Geophysical Research Abstracts
Vol. 21, EGU2019-7866, 2019
EGU General Assembly 2019

Real-Time Geophysical Applications with Android GNSS Raw Measurements

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In the past two years Google has started a revolution within the GNSS mass-market world through the release of an API to extract GNSS raw measurements from Android devices running Nougat version or higher. The number of smartphones nowadays compatible with the Google API is increasing quickly and, in particular, during the last year the Xiaomi Mi8 has been released in the mass-market. This device is the first GNSS dual-frequency smartphone embedded with the Broadcom BCM47755 GNSS chipset, aiming at improve signal tracking and positioning accuracy exploiting the features of L5/E5 observations in addition to the traditional L1/E1 observations.
The availability of multi frequency and multi GNSS observables from smartphones enables to extend to mass-market devices the use of algorithms, developed for low cost and geodetic class receivers, inspiring researches for innovative applications. Along with the benefits in location accuracy, the Android GNSS raw measurements could represent a significant plus in Geosciences applications through a wider densification of GNSS information, not achievable with low cost and geodetic class receivers generally deployed in a selected market.
Sapienza research team is responsible for the development and the implementation of two algorithms mainly related to high-precision applications for Geoscience: VADASE (Variometric Approach for Displacement Analysis Stand-alone Engine) and VARION (Variometric Approach for Real-Time Ionosphere Observations). VADASE is a variometric algorithm able to retrieve in real-time the velocities of a stand-alone receiver, with accuracies of few millimetres per second. It was firstly developed for GNSS seismology providing fast movement displacements with less than 1-2 cm accuracy with geodetic class receivers [1]. Furthermore, the occurrence of an earthquake generates acoustic waves around the epicentre that can reach the atmosphere causing ionospheric perturbations named Travelling Ionospheric Disturbances (TIDs). VARION has been developed, based on variometric approach, to reconstruct real-time sTEC (slant Total Electron Content) variations connected to the TIDs with a stand-alone GNSS receiver. The continuous monitoring of ionosphere status can be fundamental for marine earthquakes: VARION is able to detect tsunami waves also in deep water and far from the coast increasing the efficiency of early warning systems [2].
The aim of this work is to extend the application of VADASE and VARION to multi frequencies and multi-GNSS Android raw measurements, demonstrating the contribution that mass-market devices can offer to Geosciences. As regard the VADASE, experimental tests on observations data collected from the Xiaomi Mi8 placed over a vibrating table (able to work in one direction, with frequency shaking and oscillation amplitude comparable to seismic waveforms) were carried out. On the other hand, the assessment of the possibility to perform ionospheric sounding is evaluated through the comparison of VARION sTEC computation for Xiaomi Mi8 and a CORS stations placed in its surroundings.

References
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