Paper ID: 32602
oral

EARTH OBSERVATION SYMPOSIUM (B1)
Earth Observation Sensors and Technology (3)

Author: Mr. Bas van de Kerkhof
Netherlands Aerospace Centre (NLR), The Netherlands, Bas.van.de.Kerkhof@nlr.nl

Mr. Bert-Johan Vollmuller
Netherlands Aerospace Centre (NLR), The Netherlands, bert-johan.vollmuller@nlr.nl
Mr. Hein Zelle
Netherlands Aerospace Centre (NLR), The Netherlands, Hein.Zelle@nlr.nl
Dr. Hans van der Marel
Delft University of Technology (TU Delft), The Netherlands, h.vandermarel@tudelft.nl

ON BOARD PAYLOAD DATA PROCESSING FOR GNSS-R; USING FFT-PROCESSING TO COMPUTE DOPPLER DELAY MAPS

Abstract

GNSS reflectometry (GNSS-R) will become a powerful remote sensing technique for observing ocean altimetry, sea state and soil moisture. With more than 130 GNSS satellites to be available in the near future, the use of GNSS signals for novel sensing applications such as GNSS-R is possible. The first GNSS-R satellite, TechDemoSat-1, is already available and soon other missions will become available (e.g. Cygnss). In each of these missions the on-board processing of the data is challenging. A GNSS-R payload performs a correlation between the direct received signal (or a replica of it) and the reflected signal, to generate a so-called Doppler Delay Map (DDM). This is normally done in the time domain and requires a lot of processing power which is hard to achieve with traditional implementations: space qualified processors are relatively slow, FPGAs can only incorporate small algorithms and mission specific ASICs are expensive.

This project shows an innovative solution for generating these Doppler Delay Maps in the frequency domain, using the space qualified FFT Co-processor ASIC. This chip is the fastest space qualified FFT-coprocessor in the world, with full floating point accuracy and approximately 4 GFLOPS of performance. With this solution the DDM calculation can be performed much quicker and more accurate than in the traditional way in the time domain.

The algorithm used to generate DDMs in the frequency domain is based on Radar's algorithm. C.M. Radar developed an improved algorithm for high speed autocorrelation in case a small number of lag values are desired for extremely long data sequences. The basic idea is to divide the data into windows of M/2 points each and use only M-point FFTs to compute the first M/2+1 lags of the cross-correlation function, even though the data series could be indefinitely long. So for N data samples the calculation of the correlation function reduces to 2 M-point FFTs for each M/2 data points and 1 IFFT instead of M/2+1 N-point dot products. The algorithm to generate Doppler Delay Maps is a natural extension of Radar's algorithm and is validated using Level 0 data from TechDemoSat-1.

The paper will show the detailed structure of the calculation of the DDM, performed with FFTs, validation results and some performance figures.