SysNova: Challenge #3 – Weather

Executive Summary

This summary presents the work by the University of Strathclyde, SCISYS and Roke Manor Research in response to the ESA SysNova Challenge AO7891; Remote sensing with cooperative nanosats, Challenge #3 – Weather. The objective of this work was to evaluate the performance and cost of multi-agent satellite networks capable of providing data in support of severe weather monitoring.

Each 6U CubeSat platform accommodates a continuously operational passive nine-frequency microwave radiometry instrument designed to concept stage using requirements defined in discussion with the user community. The instrument has four channels centred on the oxygen absorption line at 118.75GHz, and again at the water vapour absorption line at 183GHz, plus a window channel at 108.5GHz to produce profiles of the different atmospheric components with altitude.

A trade-space exploratory approach was employed in which 1806 different design architectures were analysed. The utility of each design, which is a combination of pixel resolution, revisit rate, data latency and delivery ratio, is compared against mission cost, and visualised in a solution space. Of the 1303 compliant designs, two were analysed in greater detail, one of which features inter-satellite links, which is identified as an emerging, enabling technology for this kind of mission. Resolution of 39.4km, mean revisit rate of 1.79 visits per hour, mean latency of 20.6 minutes to a ground station and complete data delivery is found for the 26-platform ISL-capable design. A visualisation of the constellation's coverage is shown in Figure 1. Cost of the compliant architectures range from 30.7 – 87.7M€, for the design, development, manufacture, launch, operations and replenishment during the first three years of operation. Uncertainty analysis suggests a 12% reduction in revisit rate during the first 3 years of operation is possible.

A file-based operations approach is recommended, where data packets are delivered to the distributed ground station network, processed to level 1c data at a central processing facility and then delivered to the user. The data repatriation time from reaching a ground station to user deliver is predicted at <30 minutes, offering the user community a global data set, with better than hourly revisit rate and sub-hour latency.

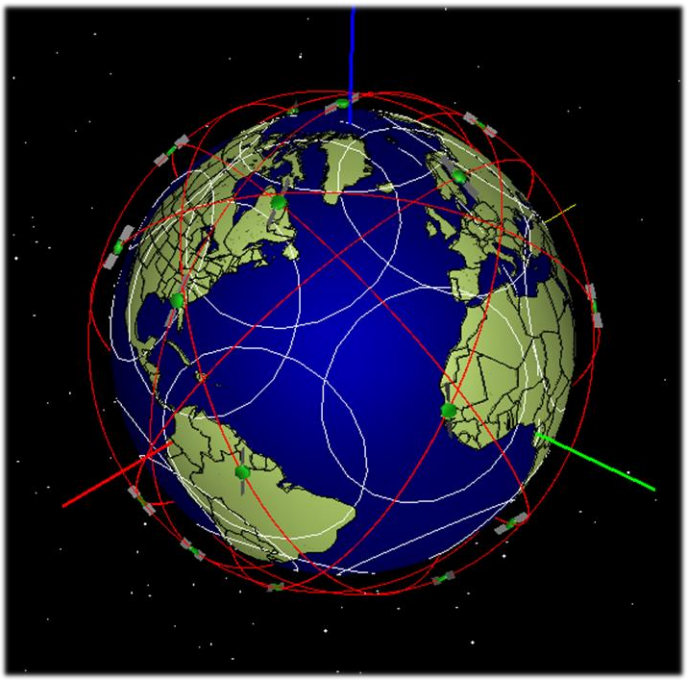

Figure 1 Visualisation of CubeSat constellation coverage

Key areas of technology considered in need of further analysis and development include; inter-satellite link technology, Indium Phosphide transistor's, micro-machining of microwave instrument waveguides and the application of file-based data packet transfer from CubeSats; potential sources of all key technologies have been identified within ESA member states. Data acquisition and distribution processes also need further attention, which should involve the user and customer community, in order to highlight any potential for revenue gain and global application of the provided data.

The mission concept is considered viable at this stage.