

Cooperative positioning and drone swarms



Maija Mäkelä
Department of Navigation and Positioning
maija.makela@nls.fi

"FLOCKING IS THE COLLECTIVE MOTION OF A LARGE NUMBER OF SELF-PROPELLED ENTITIES" (WIKIPEDIA)

- Birds, fish, insects...
- Flocking rules
 - **Separation:** don't crash to your neighbour
 - **Alignment:** aim towards a common target
 - **Cohesion:** don't wander too far from the group

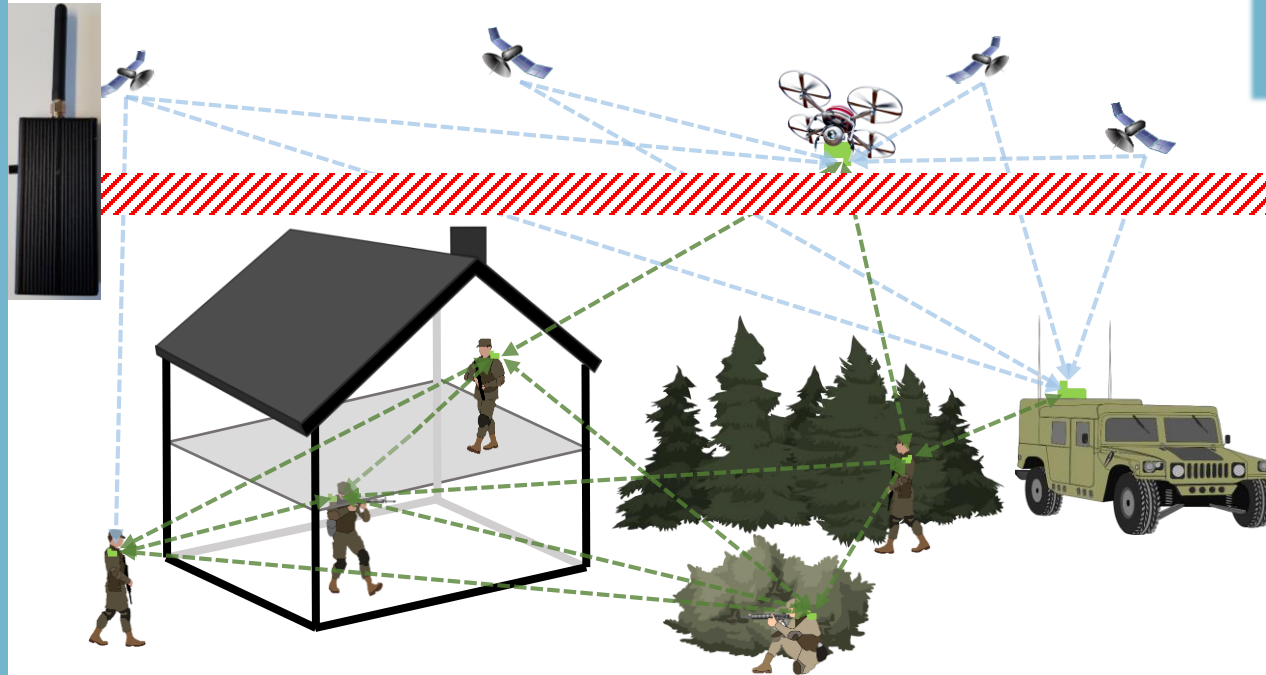


FLOCKING AND SWARM INTELLIGENCE OF NON-LIVING OBJECTS STARTS WITH COOPERATIVE POSITIONING

- Know where your neighbours are and where they are going to
- Performing tasks is easier when crashing is avoided...



