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Consumer GNSS Chipsets-Based, Dual-Frequency Receivers as Enablers of Dense Networks for both Long-Term Geodynamic Monitoring and GNSS Seismology by VADASE Approach

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It is well known for a while the key importance of dual-frequency GNSS receivers for high precision geodetic and geophysical applications. Nevertheless, the (still) high cost of dual-frequency geodetic class receivers very often limited their deployment and use (especially - but not only - in third world countries), preventing from realizing dense permanent networks, which are of high relevance both for long term geodynamic monitoring/earthquake hazard assessment, and for GNSS seismology.

In order to make feasible the realization of such networks, with a density of GNSS permanent stations one order of magnitude higher than actual ones, a new and very low-cost dual-frequency receiver working at present on the L1/L2C pair but easily amenable to GALILEO E1/E5a operation has been designed and successfully tested. For this purpose, redundant baseband processing resources present in some commercial chipsets for the automotive market (designed originally for L1-only signal processing) have been exploited. The joint use of an additional L2C downconversion chain built by low-cost ASICs has allowed obtaining a compact board, providing at its output, at both frequencies, all the raw data (code pseudorange, phase pseudorange, Doppler etc.) needed by standard high-precision positioning algorithms as Precise Point Positioning (PPP) or Differential Positioning (DP), currently used for long term geodynamic monitoring.

The new hardware seems, however, particularly suitable to support the VADASE approach, developed and patented for GNSS seismology at the Geodesy and Geomatics Division - DICEA, University of Rome La Sapienza. VADASE is based on a variometric approach, departing significantly from the more widely known approaches PPP and DP, as it just needs the observations and ancillary products (orbits and clocks) available in real-time at a standalone receiver, and it does not require preliminary convergence for ambiguities resolution to estimate the velocity of the receiver. VADASE has proven its capability to provide velocities, waveforms and thus coseismic displacements in real time during major seismic events, offering a real alternative to other high-bandwidth seismic sensors that can undergo saturation during strong earthquakes.

To confirm the feasibility of the joint use of VADASE and of the new low-cost dual-frequency receiver, the latter has been tested in high dynamic environment on vehicles, featuring significant variations in their dynamical characteristics, and experiencing sudden stops and restarts, which usually impair the Kalman filter performance in standard GNSS units. Being totally independent from ambiguity fixing, the response of VADASE in velocity and displacements has proven to be very fast and suitable to enable the collection of seismic data even under extreme circumstances.

The relevance of the result for the possible deployment of a dense network for GNSS seismology applications is commented, on the grounds of previous experiences.