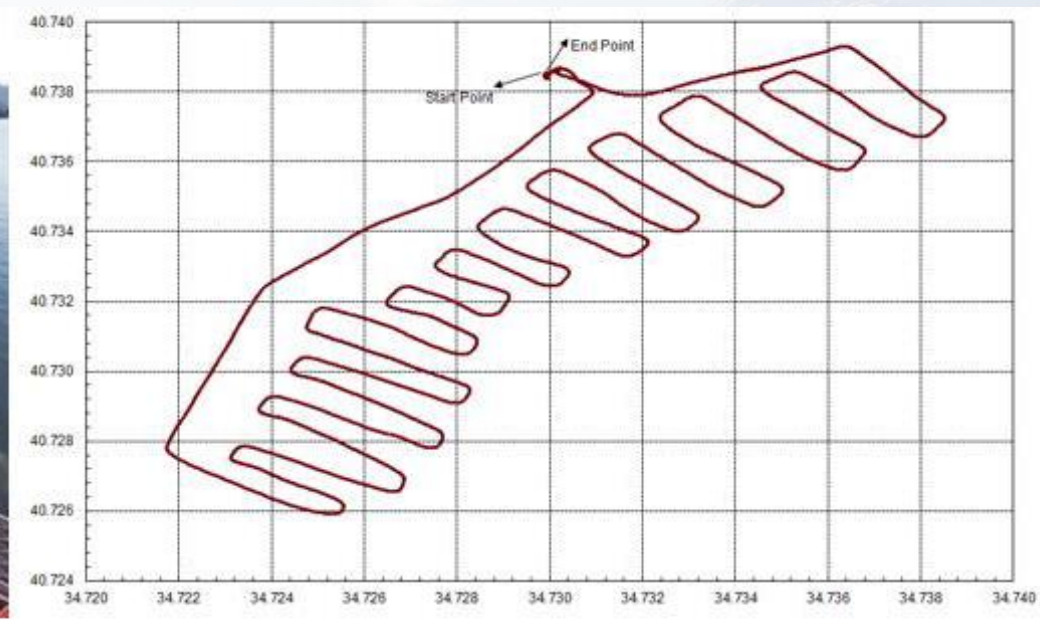
from http://www.novatel.com

In this study, we aim to make an accuracy comparison of the Network-RTK and the PPP techniques in a dynamic environment.

Aplication - Kinematic Test

In order to compare the TUSAGA-Aktif Service and PPP technique in terms of accuracy in a dynamic environment, a kinematic test was conducted at the Obruk Lake Dam, in Çorum, Turkey in October of 2015.

The kinematic part of the study was started with static initialization for a short time and the receiver was then moved to the vessel and data was collected for approximately 1.5 hours at 1-second interval with an elevation mask of 10°



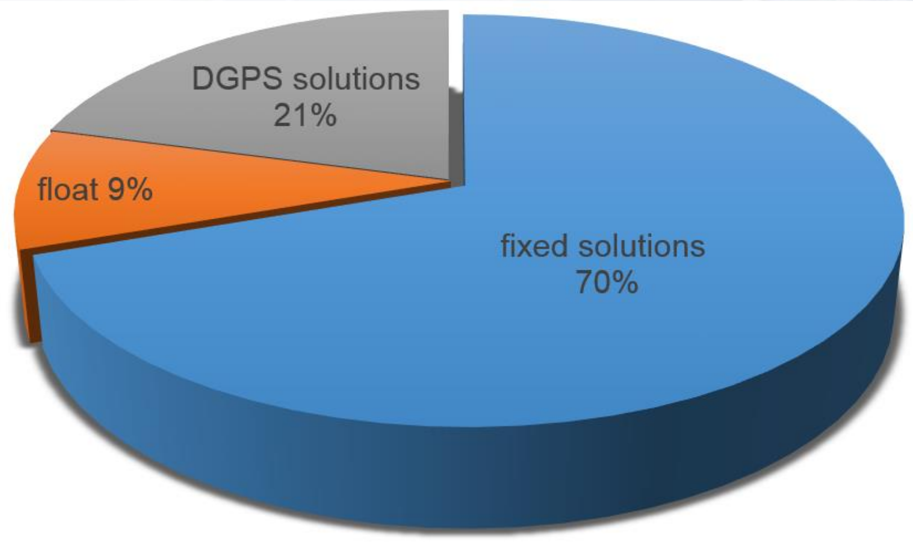
While the kinematic test was lasting, another receiver was occupied on a known point at the shore and GPS data was collected in static mode.

The precise coordinates (or reference trajectory) of the vessel for each epoch with the differential (relative) GNSS method using both the GNSS data collected to the vessel and at the reference station on the shore.

In this test study, **ProFlex 500 GNSS receivers** with geodetic–grade antenna was used.

ProFlex 500 is a 75 channel (GPS L1 C/A L1/L2 P-code, L2C, L1/L2; GLONASS L1 C/A, L2 C/A code, L1/L2) receiver with having up to 20 Hz of raw data and position output.

While the kinematic measurement was lasting, the Network-RTK coordinates were recorded simultaneously for each measurement epoch in real-time from the nearest TUSAGA-Aktif Network's point.



