

GNSS measurement and Network RTK measurement

April 24, 2019

Meeting point: Kone building, lobby (Otakaari 4)

GNSS measurements:

- static or relative GNSS measurement, and
- Network RTK, i.e., Network Real-Time Kinematic (NRTK) measurement

The field measurement lasts two hours.

In the exercise, three fixed points, GNSS 1–3, are measured using the static technique, in order to georeference the tacheometer measurements, and the lower-order fixed points are measured using Network Real-Time Kinematic (NRTK) for the laser-scan exercise.

In this instruction we present the stages of the exercise in detail. It is recommended that the student has studied the instruction carefully before the actual field exercise takes place.

If there is anything unclear in the instruction, please contact the course assistant. Student feedback is very welcome as the course continues to be under development.

Learning outcomes:

After the instrument and calculation exercises, the student is able to set up a GNSS receiver on a point for static measurement. He understands the principles of operation of static measurement and NRTK-measurement and understands the advantages of combining the different methods. She is able to carry out a coordinate transformation from the WGS84 system to ETRS-TM35FIN plane coordinates. Additionally the student masters the basics of 3D modelling using the Matlab computation software. In the exercise, the use of geodetic computation software is avoided, so that the student can internalize the principles of geodetic computation.

1 Preparations

1.1 Pre-materials

In the MyCourses page for the course there is under Harjoitukset/Exercises pre-material, which the student should study before the exercise.

For the GNSS exercise, one should watch the videos on setting up a tripod and use of a forced-centring device, in which it is explained how a tripod is set up and the forced-centring device is levelled. In addition to the videos, MyCourses offers the document “Setting up a GPS antenna” and “GPS observation form”.

For the static GNSS exercise, there is also the lecture text sections 12.1, 12.2 and 12.4.2.

1.2 Resources

1. **Safety vests for all students! Also for the assistants!** ☺
2. **Tripod:** known from the video
3. **Forced-centring device:** known from the video
4. **Measurement stick:** known from the video on tacheometer measurement. The stick is used to measure the antenna height, see Appendix A
5. Trimble NET-R5 receiver, GNSS antenna, antenna cable, power cable
6. **Observation form:** in this exercise we use an observation form into which we write, i.a., the name of the file, the antenna height and the starting and ending times (*at least an hour!*). The form is on MyCourses. The assistants will print the forms out.
7. **The Trimble GNSS instrument case:** contains the GNSS antenna and receiver and the field computer.
8. **The pole for the GNSS instrument:** known from the video on tacheometer measurements. In this NRTK exercise, the GNSS receiver is mounted on top of the pole that is placed on the point. In this instance, we will not use a GNSS receiver mounted on a tripod.
9. **A stopwatch:** the one in a mobile phone is good for this.
10. **NRTK instructions:** the instructions for the exercise are the basis for the measurements. The assistants will print the instructions for the NRTK exercise.

11. **The NRTK measurement form:** in this exercise we use an NRTK measurement form into which we write up i.a., the instrument height and important metadata. The NRTK measurement form is on My-Courses. The course assistants will print the measurement forms ready for the NRTK exercise.
12. The GPS calendar form is useful when giving names to files.

2 Operating in the terrain

At the beginning of the exercise we set up and start three GNSS receivers on known points at the same time. We let these receivers collect data *at least for a whole hour or more* as static measurements. For this we use Trimble dual-frequency receivers.

Once the static measurements have been started, the instruments work on their own. During the static measurements, we do NRTK measurements using Trimble GNSS receivers. Because of the number of groups, and in order to reap the didactic benefits, we do with two GNSS instruments simultaneous NRTK measurements. These devices are connected to the Internet over GPRS, to Geotrim's TrimNet computing centre. These modern trimble receivers can observe signals from multiple systems (GLONASS, BEIDOU and GALILEO). This is why the receivers are called GNSS receivers.

So there are in total five GNSS instruments, three Trimble NET-r5 receivers, and two Trimble R10 receivers of which each group picks one.

The static and NRTK measurements are carried out on Elissa Plaza. In the below figure 1 is a sketch of the locations of the static known points GNSS 1-3. In figure 2 the measurement areas have been drawn per group, red circles for NRTK points to be measured and in greenish text, the known points to be measured by static GNSS (not considered in this exercise).

3 Doing the exercise:

1. Every student dons the yellow safety vest. There isn't much traffic on Elissa Plaza, but accidents happen.
2. Every group sets up an antenna on a point, starts the measurement (appendix A,
3. We form three groups, A, B and C
4. Every group checks on the map where the point is located! Every point is an asphalt nail
5. Next, the field computer...



Figure 1: The static GNSS points to be measured on Elissa Plaza.

