Commercial and civil applications of unmanned aircraft systems (UAS) are projected to have a significant growth in the global market [], with the European UAS industry, expected to exceed 10 billion euro annually by 2035, and over 15 billion euro annually by 2050 [] [] (note that these projections are pre-Covid-19 pandemic). Furthermore, taking into consideration the characteristics of the missions and application fields, it is expeditious that the most market value will be in operations of small UAS (sUAS) and the very-low-level airspace (VLL). Such a growing trend will be accompanied by an anticipated increase in traffic density and new challenges related to safety, reliability, efficiency, etc.

Focusing on safety, one main concern is the risk for probable conflicts between UAS, which can lead to mid-air collisions when the conflicts are not mitigated in time. Essentially, a *conflict* refers to a state where two or more UAS are at a distance less than a predetermined separation minimum. Methods and systems that are well established to evaluate and maintain safety in manned aviation, have been adapted and extended to UAS. In Europe, SESAR is leading efforts to develop U-space (UAS traffic management solution for Europe), a set of services that accommodate current and future traffic, in all classes of airspace and all types of vehicles. It is also will provide a suitable interface for interoperability with Air Traffic Management services [] []. Whereas in the USA, NASA is under development and implementation of a UAS Traffic Management (UTM) system, that will make it possible for a large number of UAS to fly at low altitudes along with other airspace users []. Similar approaches are followed by other countries such China and Japan, and private stakeholders such Airbus [], Google [], Amazon [], etc. The above-mentioned frameworks provide services for operating the airspace free of conflicts, by the means of Conflict Detection and Resolution (CD&R), and Collision Avoidance (CA) methods.In UTM, similar to Air Traffic Management (ATM), conflict mitigation functions are widely conducted in three levels: Strategic Level, Tactical Level, and Sense and Avoid (SAA)/Detect and Avoid (DAA). These concepts are elaborated further in the second chapter.

In this work, we will focus on tactical CD&R applicable for small UAS missions. Despite the progressive work done in traffic management of UAS, the up-to-date separation metrics, and criteria is not adequate for operations in VLL airspace and sUAS-sUAS encounters [] [] []. This comes as a consequence of heterogeneous small UAS types (i.e. multirotor, fixed-wing), their performance capabilities (i.e size, maximum take-off weight, maximum airspeed), airspace structure, Communication, Navigation, and Surveillance (CNS), etc. [] []. To assess the issue of traffic safety of small UAS, in this paper we attempt to give answers to the following research gaps:

1. What safe-separation (deconfliction) models are more efficient and reliable ( i.e. the need for dynamic separation thresholds)?
2. What are the inter-dependencies of minimum criteria and uncertainties, given a reference CD&R method, airspace environment, and safe-separation model?
3. What minimum separation metrics and criteria can be applied for sUAS only, encounters?

To answer these questions, we adopt a dynamic protection zone as a separation model, based on the work in [ref][ref], and use it to specify minimal pairwise separation criteria at the tactical level between sUAS. The proposed methodology considers 1) Multirotor type sUAS; 2) The response time of the detection and resolution logic; 3) Delay in communication (i.e. both sUAS use ADS-B like type sensors) 4) Influence of uncertainties coming from GNSS navigation and wind.

To evaluate the proposed metrics and criteria, we utilized ICAROUS, which is an open-source (<https://github.com/nasa/icarous>) distributed software enabling safe autonomous operations of UAS. We consider pair-wise scenarios operating in low-altitude, uncontrolled airspace, and assume that one of the sUAS is equipped with a DAA reference system, which will be addressed as the *ownship* sUAS. Synthetic traffic is injected by varying bearing, ranging, and heading, always resulting in loss of separation following the Closest Point of Approach (CPA) strategy [ref]. Hereafter the traffic will be referred to as the *intruder*, with no capabilities to maneuver.

Furthermore, due to inter-disciplinary research topics in the world of UAS, we attempt to bring a comprehensive terminology, more clarity, and completeness to the subject of traffic management systems in sUAS, to facilitate research communities different from aeronautics such as engineering (i.e telecommunications, software, systems, etc.), social sciences (economics, law) and others.

Overall, the main contribution of the work is estimation and recommendation of adequate separation minima and alerting criteria that can apply to tactical CD&R methods for sUAS only encounters, by evaluating conflict severities under the influence of the effects in communication delay, encounter geometry, cruising airspeed, and uncertainties such wind and navigation errors.

The rest of this work is structured in the following way: Section II contains some background regarding tactical traffic management. Section III summaries related works. In Section IV we introduce the methodology and experimental setup. This is followed by a discussion of the results in Section V, and a summary of the conclusions and future work in Section VI.