



Advanced Air Mobility: New Frontier

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Use Cases and Enabling Standards
IEEE P1920.1 (approved)
IEEE P1920.2 (ongoing)
IEEE P1954 (ongoing)

MOBILITY 2024 series = <https://www.iaria.org/conferences2024/MOBILITY24.html>

Advanced Air Mobility

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Fully automated airspace with AAM services like air taxis, air ambulances, and cargo delivery.



Image Credit: NASA

IEEE P1920.1

Standard for Aerial Network Communications

IEEE P1920.1 standard defines air-to-air communications for self-organized ad hoc aerial networks. The communications and networking standard is independent of the type of network (Wireless or Cellular or other) and are applicable to manned and unmanned, small and large, and civil and commercial aircraft systems.

<https://standards.ieee.org/ieee/1920.1/10352/>

IEEE P1920.2

Standard for Vehicle-to-Vehicle Communications for Unmanned Aircraft Systems

Vehicle to Vehicle Communications (V2V) standard for Unmanned Aircraft Systems defines the protocol for exchanging information between the vehicles. The information exchange will facilitate beyond line of sight (BLOS) and beyond radio line of sight (BRLOS) communications. The information exchanged between the aircraft may be for the purpose of command, control, and navigation or for any application specific purpose.

Chair: Kamesh Namuduri

<https://sagroups.ieee.org/1920-2/>

IEEE 1954

Standard for Self-Organizing Spectrum-Agile Unmanned Aerial Vehicles Communications

This standard defines an architecture and protocols to enable self-organizing spectrum-agile communications among unmanned aerial vehicles. The standard enables Unmanned Aerial Vehicles (UAVs) to automatically build a network exploiting available spectrum resources and deploy connectivity to terrestrial users and devices. The standard focuses on enabling the usage of unmanned aerial vehicles for fast network deployment. This standard does not cover specific communication technologies, but it is expected to leverage existing communication standards while introducing additional functionalities at system level.

