„Aus den Leistungsvereinbarungen“

Autonomous Networked Aerial Robot Systems

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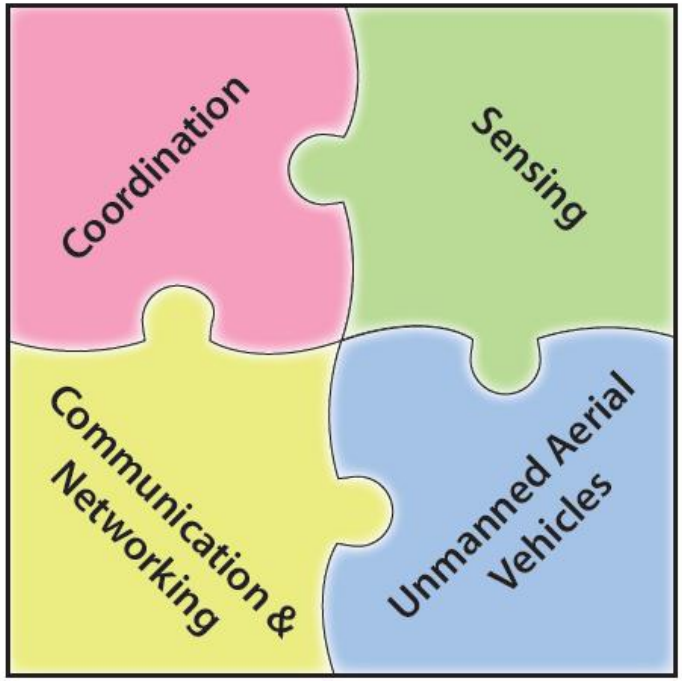
Unmaned Aerial Vehicles (UAV)

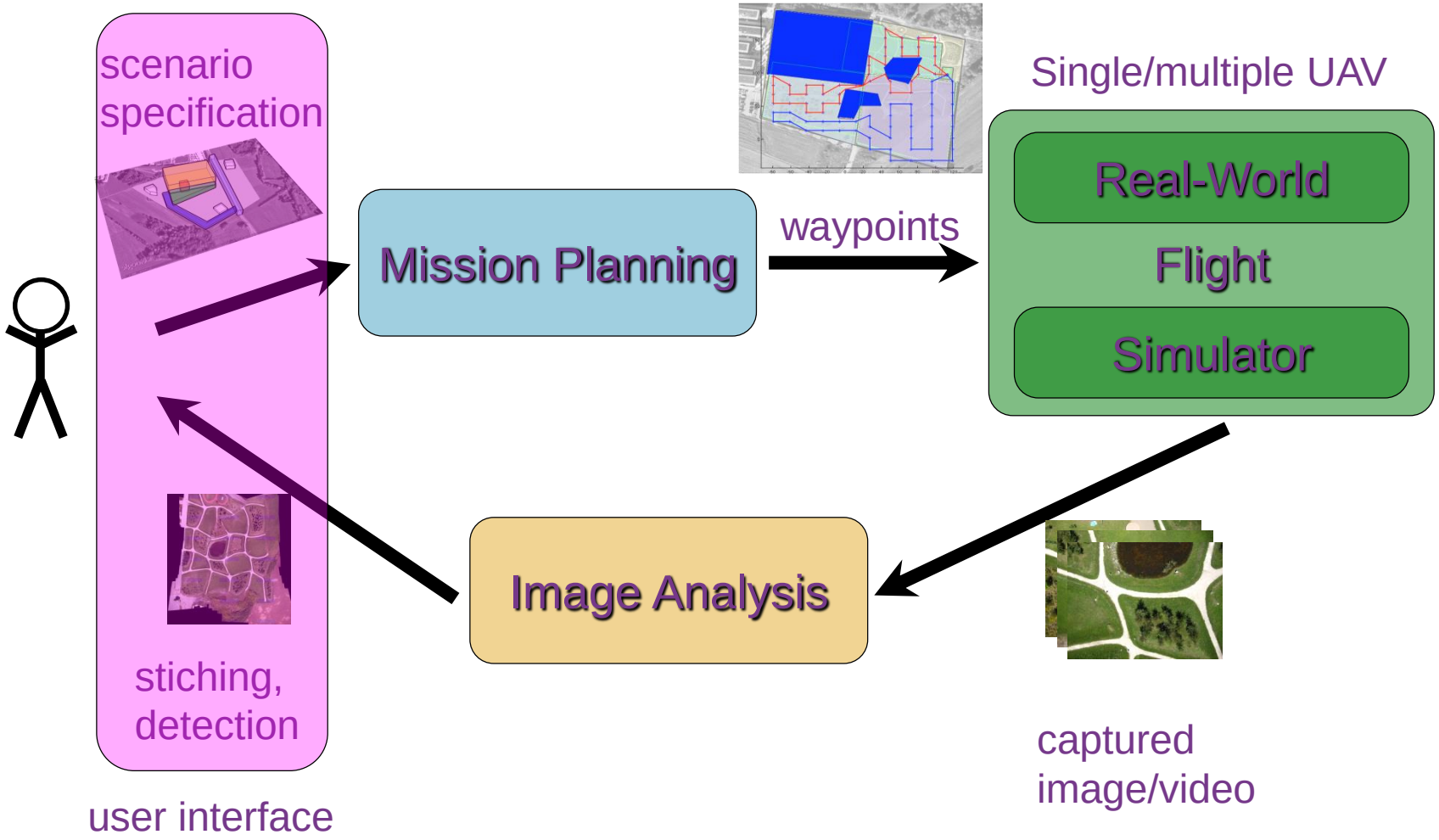
- Multi-copter platform with onboard sensors
- Attached cameras for sensing the environment
- GPS receiver for autonomous waypoint flights
- Constrained onboard processing and networking
- Limitations on payloads, flight time, weather conditions