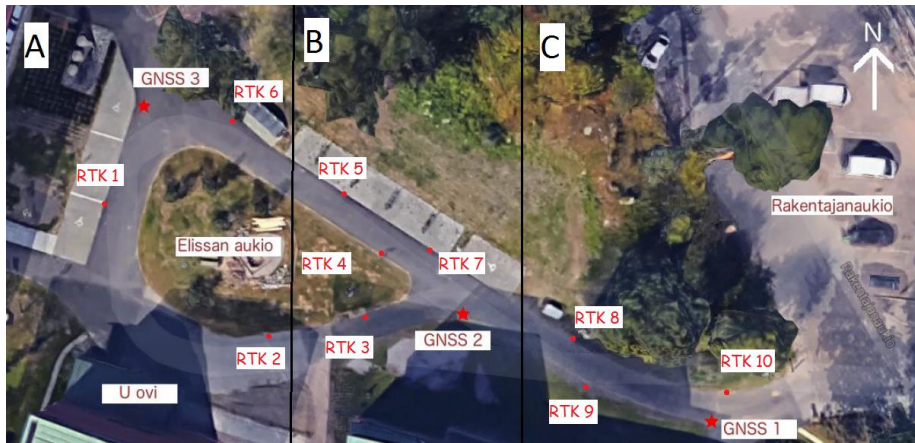


Figure 2: The RTK points on Elissa Plaza.

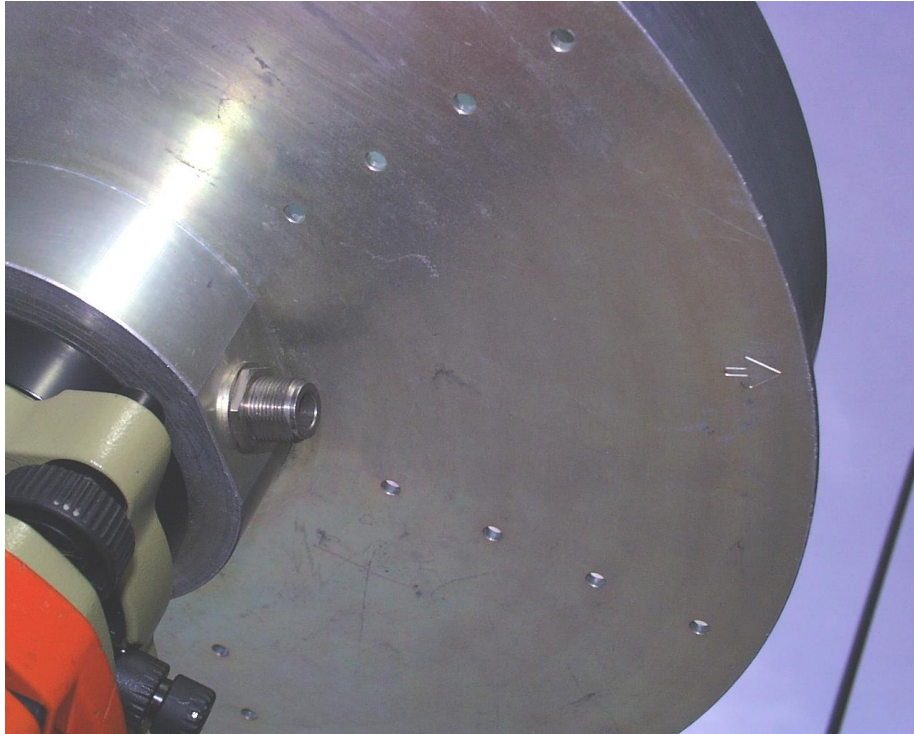
Appendix A Detailed instructions for setting up and starting the NET-R% receiver!

Appendix B Observation form for static GPS measurement

Appendix C Instruction for NRTK measurement

A Static measurements. Setting up a GPS antenna

In measurements we strive for millimetre-class precision. it is easy to make mistakes when setting up the antenna, which may cause errors of centimetres in the observed location, so one must be precise when setting up. The forced-centring device is centred on the point and levelled using the optical plummet and bull's-eye level. The antenna cable is attached to the antenna, and the antenna to the forced-centring device, before the final centring, levelling and height measurement. Note that the antenna connector has a long thread that must be screwed all the way.



All participating antennas must point in the same direction. This is because the antenna phase centre is not in the middle. If the antennas are pointing at random, this may cause an error of several centimetres in the observed location. The arrow at the bottom surface of the antenna (see figure) is aimed at the

magnetic North using a separate compass. This is best done by first looking at the bottom of the antenna where between the radial series of holes the arrow is. Because the arrow is halfway between the rows of holes, the actual aiming can be done while your head is above the antenna.

