28 - Team Taking Control

The region between 20 to 100km in altitude, defined as NearSpace, is expected to experience a rapid increase in the number of aerial vehicles in the coming years, which poses an increased risk of collision or interference and will impact the environment. To prevent incidents, a control concept for this NearSpace is required and has been designed, which involves integrating the current Air Traffic Management (ATM) and Space Traffic Management (STM) systems with a newly designed NearSpace Operation Management System (NOMS) to surveil and manage all aerial objects passing through NearSpace. To incentivise a reduction in the environmental impact of aerial vehicles, a fee system based on vehicle emissions and spatial use can be implemented in the NOMS. One of the greatest environmental issues in NearSpace is the unmonitored emission of water vapour by air-breathing vehicles; both as a greenhouse gas and as an ozone-depleting agent. To act on this; a system for monitoring both the radiative forcing and the dynamic evolution of exhaust trails in NearSpace was designed. The client, Royal Netherlands Aerospace Centre (NLR), has a civil interest in the development of a NOMS and has therefore provided the top-level requirements; from which the architecture and high-level protocols for such a system were designed by the Taking Control project team.

Mission Objective

To begin the project, the objective of the team was to design a traffic operation management system for vehicles in NearSpace fully covering Europe with a focus on The Netherlands, interoperable with current traffic systems. This meant that an inventory of all the required system components was made and the different options and combinations for surveillance, concepts of operations (ConOps), protocols and architecture had to be investigated. With this completed, the team focussed on designing a space-based platform that is capable of monitoring the radiative forcing effects and the dynamic evolution of exhaust trails from air-breathing vehicles in NearSpace, to integrate with the fee system of the NOMS and enable research. Therefore NOMS operations form the basis of the set of requirements, from which both a preliminary and detailed design for the platform was performed.

System Design

From the performed literature study on NOMS, it became evident that the system should have the ability to surveil and communicate. This had to be accommodated by a set of ConOps and infrastructure. It was decided that a fully off-the-shelf approach for the architecture would be the most cost-effective and sustainable while still guaranteeing a sufficient amount of safety. For the pre-flight ConOps partial flight plans using 4D trajectories would be used, while in-flight ConOps would require centralised semi-automated rule-centric communication where a central station communicates with the operators using both data and voice. This communication would be done using a combination of super and ultra-high frequencies. Finally, for the surveillance of cooperative objects, ADS-B would be used, whereas a modelling approach was taken for uncooperative objects such as reentry vehicles and space debris.

For the design of the contrail-sensing part of the NOMS, a constellation of three satellites in polar orbits is used to have global coverage twice every day with an increased spatial resolution for latitudes above 13°compared to the MetOp mission. Moreover, it was decided to launch using a Falcon Heavy, which will allow the three Infrared Atmospheric Sounding Interferometer - Next Generation payloads to create profile measurements of carbon dioxide (CO_2), methane (CH_4), reactive nitrous oxides (NO_x) and water vapour (H_2O) of NearSpace.