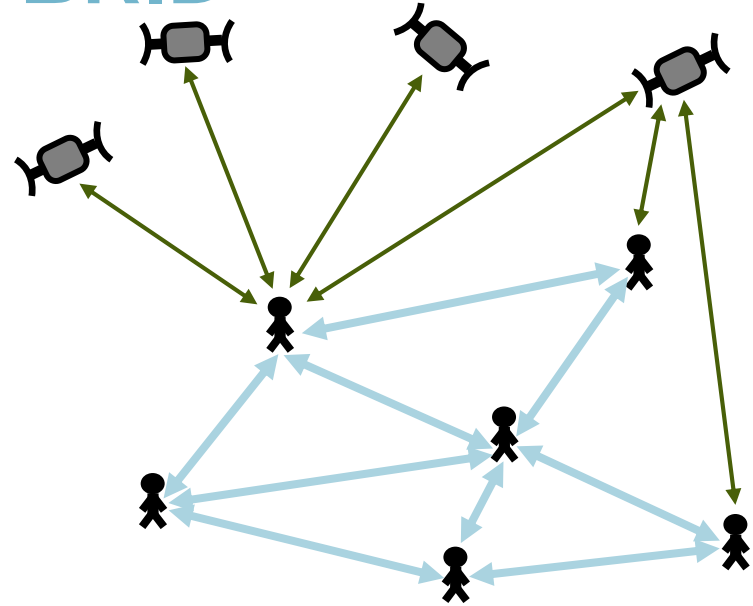
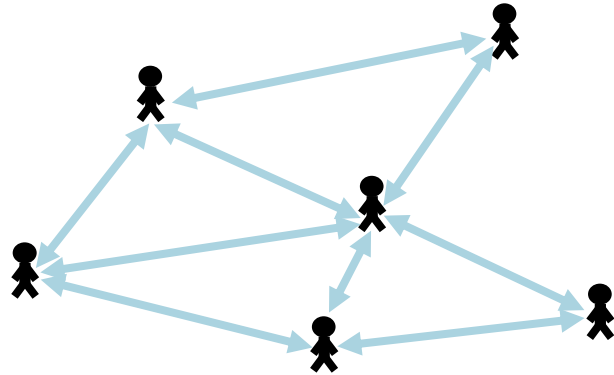
INFRASTRUCTURE-FREE COOPERATIVE POSITIONING



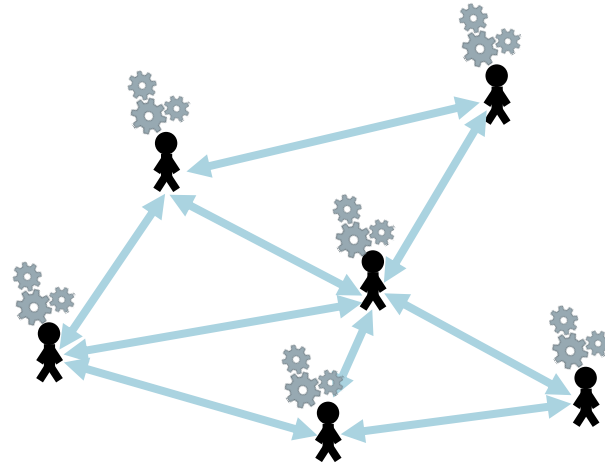
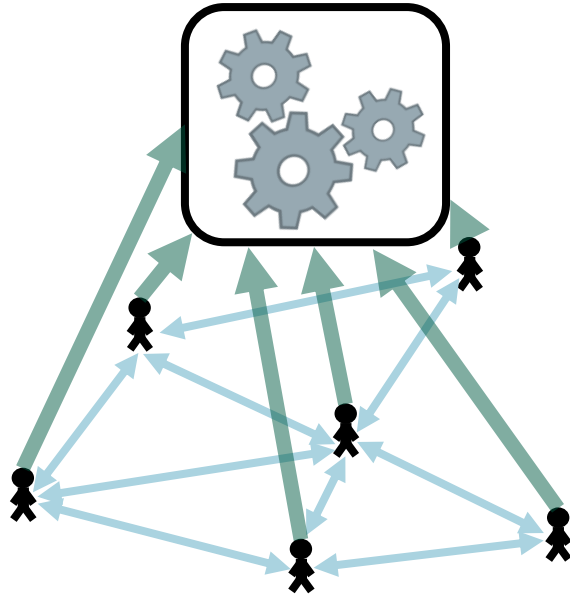
Terrestrial Ranging and
Exchange of Information

Improved
positioning
accuracy in
challenging
conditions!

