SURREY SATELLITE TECHNOLOGY LTD

Centre for EO Instrumentation

Technology Market Case Study No. 1

GNSS Reflectometry

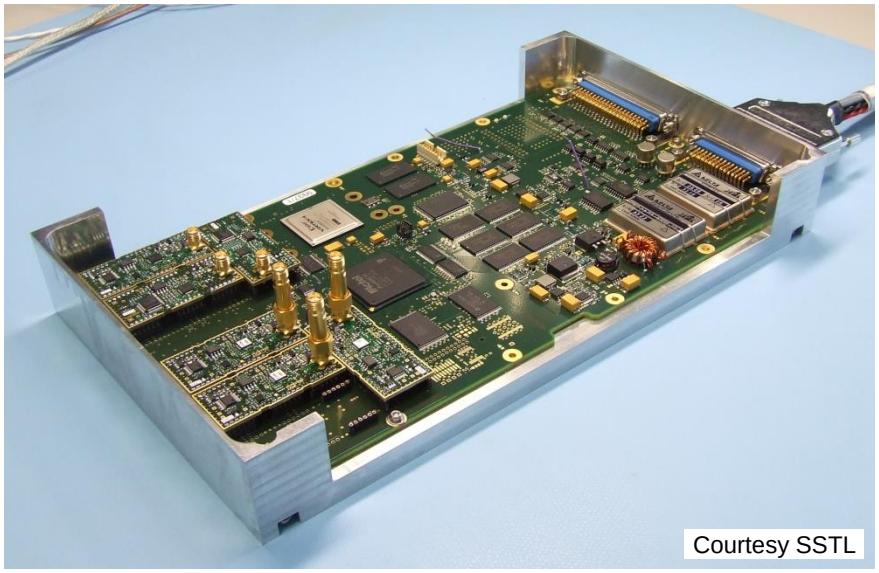
The Idea

Important scientific data on sea-surface roughness or soil moisture content can be derived from GPS/GNSS navigation signals reflected from land, ice and ocean. They can be analysed using an instrument flying on a separate small satellite and taking measurements from the reflecting surface to derive the data. Surface wind-speed can be derived from the measurements of ocean roughness, which is important for operational ocean and weather forecasting.

Support from CEOI

In order to turn this idea from concept to proven technology, CEOI provided funding to a team led by Surrey Satellite Technology Ltd (SSTL) through two successive Open Calls to develop a flexible multi-channel receiver of reflected GNSS signals. The work included:

- the definition of the applications, specification of the technical requirements and development of an engineering model of the receiver instrument;
- further development of the receiver instrument towards flight standard to fly on TechDemoSat-1 and parallel development of the science applications for the instrument;
- review of state of the art of the technology and outstanding issues for ocean roughness retrieval with GNSS Reflectometry (in collaboration with the National Oceanography Centre (NOC);
- design and manufacture work to prepare a proto-flight level instrument suitable for demonstration in orbit.

