

# Bachelor Thesis

## Design and Simulation of Communication Protocols for UAV Traffic Management in Flying Ad-Hoc Networks

### Motivation

The use of Unmanned Aerial Vehicles (UAVs) in applications such as drone delivery, infrastructure monitoring, and disaster response requires reliable communication systems for safe and efficient operation. UAV Traffic Management (UTM) systems aim to coordinate large numbers of drones operating in shared airspace. To support such systems, UAVs must continuously exchange position and status information to maintain situational awareness and avoid collisions. In addition, reliable point-to-point communication is required for coordination between UAVs and communication with control stations.

Flying Ad-Hoc Networks (FANETs), where UAVs communicate directly with each other without relying on fixed infrastructure, provide a promising solution. However, designing efficient communication mechanisms for FANETs is challenging due to high mobility, rapidly changing network topology, and limited wireless resources.

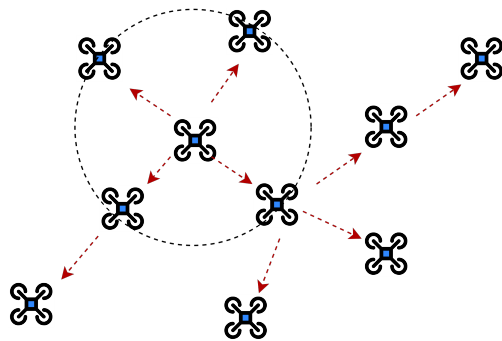


Figure 1: Position flooding in UAVs.

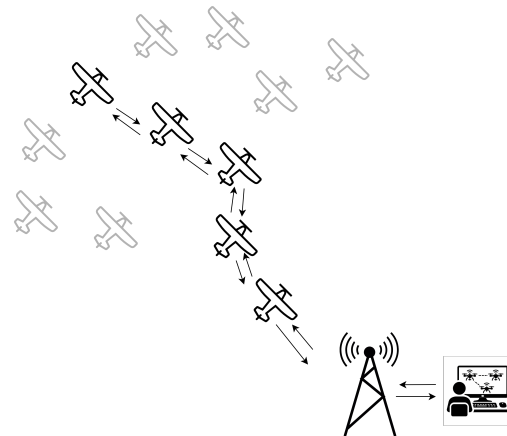


Figure 2: Direct communication from source to destination.

### Objective

The goal of this thesis is to investigate communication strategies for efficient information exchange in Flying Ad-Hoc Networks. The focus will be on mechanisms that support:

**Project type** Bachelor Thesis  
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**Language(s)** English  
**Field** Computer Science

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- Position information dissemination for situational awareness
- Reliable point-to-point communication between UAV nodes

### Key Tasks

- Study communication requirements for UAV Traffic Management (UTM) and FANETs
- Review existing communication approaches for position dissemination and point-to-point communication
- Investigate forwarding strategies suitable for dynamic UAV networks
- Implement selected mechanisms in a network simulator (e.g., ns-3)
- Evaluate the approaches under different network scenarios (node density and mobility)
- Compare performance using metrics such as:
  - Packet Delivery Ratio (PDR)
  - End-to-end delay
  - Communication overhead
  - Scalability

### Prerequisites / Required Knowledge

- Basic knowledge of computer networks
- Programming experience in C++, Python
- Interest in wireless communication and network simulation

### References

- [1] K. Fuger, M. R.-A. Rasik, K. Kuladinithi, and A. Timm-Giel, "Spotlight Flooding: Enabling Point-to-Point Control Connection in Urban UAV Networks," Proc. IEEE WiMob, 2024.
- [2] K. Fuger and A. Timm-Giel, "On the Feasibility of Position-Flooding in Urban UAV Networks," Proc. IEEE Vehicular Technology Conference (VTC), 2023.
- [3] R. Shrestha et al., "6G Enabled Unmanned Aerial Vehicle Traffic Management: A Perspective," IEEE Access, 2021.
- [4] G. Pantelimon, K. Tepe, R. Carriveau, and S. Ahmed, "Survey of Multi-Agent Communication Strategies for Information Exchange and Mission Control of Drone Deployments," Journal of Intelligent & Robotic Systems, 2019.

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