Multi-UAV Systems

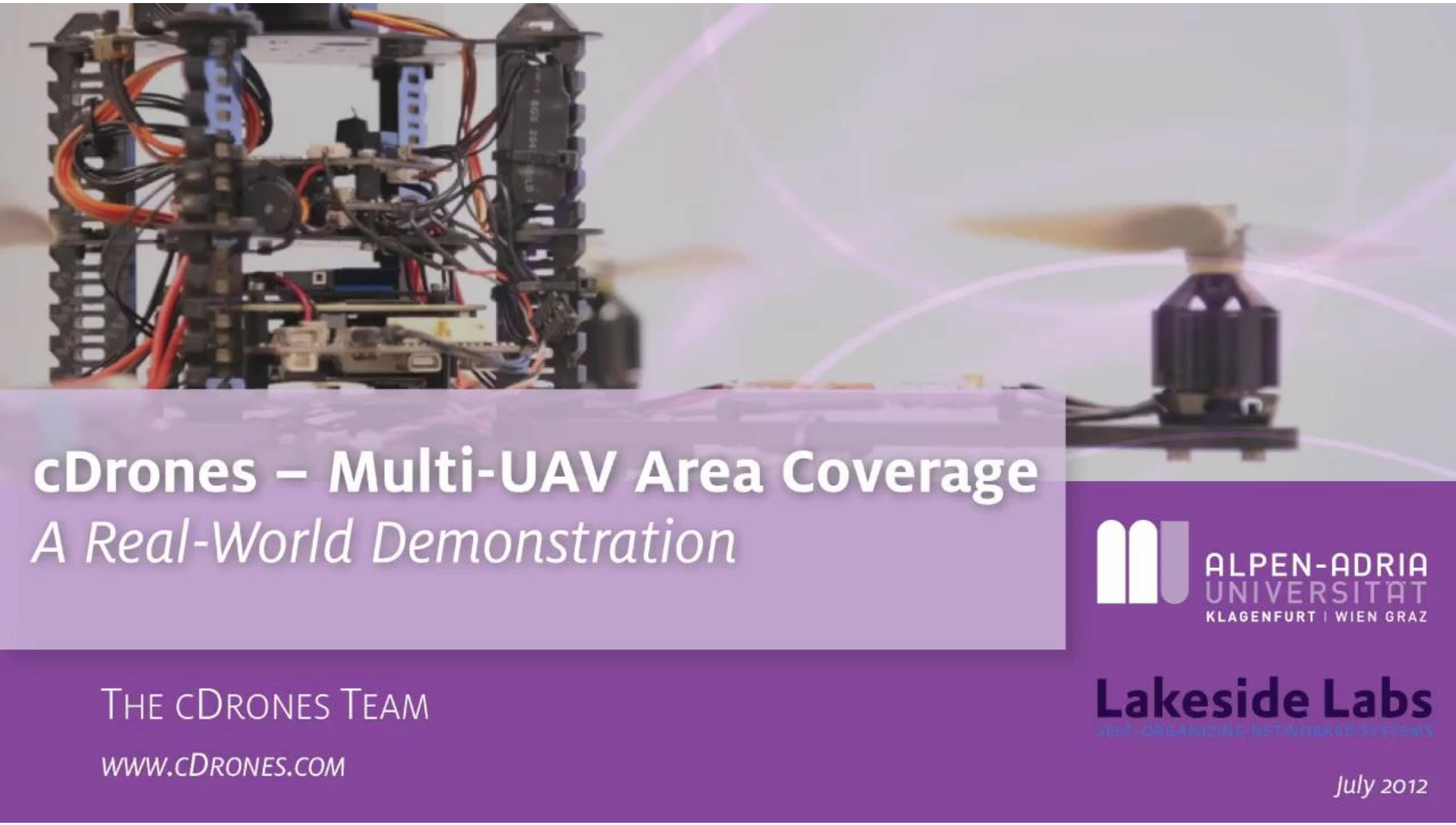
- Deploy a team of UAVs and coordinate them
- Scientific goals
  - Establish reliable aerial networking
  - Investigate multi-UAV coordination (tasks and movement)
  - Provide adaptive multimedia streaming
- Application scenarios
  - Large area observation
  - Search and rescue