Chair: Fabrizio Granelli

Air-to-Air Communications

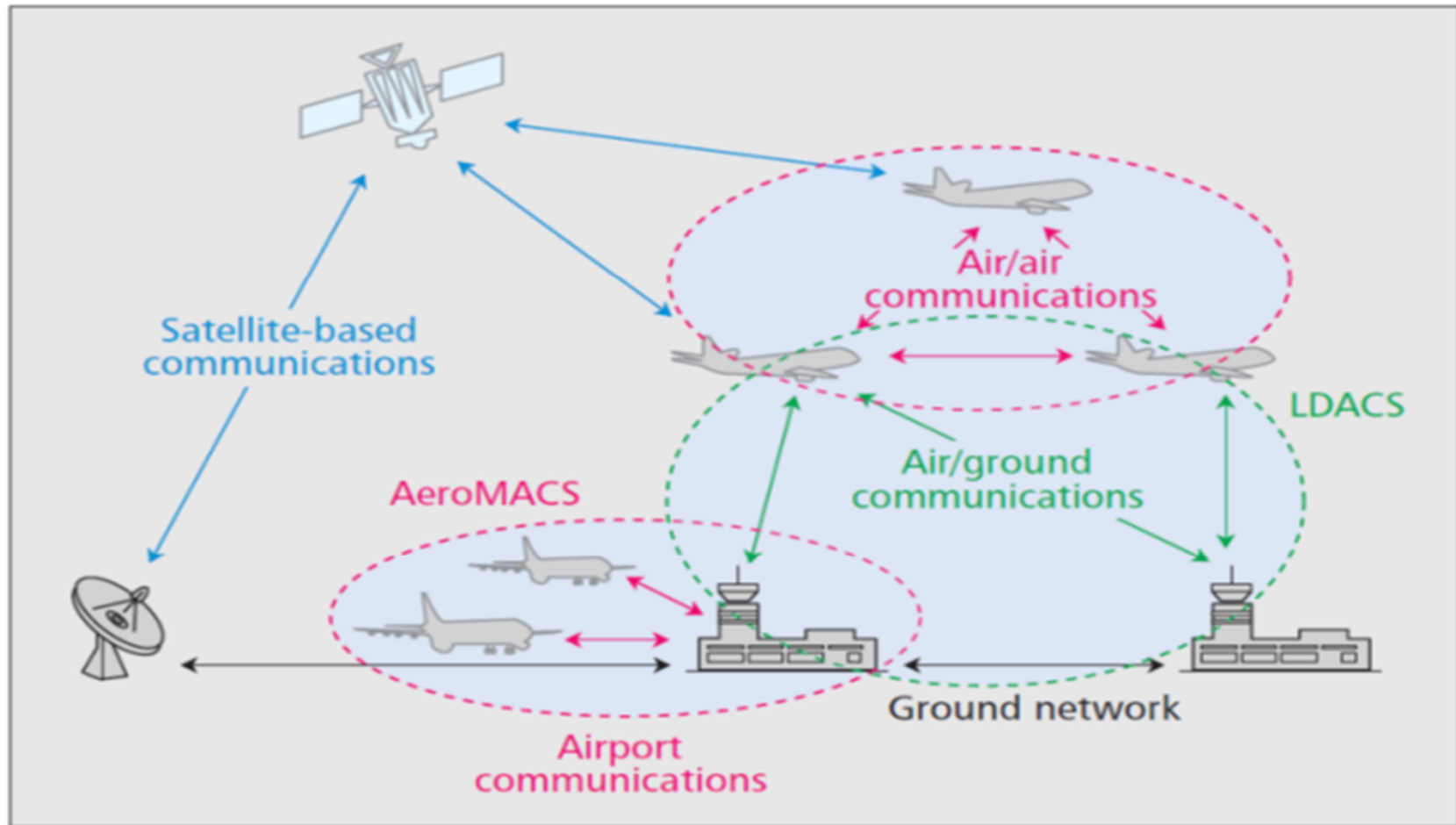


Fig. 1: Aeronautical Communications [1, Courtesy IEEE]

Focus of IEEE P1920.1

- The focus of this group is on over-the-air communications among the aircrafts. This includes
 - Radio Line of Sight (RLOS) communication among the aircraft systems
 - Beyond RLOS (BRLOS) communications among the aircrafts using Ad-Hoc Networking of the aircrafts
- Mechanisms for communications with the Air Traffic Management (ATM) and UAS Traffic Management (UTM), although relevant, are not within the current scope of this standard.

Over-the-air Communications Beyond Radio Line of Sight

- There are regions where direct surveillance of aircraft by ground surveillance is impossible due to BRLOS conditions [3].
- “Typically, the absence of surveillance takes place in the area with radius more than 400 Km for flights on the altitude of 10 Km. ... in such a zone, aircraft will fly alone for a long time.” [3].
- Existing solutions with Secondary Surveillance Radar (SSR) and ADS-B communication work for RLOS. Beyond RLOS (BRLOS) communication is not possible within SSR and ADS-B framework.

Three Paradigms for UAS Navigational Support

- ❑ Satellite-based navigational support
- ❑ 5G cellular network-based navigational support
- ❑ Ad hoc aerial network-based navigational support

Satellite-based Navigational Support

“DeSIRE (Demonstration of Satellites enabling the Insertion of RPAS in Europe) aims to demonstrate how space-based (satellite) data link communication could be a key technology for future BRLOS operations in non-segregated airspace, because of its ability to offer global, broadband and safe communications for both payload and safety communications.”

Source: <https://www.ap-swiss.ch/portfolio/desire2/>

5G-Cellular Network based Navigational Support: Challenges

- ❑ **Interference management:** Interference at higher altitudes is much higher than on the ground.
- ❑ **Handover optimization:** Handover characteristics for drones is different compared to ground mobile devices.

Source

<https://www.qualcomm.com/news/onq/2016/09/06/paving-path-5g-optimizing-commercial-lte-networks-drone-communication>

Aerial Communications Framework Complements Satellite and Cellular Communications

- SatCom is a centralized solution that allows aircraft to communicate to the ATC
- It does not allow one aircraft to communicate with other aircraft directly.
- Aerial communications is a decentralized solution that facilitates efficient and faster communication and information sharing between the aircrafts.
- Aerial networks facilitate BRLOS communication among the aircrafts.

Use Cases

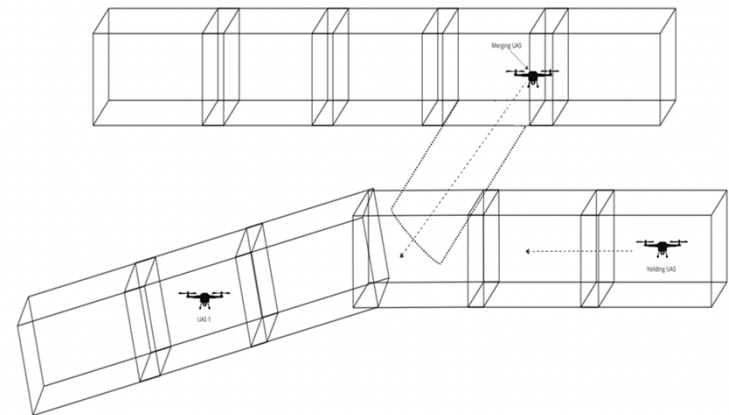
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- Merging
- Crossroads
- Minimum Separation
- Collaborative Sensing
- Airbourne Rerouting
- Information Relay