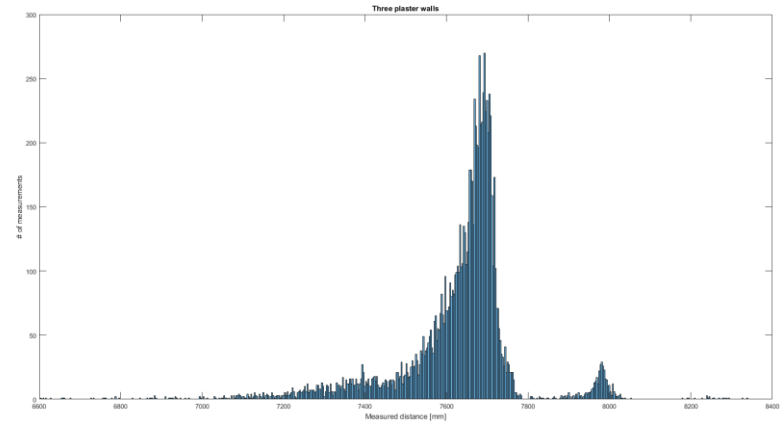
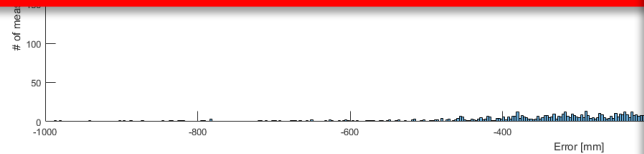
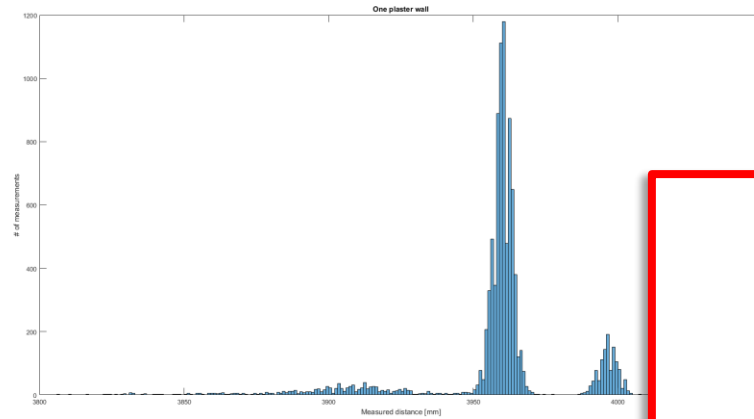
COOPERATIVE POSITIONING: GNSS-FREE OR HYBRID