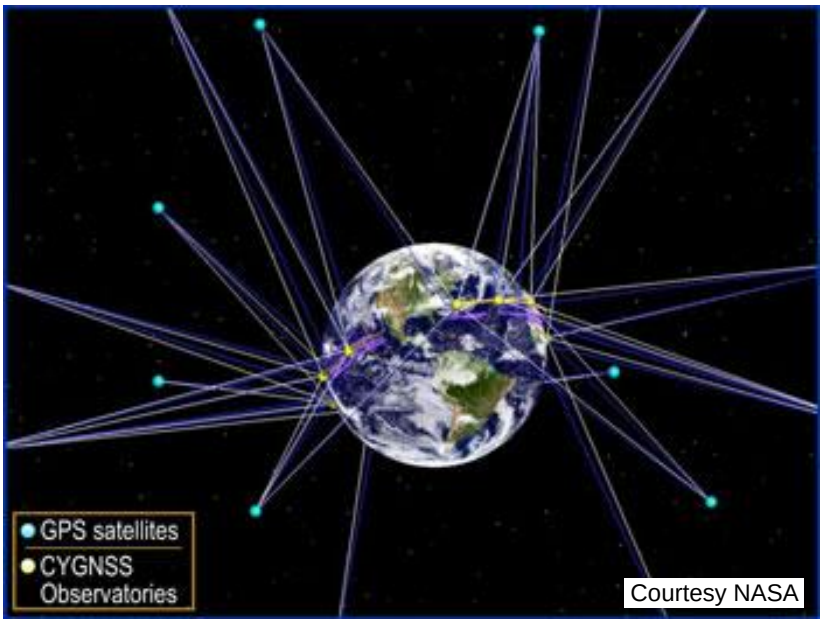


Courtesy SSTL

The Result

The outcome of the funding was the successful development and manufacture of a proto-flight low mass GNSS reflectometry instrument (known as SGR-ReSI). The flight-readiness led to the selection of the instrument for demonstration in orbit on TechDemoSat-1, with support from ESA to demonstrate the measurement of ocean roughness and wind speed using this new technique. At the end of the programme, the instrument was at TRL Level 9, with 8 papers being published and 4 PhD and Case studentships funded.

Wider Deployment



The SGR-ReSI instrument also made the NASA CYGNSS mission possible. The mission will enable scientists, for the first time, to probe key air-sea interaction processes that take place near the inner core of storms which are rapidly changing and which play large roles in the genesis and intensification of hurricanes. CYGNSS is part of the NASA Earth Venture programme and the instrument enabled the University of Michigan to win $150m of NASA funding for the mission.

SSTL and Surrey Satellite Technology US subsequently won the contract to supply the eight instruments for the CYGNSS mission microsatellite constellation. Additional leveraged funding was also obtained for the WaveSentry Study, which looked at marine forecasting using diverse data sets, including GNSS reflectometry.

The SGR-ReSI instrument is also the basis of Surrey Satellite Technology Ltd's next generation space GNSS receiver product, the SGR-Axio. This has been selected and delivered for the NovaSAR mission, and will be supplied for four other satellite missions.

The Future

The GNSS reflectometry instrument has now been selected for the ESA "HydroGNSS" Scout Mission. This will make observations of essential climate variables relevant to the hydrological cycle: soil moisture, freeze/thaw in permafrost, above-ground biomass and ocean wind speed. The mission will have two micro-satellites embarking a GNSS reflectometry instrument in a sun-synchronous orbit (SSO) at 550 km altitude.
Unlike missions such as CyGNSS (Cyclone Global Navigation Satellite System) and TDS-1 (TechDemoSat-1), which were focused on sea/wind, HydroGNSS will focus on GNSS-Reflections (GPS and Galileo) from land and ice, in order to measure Soil Moisture Content, Above-Ground Biomass and Permafrost state. The satellites will:
1) use Galileo E1/E5, which will give much higher measurement resolution compared to GPS L1/L2 in other missions like CyGNSS. This would apply especially to the biomass estimates, where the resolution would improve from 25 km to 1 km.
2) incorporate dual circular polarisation, which can mitigate the effect of roughness and improve the correlation with soil moisture. The PR also exhibits a good sensitivity to different levels of above-ground biomass ranging from 100 ton/ha (boreal forest) to 350 ton/ha (tropical forest).
3) incorporate a coherent channel with amplitude and phase information to give greater sensitivity to different soil conditions, freeze / thaw effects, and wetlands.

CEOI

The Centre for Earth Observation Instrumentation (CEOI) works with UK organisations, both academic and industry. Its objective is to develop a world leading, internationally competitive, national Earth Observation (EO) instrument and technology R&D capability through the teaming of scientists and industrialists. The CEOI is funded by the UK Space Agency with parallel technology investment from industry.

Further information about this technology and others funded by the CEOI can be found at www.ceoi.ac.uk.
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