Merging

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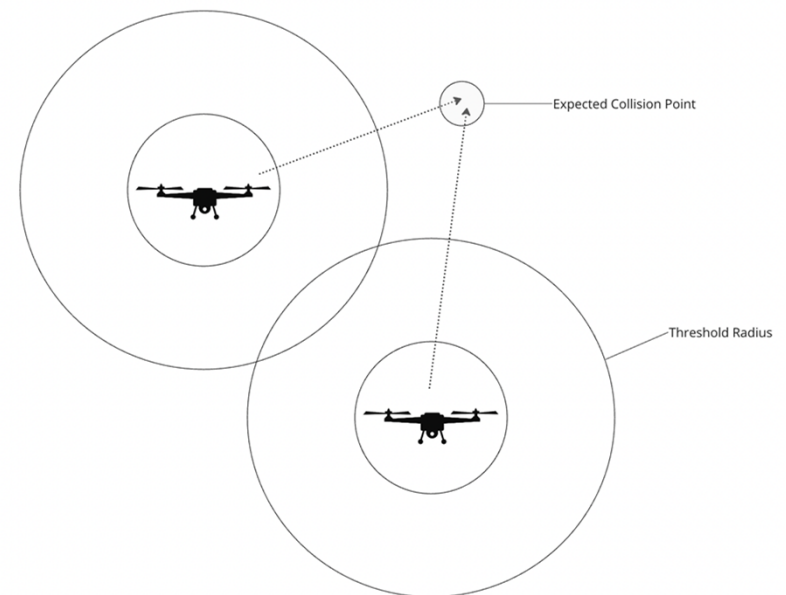
Merging is a use case scenario within structured airspace. Merging focuses on a UAS transition from one corridor to another. In this use case, UAS to UAS (U2U) communication is used for collaboration and negotiation between two vehicles to determine who yields and who continues in order to prevent a collision.



Crossroads

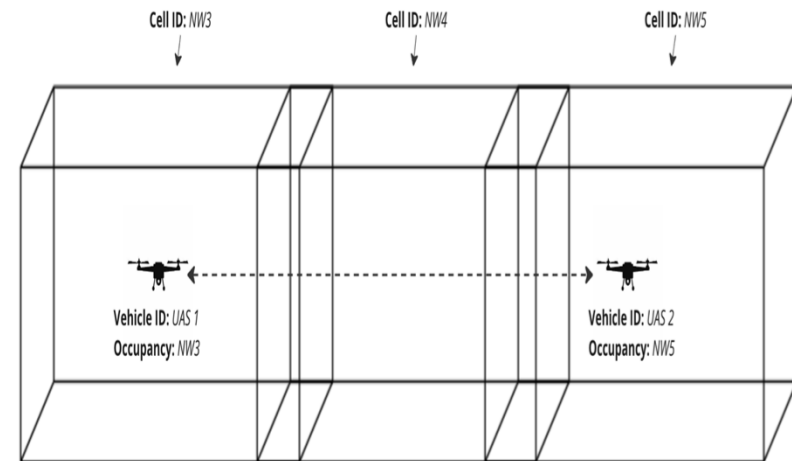
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Crossroads is a use case within unstructured airspace where there is an expected collision point. Here, vehicles use the information contained within the discovery to determine their action, which is either to yield or proceed. The role a vehicle plays is based on the priority. In this case, the vehicle with higher priority will proceed, while the vehicle with lower priority will yield.