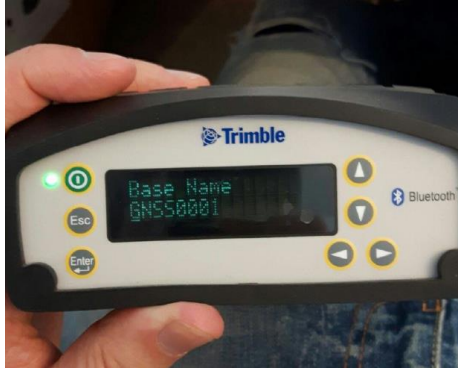


Normally, the slant height is written onto the observation form from the centre point of the mark to the lower edge of the antenna's outer ring, as shown in the pictures. In the rightmost picture the measured height is thus approx. 1.389 metres. The measurement is repeated three times on different sides of the antenna, so that a possible poor levelling or a measurement error will expose itself. The measurement results are not allowed to differ from each other by more than 1 mm. These three measurements are done both before and after the GPS session.

B Starting up the Trimble NET-R5 GNSS receiver

Start the instrument. The settings are changed using the arrow keys, in the menus, one moves using the Enter and Esc keys. Press Enter long enough, that

“Base Name” appears in the display, then press the right arrow key. Now you may choose letters by pressing the arrow keys up/down. After this, press Enter long enough, so you can enter the antenna height in the same fashion.



Finally the antenna cable is attached and the instrument starts measuring!

C Static measurements, observation form

GPS FIELD LOG Page 1 of __

Project Name _____ Project Number _____

Receiver Model/No. _____	Station Name _____
Receiver Software Version _____	Station Number _____
Data Logger Type/No. _____	4-Character ID _____
Antenna Model/No. _____	Date _____
Cable Length _____	Obs. Session _____
Ground Plane Extensions Yes () No ()	Operator _____

<i>Data Collection</i>	<i>Receiver Position</i>
Collection Rate _____	Latitude _____
Start Day/Time _____	Longitude _____
End Day/Time _____	Height _____

Obstruction or possible interference sources _____

General weather conditions _____

Detailed meteorological observations recorded: Yes () No ()

Antenna Height Measurement

Show on sketch measurements taken to derive the antenna height. If slant measurements are taken, make measurement on two opposite sides of the antenna. Make measurements before and after observing session.

Vertical measurements ()

Slant measurements (): radius ____ m

BEFORE	AFTER
____ m ____ in.	____ m ____ in.
____ m ____ in.	____ m ____ in.
Mean _____	
Corrected to vertical if slant measurement _____	
Vertical offset to phase center _____	
Other offset (indicate on sketch) _____	
TOTAL HEIGHT _____	

Verified by: _____

FIGURE 7.18 GPS Field Log. (Courtesy of Geomatics, Canada)

D Network RTK instruction

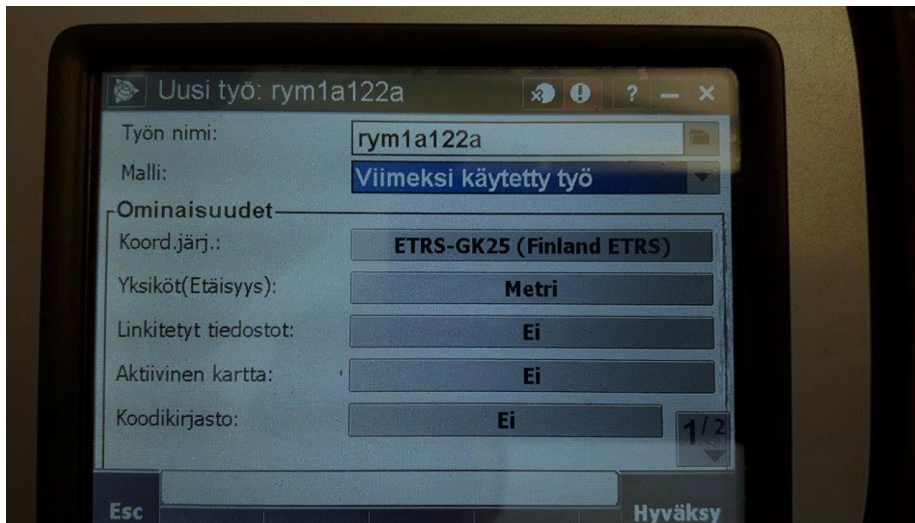
Start the device, press the power button both on the receiver and on the field computer.

Start a new job: choose initialization (?) from the TYÖT (“jobs”) menu.
From the list that opens, choose new job.

