UAM tactical deconfliction via Mixed Integer Programming

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Urban Air Mobility (UAM) will exploit the third dimension to smooth ground traffic in densely populated areas [1]. On-line automated air traffic management will be key to ensure safety and optimize airspace capacity. Airspace conflict management consists of three layers : strategic deconfliction, which takes place before departure, tactical deconfliction to maintain separation provision during flight, and collision avoidance to avoid imminent conflicts [2]. This work addresses the problem of tactical deconfliction in UAM, considering different sources of unexpected traffic disruptions :

— Scenario 1 : Some trips missed their departure and/or an in-flight trip suffered a drift.
— Scenario 2 : A new operation must be accommodated with high priority.
— Scenario 3 : A non-collaborative intruder is expected to cross the UAM network.

We propose a mathematical programming model that generalizes the problem of tactical deconfliction for the three scenarios. The UAM network is modeled with a graph, while vehicle separation is modeled with linear constraints defined on this graph. Different objectives are considered, including time deviation from the nominal schedule, delays of priority trips, and maximum delays at destination. A restriction of the resulting mixed integer program where schedules of trips that are not directly affected by the disruptions are fixed is also considered. This is contemplated as a local model, where only the pairs of trips containing a disrupted or unexpected flight can receive adjustments.

We test our model on three synthetically generated topologies of the UAM network representing different underlying urban configurations. Maximum traffic congestion is simulated. We explore the benefits of using global deconfliction over a local approach. The different objective functions will be also compared, analyzing implications concerning solution fairness.

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