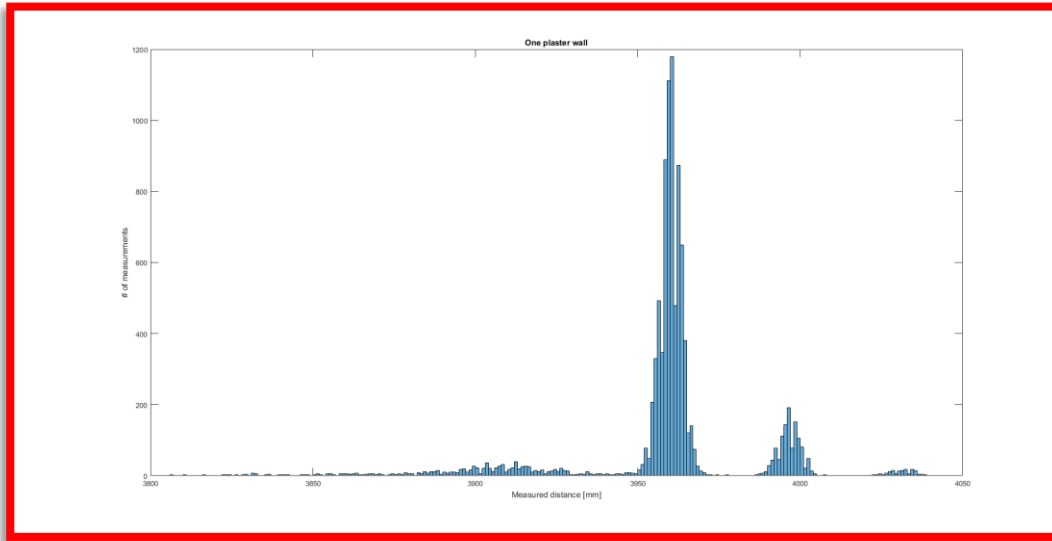
COOPERATIVE POSITION ESTIMATION: CENTRALIZED OR DECENTRALIZED



ULTRA WIDEBAND RANGE MEASUREMENTS



ULTRA WIDEBAND RANGE MEASUREMENTS



~~KF~~
?

COOPERATIVE POSITIONING ALGORITHMS IN DRONE APPLICATIONS

- Particle filter can handle non-Gaussian errors, but at what cost?
- Power consumption of positioning algorithm needs to be minimal
- We need to find something between possibly unrobust KF and computationally heavy PF

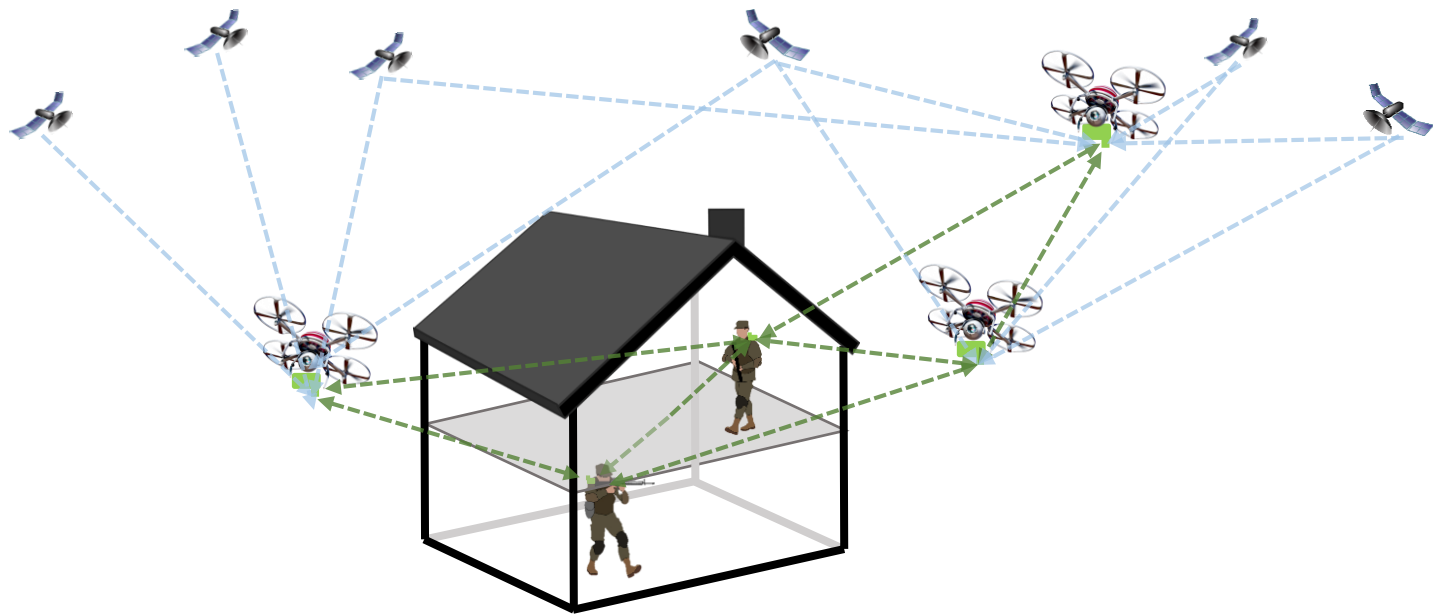
COOPERATIVE DRONES AND DRONE SWARMS

- Search and rescue, tactical
 - Autonomous and support
- SLAM: map the building before humans enter
- Entertainment
- Etc...

