

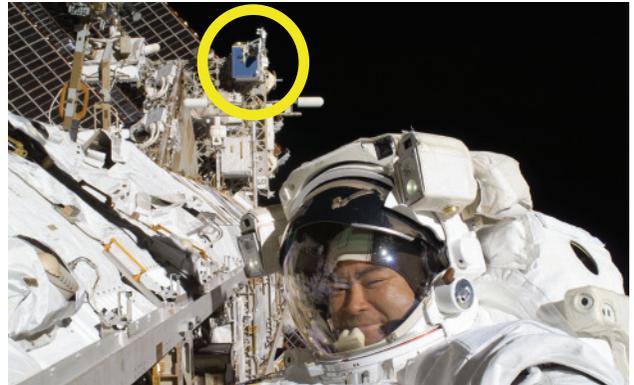
# First GPS/Galileo Receiver Flown in Space

BY Werner Enderle and James J. Miller

The European Space Agency (ESA) and the U.S. National Aeronautics and Space Administration (NASA) are conducting a joint GPS/Galileo space receiver experiment onboard the International Space Station (ISS). This will be the first time that a combined GPS/Galileo receiver will operate in space.

The project aims to demonstrate the robustness of a combined GPS/Galileo waveform uploaded to NfASA hardware already operating in the challenging space environment: the Space Communications and Navigation (SCaN) software-defined radio testbed. Testing activities include analysis of the GPS/Galileo signal and onboard position/velocity/time (PVT) performance; processing of code- and carrier-phase GPS/Galileo raw data for precise orbit determination (POD); and validating the added value of a space-borne dual-GNSS receiver compared to a single-system receiver under the same conditions.

This collaboration was initiated in 2014 and a Technical Understanding was signed in 2016.



Many new space applications may not be possible if constrained to using the limited signal availability associated with any single constellation of GNSS satellites. This research therefore seeks to demonstrate the enhanced capabilities brought by the

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use of satellites from two or more GNSS constellations in the space domain. The net result will be more resilient space operations, greater mission flexibility, and enhanced PVT performance.

The project is currently in the testing and verification phase, and it is expected that the final implementation of the combined GPS/Galileo waveform on NASA's SCan Testbed on-board the ISS will be completed in September/October 2017, so that the initial operations of the first combined GPS/Galileo receiver in space can start in the October/November 2017 timeframe. The researchers plan to present preliminary results at the UN International Committee on GNSS (ICG)-12 in Kyoto, Japan, in December.

From ESA's side, ESOC's Navigation Support Office (NavSO) and ESTEC Experts for Radio Navigation Systems and Techniques (TEC-ESN) are involved in this project.

The overall project management from ESA's side and POD aspects are covered by NavSO, and ESTEC's Technical Directorate is in charge of the Galileo waveform development and implementation of the software on the FPGA in cooperation with NASA. This activity is done with technical support from industry participants such as Qascom. Industry participation is a vital component as new markets for multi-GNSS receivers and complex space applications continue to emerge.

From NASA's side, the project is sponsored by the Space Communications and Navigation (SCaN) Program within the Human Exploration and Operations Mission Directorate (HEOMD) at NASA Headquarters in Washington D.C. Integration and experimentation activities are being performed by the NASA Glenn Research Center. NASA has initiated an international effort within the ICG to develop a fully interoperable multi-GNSS Space Service Volume (SSV), where a combination of constellation services will be available well above low-Earth

orbit (LEO) to support newly emerging geostationary Earth orbit (GEO) and high-Earth orbit (HEO) missions — ranging from more precise station keeping to extend GEO belt capacity and maneuver recovery to enabling formation flyers and satellite servicing operations. 🌐

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