Example: UVA-based Observation



Multi-UAV Observation



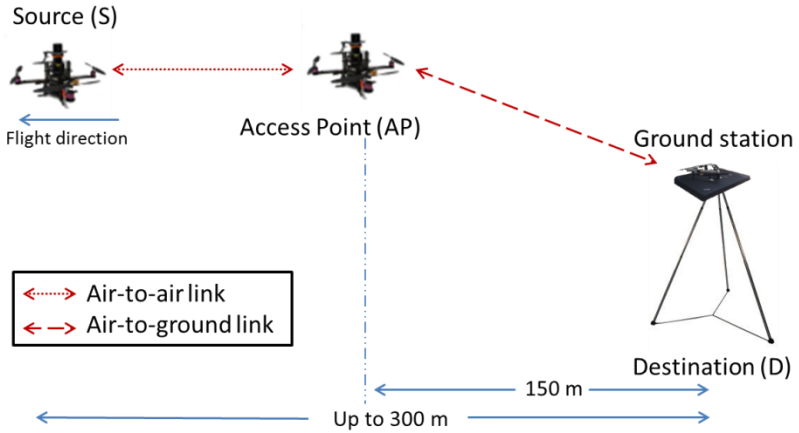
Reliable Aerial Networking

- Exploit/enhance off-the-shelf communication technology, considering the following issues
  - Influence of vehicle movement
    - 3D motion; tilting
    - Air-to-ground & air-to-air links
  - Available communication system
    - Onboard wireless interface
    - External antennas
  - Hardware limitations
    - Payload, mounting
  - Application dependent requirements
    - Mission demands, terrain, topology

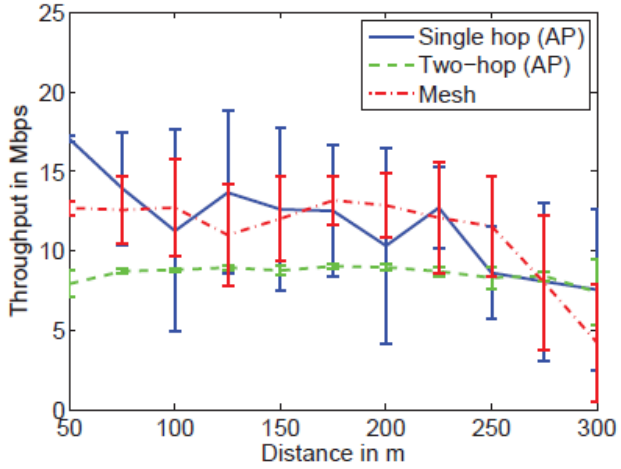
- Experimental research to answer technological questions
  - How far can we deliver data? At what rate? How do we adapt to changes?

