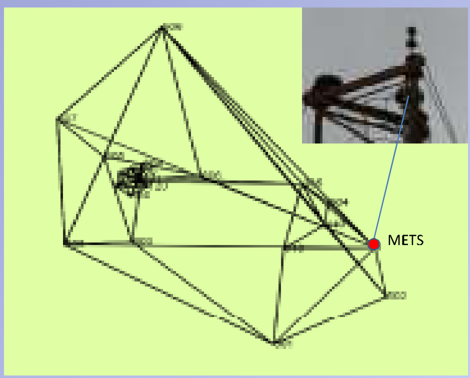
Measuring the local ties for GPS antenna change at Metsähovi

Ulla Kallio, Hannu Koivula, Pasi Häkli, Jorma Jokela, Sonja Nyberg, Paavo Rouhiainen
Finnish Geodetic Institute

Abstract

The old GPS antenna (AOAD/M_B) of Metsähovi IGS station was broken down during the summer 2010 and it was replaced with an AOAD/M_T antenna. Before removing the antenna a set of local tie measurements were performed to measure the position of the old antenna which had been kept untouched since 1992. The antenna was stabilized with a special invar wire construction which eliminates the thermal expansion of the mast. To ensure the exact re-location of the new antenna to the stabilization system we measured the tie between antenna and the ground markers before and after the change. The place of the new antenna was determined relative to the old one. Because the antenna mast is more than 20 m tall, the task to tie the antennas to the ground markers better than 1 mm accuracy was quite a demanding task. We describe a specific technique to do the local survey and show that the required accuracy was achieved.

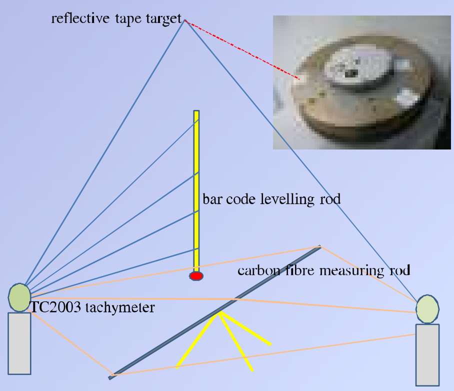
Measurements in the local network



The horizontal and vertical angles to the permanent GPS antenna were measured from several pillar points near the antenna as a part of the local network. Horizontally it is quite natural to point to the left and the right sides of the antenna and use the mean as the center. In the case of vertical angles it is not so easy because the structure of the mast blocks part of the antenna and therefore there is no clear visible reference point. Vertical angles were measured to the ground plane of the antenna and reduced to the antenna reference point before the adjustment. Vertical angle measurements determine the height difference between the antenna and the pillar points. Systematic errors in pointing and instrument heights propagate directly to the height difference.

With the network geometry shown in the figure above and instrument heights measured with a roll-up tape measure we cannot achieve precision better than 2 mm for height differences between pillar points and the antenna.

How to improve the height determination



In order to get more precise height difference between antenna ARP and the ground markers we applied the space intersection technique with a pair of TC2003 tachymeters. The instruments were collimated by pointing reciprocal to the crosshairs in all combinations. For scale determination we used the1.3m long calibrated carbon fibre measuring rod designed for the purpose in Aalto University. We aimed to the reflective tape targets on the bottom of the GPS antenna (however distances were not used in calculation). The height was transferred trigonometrically from the axes of the tachymeters to the ground benchmark with a calibrated bar code levelling rod. We used additional points with GPR1 prisms or reflective tape targets to strengthen the determination of the base vector between the tachymeters. After the least squares adjustment the standard deviations of the height differences between the target points on the bottom of the GPS antenna and the ground markers were improved to 0.4 mm. Measurements were repeated after antenna change and height difference between old and new ARP were calculated. The results were consistent with the height difference determined from physical antenna elements. It proves that the method can be used to improve the height determination. It also ensures that the invar stabilization system was succesfully reserved during the antenna change.

Orientation of the new antenna

The new antenna has individual calibrated antenna phase center variation and offset values. The antenna was oriented to the geodetic North by transfering the precalculated GPS derived azimuth to the antenna on top of the mast with the TC2003 tachymeter.