**4000-Character Abstract**

The proposed research aims to develop an analytical framework for assessing the impact of miscommunication or low-connectivity conditions on the automated separation assurance of multiple cooperative airplanes sharing the same airspace. The Intergraded Separation Assurance In Low-Connectivity (iSEALC) framework is a solution for future high-density self-separating airflow envisioned by NextGen. iSEALC framework is based on the notion of multiple cooperative aircraft flying along their parameterized routes and sharing their state and intent information. The framework takes into account the switching topology and possibly degraded connectivity of the existing communication networks defined for NextGen and performance characteristics of heterogeneous aircraft.

Research will build upon past expertise with the Coordinated Path Following (CPF) of Multiple UAVs project and the use of novel adaptive control strategies to ensure a predictable response of a system of multiple aircraft sharing the same airspace in the presence of adverse communication conditions. The CPF concept is based on the 4D notion of trajectory representation that consists of the 3-dimensional analytical definition of path and the 1-dimensional velocity profile associated with the path. Multiple airplanes can be safely assigned to follow the same paths that intersect in the space but are still separated in time. The CPF concept naturally fits the NextGen 4D notion of the airspace utilization; its fundamental results are a perfect match for the key objectives of the nationwide program.

We propose to extend the developed distributed CPF solution and apply it to the separation assurance task by addressing the following challenge. Consider multiple airplanes entering an airspace sector where they are assigned to follow a given set of paths with the nominal speed profiles. Assess the separation assurance bounds of these airplanes under modeled degraded communication conditions. Find the worst case communication scenario that would result in violation of the predefined set of separation constraints (the separation constraints are different for different classes of airplanes). Develop methods that will improve separation assurance guarantees in the case of degraded communication conditions that are limited by the current level of communication technologies.

The solution to assess the separation assurance bounds naturally follows from the results of the CPF solution. Besides the guaranteed performance bounds of path following, the key result relevant to the separation assurance objective of this NRA is a novel distributed coordination control law. The control law enforces the temporal constraints that guarantee tight coordination of the fleet of multiple airplanes in the same airspace by adjusting the speed profile of each vehicle. This adjustment is done onboard of each airplane in distributed fashion and is based on coordination states exchanged among the vehicles over a supporting communications network; for example ADS-B. Theoretical simplicity, proven stability and the distributed nature is what makes this novel solution especially suitable for the task at hand. Furthermore, the control law is proven robust to the intermittent nature and loss of QoS in communication networks; the analytical bounds of coordination performance are explicitly given as functions of the Persistency of Excitation-like condition of network connectivity. The control law is computationally inexpensive and thus is readily feasible for onboard implementation.

The nature of this research conforms to the NRA-AFCS-1.5 goals and objectives for utilization of distributed heterogeneous communication resources which are either given by existing technologies (ADS-B, GPS, TIS-B, CPDLC) or will be developed in the near future. The proposed research provides solutions for the analysis and assessment of the adverse impact of communication disruptions on separation assurance.