AIRBUS

Call for pitches – Guidelines for R&T topics

Topic of interest: Space Surveillance and Tracking (SST)

Airbus Contact Person: Cyrille Tourneur

Short description of research topic:

LEO Debris Cataloguing with Space Based Surveillance System.

Detailed areas of research proposed:

LEO debris population is increasing threat for operational systems with a current risk of $20M/year with currently deployed fleet of assets in orbit according to a study released in summer 2020. This trend and value of the related Bayesian risk will increase tremendously in the coming years due to the augmentation of assets to be deployed in the LEO domain (incl. mega constellations) on one hand and to the permanent increase of debris population in this regime on the other hand.

Ground based surveillance systems, mainly based on radar, can track debris down to 10cm and 5cm very soon. Unfortunately, debris down to 2mm to 4mm are a lethal threat to operational satellites in LEO and cannot be monitored by ground based systems due to the constraints of the laws of physics. This gap in surveillance has to be filled, especially with regards to the fact that distribution of debris in LEO follows a power law vs the inverse of their size.

In addition, surveillance of LEO resident debris requires accurate cataloguing performance (i.e. accuracy of the components of their state vector such as osculating Keplerian parameters, ballistic coefficient, solar radiation pressure coefficient,..) so as to enable efficient operational collision avoidance services (poor state vector covariance results in unacceptable collision false alarm rates).

An alternative concept to ground based surveillance systems, currently considered by various commercial and governmental players so as to fill the observation gap, consists in deploying small satellite constellations for in-situ optical detection and tracking of LEO objects (i.e. Space Based Surveillance Systems – aka SBSS). However, due to the observation concept (short arcs observation due to optical instruments narrow field of view), several challenges have to be tackled so as to enable emergence of operational SBSS. Two of these challenges are identified as potential R&D topics with Australia & NZ.

Target results foreseen (e.g. maturity level to reach, deliverables to produce, estimated timing, etc.):

- Challenge 1:

Initial Orbit Determination (IOD) of LEO debris from several short arcs measurement.

A single short arc observation usually provides 2 to 4 independent measures whereas at least 8 measures are needed to retrieve the 8 components state vector of the debris (more observations are actually needed to achieve accurate cataloguing performance). Hence several time separated (by a significant fraction of the debris orbital period so as to avoid singularities) observations of the same object are required to achieve a successful IOD. The main challenge associated with LEO debris IOD is the short arcs observations matching, which is a mathematically/computationally difficult problem for which few research have been done up to now (whereas numerous research works have been done for debris in GEO for which the problem is considerably simpler). The proposed R&D stream would therefore be related to the IOD techniques and short arcs matching algorithms for LEO debris cataloguing performed by a SBSS constellation operated in LEO orbit.

Other relevant aspects to consider (e.g. previous experience required working in Defence and Space sector, access to specific facilities or laboratories, etc.)

A clear expertise in the technological area and possibilities to bring to the consortia material, laboratories, test-facilities and workforce would be of high interest.