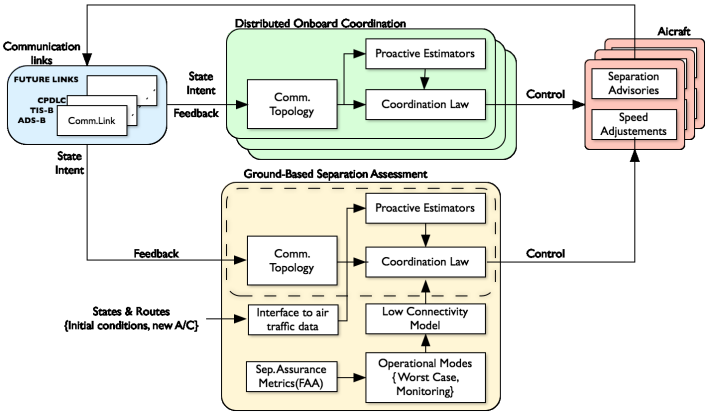
Executive Summary

***Objective*:** The proposed research will develop an analytical framework for assessing the impact of mis-communication or low-connectivity conditions on the automated separation assurance of multiple cooperative airplanes sharing the same airspace. The Integrated Separation Assurance In Low-Connectivity (iSEALC) framework is a solution of future high-density self-separating airflow envisioned by NextGen. The 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 as well as performance characteristics of heterogeneous aircraft. The technical challenges that will be addressed are the four subtopics of AFSC-1.5:

- formalize the failure space of individual and integrated communication technologies,
- design the loss of separation metrics and a unified distributed mitigation mechanism,
- analyze the impact of communication constraints onto the separation assurance, and
- develop a mechanism by which degraded communication and associated detection and mitigation strategies will guarantee separation assurance.

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 solution is based on transforming the key theoretical results of the CPF framework that is based on the 4D notion of trajectory representation; the trajectory consists of the 3D analytical path and the 1D velocity profile associated with the path. Multiple aircraft can safely follow the same paths that intersect in space but are still separated in time.



iSEALC: **I**ntegrated **Se**paration **A**ssurance in **L**ow **C**onnectivity conditions.

***Expected Outcomes and Benefits*:** The key outcome will be the iSEALC system (depicted in the figure). For a given ATC sector the system will "ingest" the current ATC status (class and geometry of the segment, number and type of airplanes along with the assigned routes, the communication links of aircraft and ground support infrastructure) and produce a detailed report addressing possible separation assurance violations and remedies (controls).

***Relevance to NASA Strategic Plan*:** The proposed research develops novel distributed control architecture that facilitates automation in airspace management while preserving robust separation assurance properties through scalability and cooperative computation. The proposed framework assures safe operation under the communication technologies and the air traffic mode of operation defined for NextGen. The proposed framework addresses the fundamental objectives of Subtopic AFCS-1.5 that are a part of the System-Wide Safety Assurance Technologies project announced by the NASA Aeronautics Research Mission Directorate in support of NASA Strategic Goal 4 and Outcomes 4.1 and 4.2.