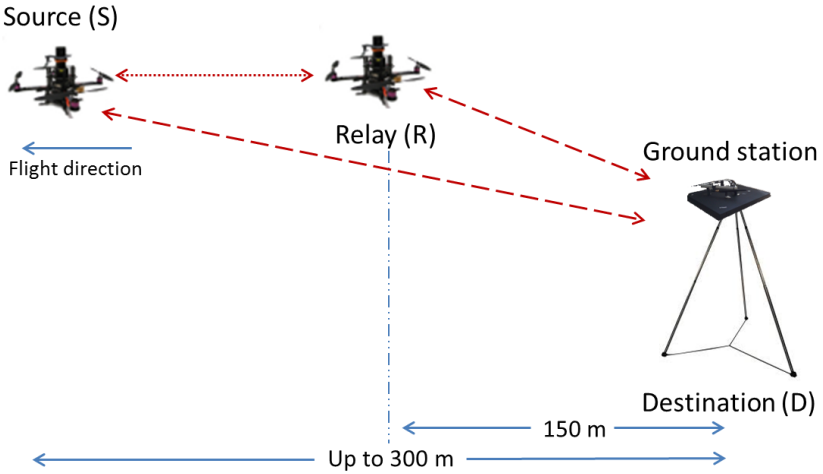
802.11 Networking Modes

- Experimental evaluation of different networking modes
  - Single-hop (AP)
  - Two-hop (AP)
  - Mesh



- Impact of network architecture

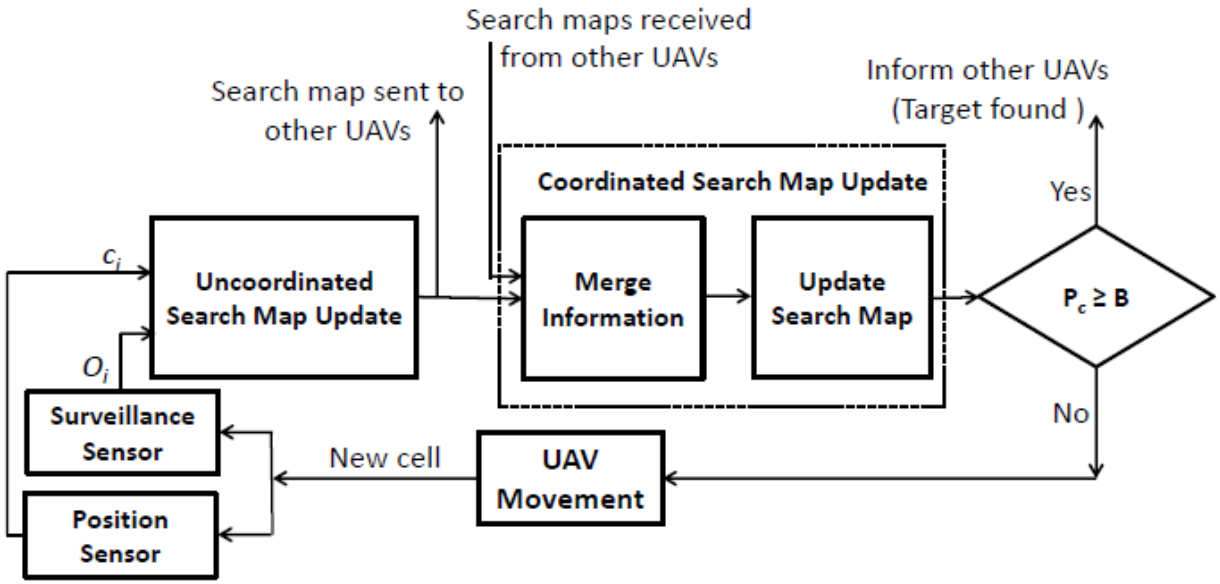




[Andre et al. Application-driven design of aerial communication networks. IEEE Communications Magazine, 2014]