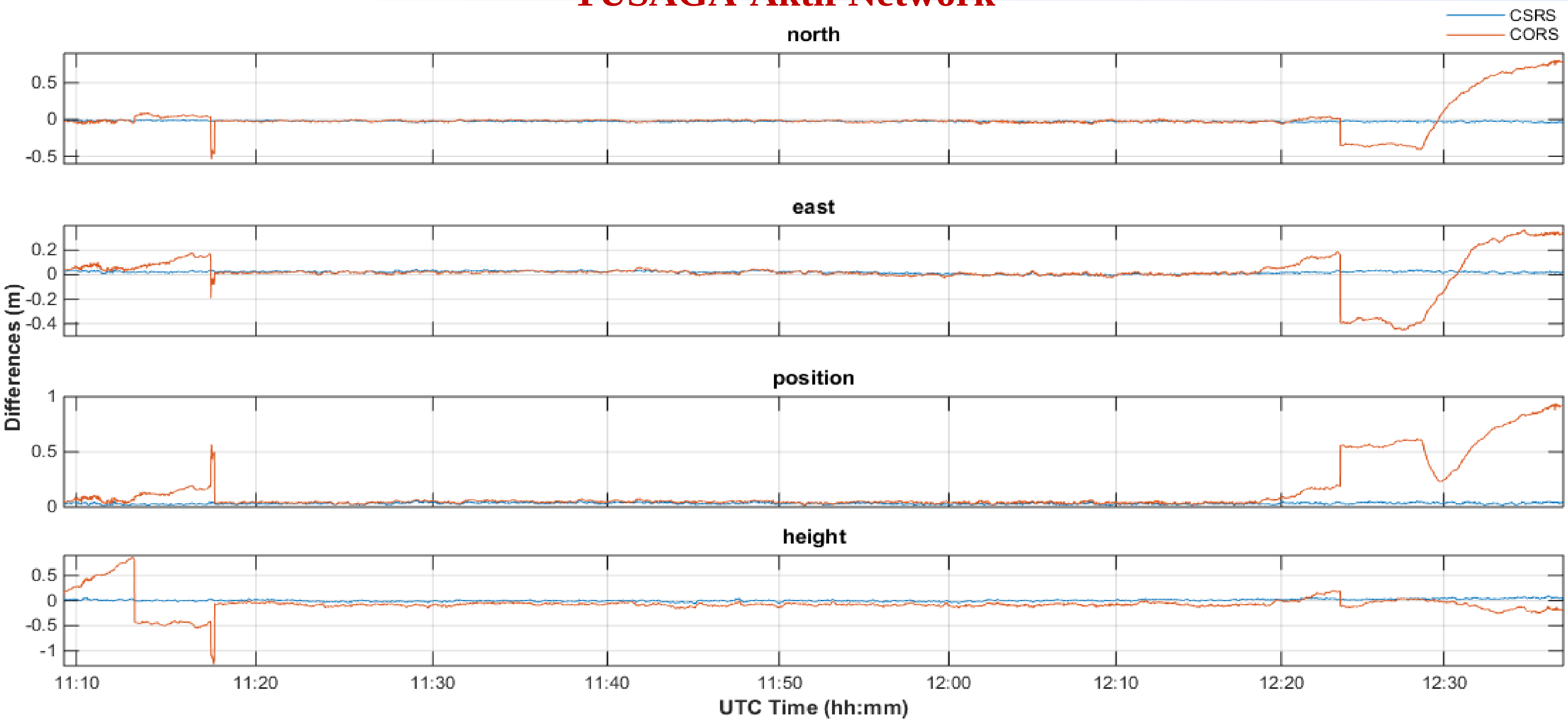
Evaluation of the Measurements

The collected data from the vessel was sent to the CSRS-PPP service the day after the data collection date, using the service's interactive web page by choosing the kinematic processing option.

The kinematic PPP coordinates for each measurement epoch with solution reports were retrieved a short time later via e-mail from the service.

The coordinates of the vessel determined with the TUSAGA-Aktif Network and NRCan's CSRS-PPP online service were compared with those of differential solution of the LGO software, i.e. to the reference coordinates, epoch-by-epoch.

Differences between Known-coordinates (Differential Solution) and NRCan's CSRS-PPP & TUSAGA-Aktif Network



blue line; CSRS-PPP, ***red line***: CORS or TUSAGA-Aktif Network

Statistical Comparison of the Results

	Position (m)				Height (m)			
	Min.	Max.	Mean	RMSE	Min.	Max.	Mean	RMSE
NRCan's CSRS-PPP Service								
	0.01	0.06	0.03	±0.03	-0.07	0.10	0.01	±0.02
TUSAGA-Aktif CORS Service								
Whole Results (including Float/DGPS/Fixed Solutions)	0.01	0.94	0.14	±0.26	-1.26	0.86	-0.07	±0.19
Results from Only Fixed Solutions (69.7 % of whole of the solutions)	0.00	0.05	0.01	±0.01	-0.08	0.03	-0.02	±0.03

Conclusions and Results

The results of the test measurement show that,

the Network-RTK provides a cm level of accuracy when the solution can be fixed. Otherwise, the accuracy decreases dramatically to even a meter-level of accuracy if the float/DGPS solution occurs due to problems in the communication link, outside the coverage area of the GSM network or where the absence of data transmission is poor.

Conclusions and Results

Concerning the PPP technique, the kinematic test results showed that the PPP-derived coordinates converge to the relative solutions with a couple of cm-level of accuracy. This accuracy has allowed the technique to be a viable alternative to conventional differential GNSS techniques in terms of accuracy, easy-use and cost-effectiveness while reducing labour and equipment costs.

Conclusions and Results

Although Network-RTK offers many advantages over conventional differential GNSS techniques, PPP techniques needs a single receiver and this removes the necessity for the base (reference) station(s) or data from the CORS-like networks. **Thus PPP is still useful in areas that are not covered by CORS infrastructure due to low population density, economic reasons, or operational constrains**.

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Hoping to see you in İstanbul for FIG 2018

Thank you very much for your interest and attention…

Contributions, Questions???

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