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The majority of the seven papers in the Separation Track involved analyses or simulation of concepts ranging from the mid-to-far time horizon. Only one paper reported on the results of an operational evaluation. The papers found that automation poses the potential to reduce separation while improving efficiency and capacity. The papers also pointed to the interdependencies in how algorithms develop trajectory prediction errors when accounting for unknown variables such as aircraft weight and descent speed. Authors from each of the seven papers were from either a government entity or a federally funded research and development center. Brief highlights of each paper follow.

MITRE developed a method for reducing the turn required by existing divergence criteria for one of the departing aircraft using the same runway for straight out departures, as well as departures at parallel runways. This reduction makes use of current area navigation procedures utilized in many operations. Using a desired lateral separation of 3 miles when 10 miles downrange, they applied analytical geometry to ground tracks collected at the Denver and Dallas airports. A reduction in the required turn from 15 degs to between 5 and 10 degs seemed possible resulting in combined use of radar and RNAV as credit from improved navigational precision and with further reduction fro use of ADS-B and RNP.

NASA stress tested an automated separation assurance system in a high fidelity human-in-the-loop simulation. The ground automation system managed separation by allowing controllers to oversee the automation, which resulted in the control of twice as many aircraft en route as is possible today. A functional approach strategy balanced the roles of controllers and automation. Three-hour runs for four different conditions covering eight centers resulted in approximately 3% of the scripted separation losses to occur. Controllers preferred to stay in control during climb and descent phases of flight while having the automation handle flight planning functions. The promising system is under continued development with emphasis on improving the detection and resolution of short-term conflicts.

France’s Directorate for Air Navigation Services examined how uncertainties affected the feasibility of using en route traffic control speed adjustments, unbeknownst to the controller in an outer loop, to ease controller workload. Fast-time simulations enabled the analysis. With pessimistic uncertainties, the authors found that +/- 5% speed adjustments could resolve one-half of the conflicts.

NASA studied the relative effects of trajectory prediction uncertainties on automated separation assurance in fast-time simulation. They found that the uncertainties in the vertical plane, particularly the top-of-descent point and the descent speed combined with aircraft weight, caused the biggest headaches with missed alerts especially in the last minute of trajectory prediction. Their conclusion was that the separation assurance algorithm would need to better accommodate these uncertainties before implementation, noting that top-of-descent and descent speed contribute to system delay.

Lincoln Laboratory developed a principled analytical approach to assess the collision risk for unmanned aircraft. They developed contour plots showing the space in which a non-cooperative aircraft should remain outside of for given probabilities of a near mid-air collision. As an example they found that, for less than a 1 in 20 chance of a near mid-air collision, the space was an ellipse 8,000 ft in front, 5,000 ft behind, and 300 ft above and below the unmanned aircraft.

Lincoln Laboratory used a dynamic programming approach to create new TCAS truth tables based on models and metrics rather than starting from pseudocode. The results offered improved logic, as conflict detection increased by an order-of-magnitude while simultaneously reducing false alerts. The new method allows for reduced software verification time. Future work will aim to improve the handling of multiple conflicts.

The German Aerospace Center evaluated the performance of a wake vortex prediction and monitoring system installed at the Munich and Frankfurt airports. The system allows for dynamic adjustment of wake separation criteria depending on weather conditions. They found that capacity-improving adjustments were possible 75% of the testing period, and that the eventual capacity gain was 3%.