Developments for the next generation of Radio Occultation instruments in Europe

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This paper will focus on state-of-the-art GNSS space receiver technology in Europe, particularly suitable for Radio Occultation instrumentation in coming missions like MetOp-Second Generation (3 satellites) and Jason-CS. Key building blocks are the AGGA-4 baseband GNSS processor, RF modules, scalable antennas and new on-board open-loop processing techniques.
The GNSS Receiver for Atmospheric Sounding (GRAS) instrument, developed to ESA specifications by RUAG Space, is flying on the MetOp-A satellite since October 2006 and is currently the only fully operational Radio Occultation (RO) sensor in orbit. The key performance of the instrument has been assessed during the MetOp-A commissioning phase, and also in a recent ESA study with RUAG Space and other partners. The instrument performance was found to exceed the specifications. Fine-tuning of on-board parameters has been investigated and is now implemented for the second GRAS instrument that will be launched on MetOp-B in mid-2012. Both GRAS-a and GRAS-b will operate simultaneously, providing over 1200 highly accurate profiles per day, at least until 2017. New processing techniques, especially in open loop are being studied in follow-up ESA contracts, in collaboration with EUMETSAT.
Within the current decade new GNSS signals will be available not only from an enlarged set of GNSS constellations (e.g. modernized GPS, Galileo, GLONASS, Compass-Beidou), but also with new characteristics: e.g. public signals at several frequencies (L1, L5, and even L2 in some cases) with new features like pilot/data components and secondary codes. Navigation bit wiping in the pilot components or codeless processing will not be needed in the future, which will add robustness under lower SNR conditions.

The Advanced GPS/GLONASS ASIC (AGGA-2) is a GNSS baseband processor used in a large number of ESA missions like MetOp GRAS-a/b/c, GOCE, Sentinels 1/2/3, Swarm, EarthCARE, as well as non-ESA missions like ROSA (on Oceansat-2 and MeghaTropique), Radarsat-2 or Cosmo-Skymed. Its successor, AGGA-4, is compatible with all modernised GPS and new Galileo public signals, and also with GLONASS and Compass-Beidou (for the signals as known today). AGGA-4 benefits from the advances in integrated circuits for space allowing for much higher integration of more functionality on one chip: e.g. AGGA-4 embeds 36 dual-code single-frequency (SF) channels, compared to the 12 single-code SF in AGGA-2, as well as an on-chip LEON-2 FT microprocessor, carrier and code-loop aiding units for each channel, FFT support in hardware for fast acquisition, more and faster external interfaces, etc. AGGA-4 was designed under an ESA contract with Astrium GmbH (Germany), and Flight Models (FM) of the ASICs in Atmel ATC18RHA technology will be available in 2Q-2012. State-of-the-art RF modules developed by Saphyrion (Switzerland) to specifically support receivers based on AGGA-4, as well as scalable antennas suitable for RO in a large number of missions, are also being addressed.

Development of full RO instruments, including receivers and antennas, is being prepared for missions like Jason-CS and the multi-satellite MetOp-SG programme. An overview of the ESA programmatics for Radio Occultation applications will also be included in the full paper.