Minimum Separation

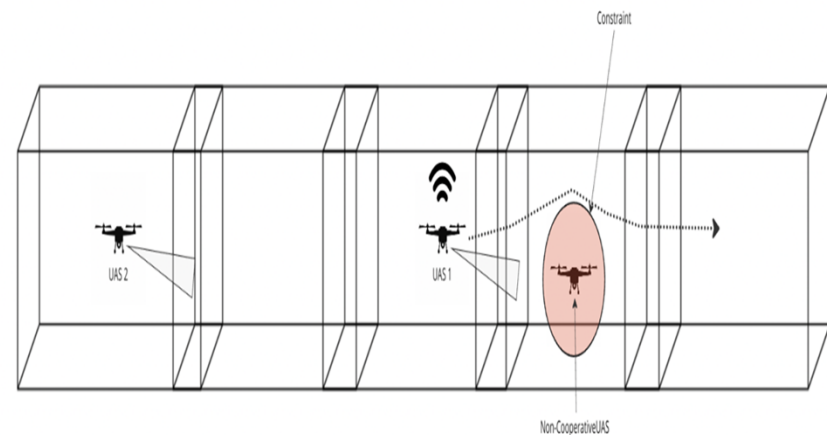
Minimum separation is a use case within structure airspace. To preserve the safety of the airways, every vehicle must conduct operations within a safe distance from one another. This minimum separation distance is a predefined distance that all vehicles must manage and maintain at all times.



Collaborative Sensing

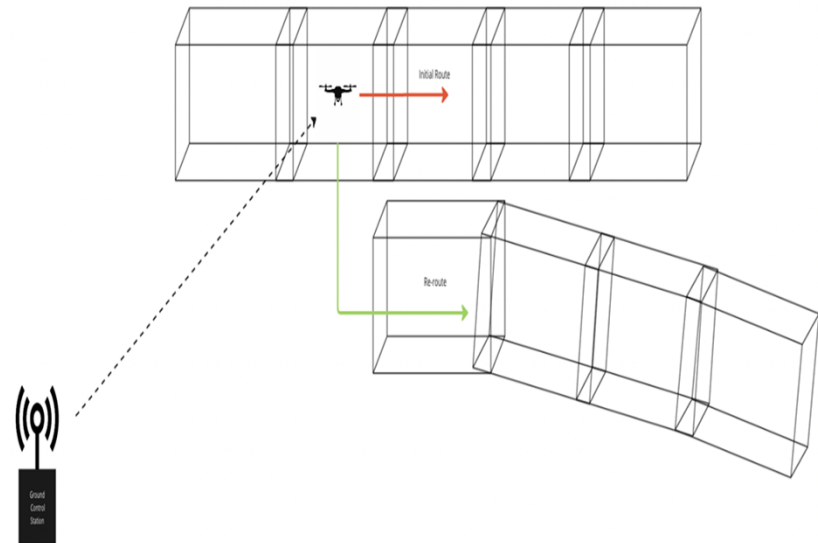
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The collaborative sensing use case is one that was proposed to provide vehicles with spatial awareness of hazards in the airways. Once a vehicle observes a hazard in the air through onboard sensors, it broadcasts a message decorated with information on the observations and sensor data to all neighboring vehicles.



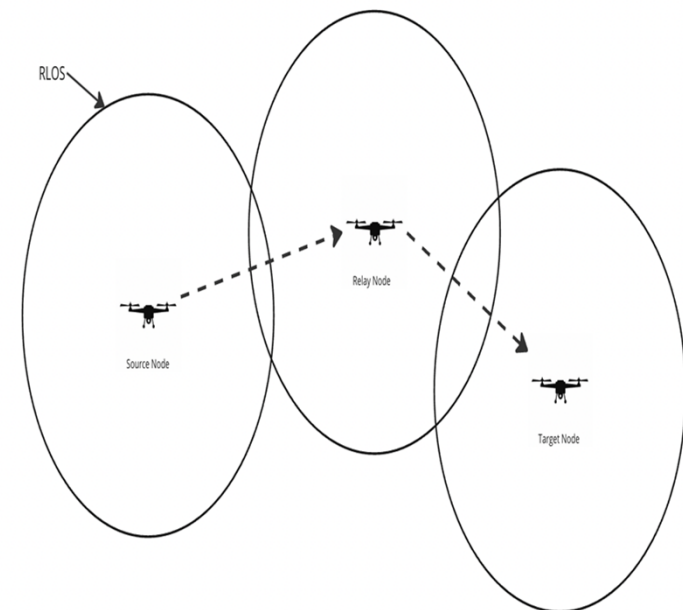
Airbourne Rerouting

Airborne rerouting is a proposed use case that allows for a UAV to have a dynamic flight plan. This dynamic flight plan is beneficial in the case of hazardous weather or other unexpected hazards situations in the airways.



Information Relay

Information relay is a use case developed to allow two UAS to communicate beyond the radio line of sight (BRLOS). This is achieved using a UAS positioned between the two to pass the message along. In this use case, a UAS can fall into three categories: a source node, a relay node, or a target node.



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Image Credit: NASA