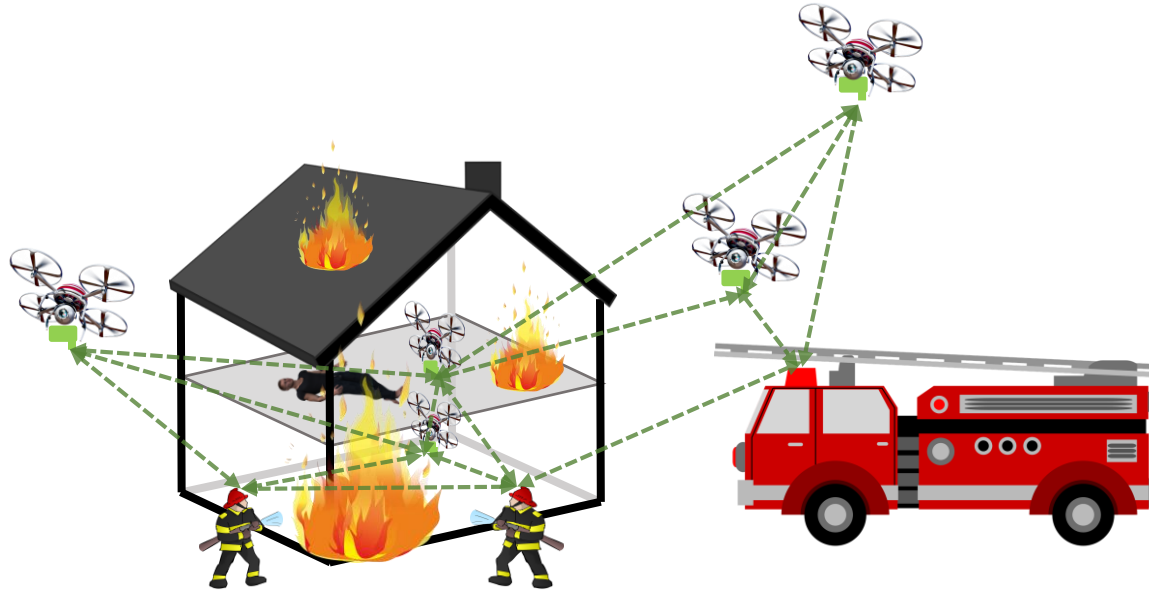


INFRASTRUCTURE-FREE INDOOR NAVIGATION CAN BENEFIT FROM DRONE SUPPORT

SUPPORTING INDOOR POSITIONING WITH DRONES



SEARCH AND MAP THE BUILDING TO ENSURE SAFE ENTRANCE



ENTERTAINMENT

Intel drone show
at 2018
Pyeongchang
Winter Olympics

Video by: Intel

COOPERATIVE BALL GAMES FOR DRONES

Video by: Institute for Dynamic
Systems and Control (IDSC),
ETH Zurich

CONCLUSION

- Flocking and use of several drones require cooperative positioning
- UWB ranging is a promising technique especially for indoor/outdoor scenarios
- Numerous applications
 - Search and rescue, entertainment etc...

INTO 2018



The Finnish Geospatial Research Institute (FGI) of the National Land Survey of Finland, the HiDATA Centre (University of Helsinki), and the Nordic Institute of Navigation (NNF) are organizing again a seminar

Indoor Navigation, INTO 2018

on Friday 23rd of November 2018, 8.30-16.00 at Scandic Park Helsinki (Mannerheimintie 46 Helsinki),

Finland. The seminar is a one-day **free of charge** event providing a glance at novel solutions in indoor navigation and networking possibilities for participants from industry and academia. We are proud to present speakers from e.g. Suunto Oy, Quuppa Oy, VimAI, Politecnico di Torino, University of Helsinki, Aalto University and the Finnish Geospatial Research Institute.

Read more about INTO 2018 and register on <https://Intoseminar.com>



THANK YOU!