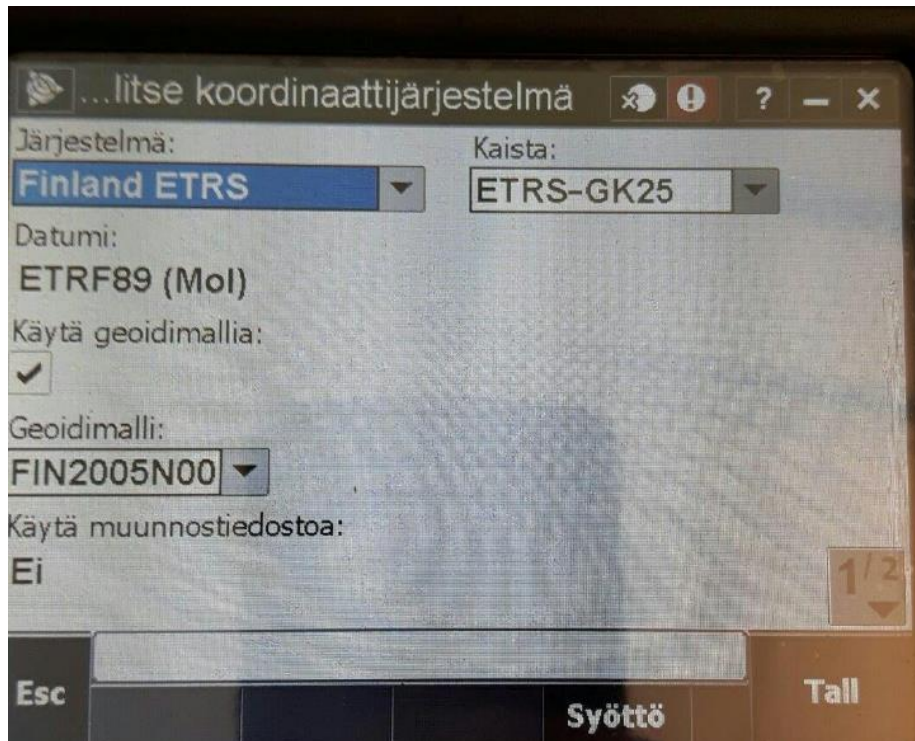
Name the job according to the name of your group, e.g. **alphaGNSS**[A, B, C], followed by GPS day.

In addition, write the operator names to the “Operators” (“Tekijät”) field.

Name the job as follows: (note to self: add GPS calendar!)



Change co-ordinate system by pressing the coordinate system bar on the touch screen. From the list that opens up, choose CHOOSE FROM LIBRARY (“VALITSE KIRJASTOSTA”). Change the setting as shown in below picture, and press ENTER.



The measurement is started by choosing “measurement” from the main menu, and “topographic mapping” from the pull-down menu.

- 1.
5. Take out the antenna from the box and take the GNSS pole. Screw the GNSS antenna onto the top of the pole, tight! Lengthen the pole to the desired height by keeping the locking button down! Remember to check that the locking button locks once a suitable height is reached, and remember the pole height!
6. Two alternatives for handling the field computer:
 - (a) Attach the field computer tightly to the pole (assistants will show). When everything is connected together, remember to handle with care!
 - (b) Keep the field computer in your own hands, while someone else holds the GNSS pole and puts it on the point and keeps it stable the textbook way.
7. Move to first point for the group to be measured within the measurement area. The most sensible is to process the points in order from lowest to highest number. (E.g., in area A, first NRTK1, then NRTK2, and at the end, NRTK4)

8. More instructions on moving from field-computer functionality to terrain operations:

9. Dry exercise (*do not execute yet!*)

In the below picture, you can see the text “Kartoitusmittaus” (“Detail survey”). In the field “Pistenumero” (“Point number”), write the number of the NRTK point. The first one is found from the NRTK form under “Piste” (“Point”). In the picture below the example is “NRTK14”. On each NRTK point, five measurements are done, and the computer will present, after completion of a point measurement, the number of the next point. So, in the blow example, one measures in a single NRTK measurement the point numbers NRTK11-NRTK15.

Into the field “Antennikorkeus” (“Antenna height”) one should feed the number from the pole, like, e.g., 1.8 m or 2.0 m. Remember to always check this!



10. *Set-up on NRTK point:* When you are at the point to be measured, the GNSS pole (with antenna on top) must be placed on the point. Aim the sharp end of the pole at the centre of the nail, and keep the pole still by watching the bull’s-eye level. The bubble must stay in the centre!

11. Start measurement: on every NRTK point, carry out five measurements.
Enter into the measurement form:
 - Measurement started (UTC time), i.e., the starting time of actual measurements.
12. Start the measurement: using the field computer, go to measurement mode. to the “Point number” field, write the NRTK point number, of which the first is found under “Piste” in the NRTK observation form. Into the field “Antennikorkeus” feed the number from the GNSS pole.
13. Move to next points and repeat the item 11, and this one!
14. When all points have been measured, mark in the observation form:
 - Measurement ended (UTC time), i.e., when all points have been measured
15. If time remains, groups can do mapping measurements, e.g., along the road at 5m intervals, edges and midline.
16. Finish the measurements and pack the equipment! Move under assistant guidance back into the storage room. Put batteries charging for the next group!