Multi-UAV Coordination

- Framework for information merging and decision making among UAVs
  - Considering uncertain observations and communication limitations
  - Probabilistic analysis of target detection
  - Comparison of centralized and distributed algorithms

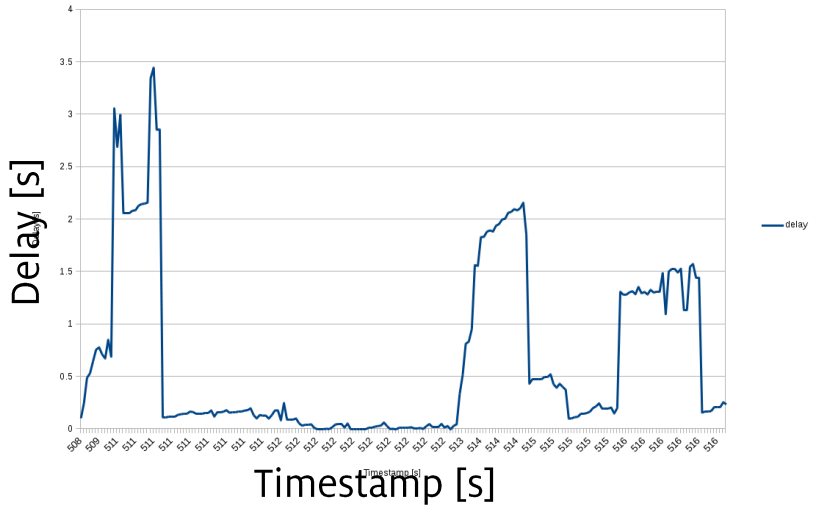


[Khan et al. Information Exchange and Decision Making in Micro Aerial Vehicle Networks for Cooperative Search. IEEE Trans. Control of Networked Systems, 2015]

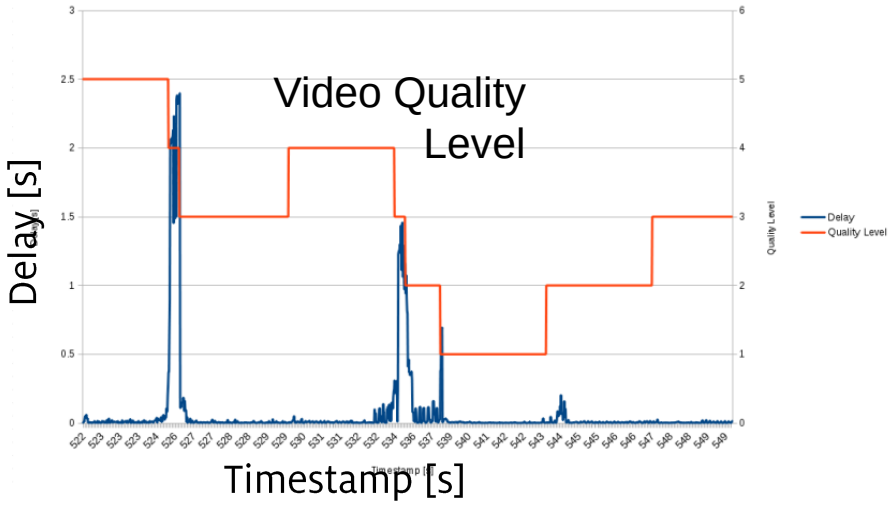
Adaptive Multimedia Delivery

- Dynamic adaptation of video content in FANET [MoVid'15]
  - Based on queuing delays of MAC/PHY packets
  - Change video rate using predefined quality levels
- Demonstrated in multi-UAV search&rescue scenario

Video delay w/o adaptation



Video delay w/ adaptation



Summary

- Joint research of four research groups with funding from
  - **Lakeside Labs**
  - Erasmus Mundus Doctoral School
- Strong synergies with newly founded JR Robotics Institute
- Stephan Weiss (NASA-JPL) new Professor of Control of Networked Systems at AAU focusing on “Collaborative mobile robot autonomy in 3D space”
- Good media coverage, e.g., Standard, WIRED-Germany