

# LAND & LOCALIZE: AN INFRASTRUCTURE-FREE AND SCALABLE NANO-DRONES SWARM WITH UWB-BASED LOCALIZATION

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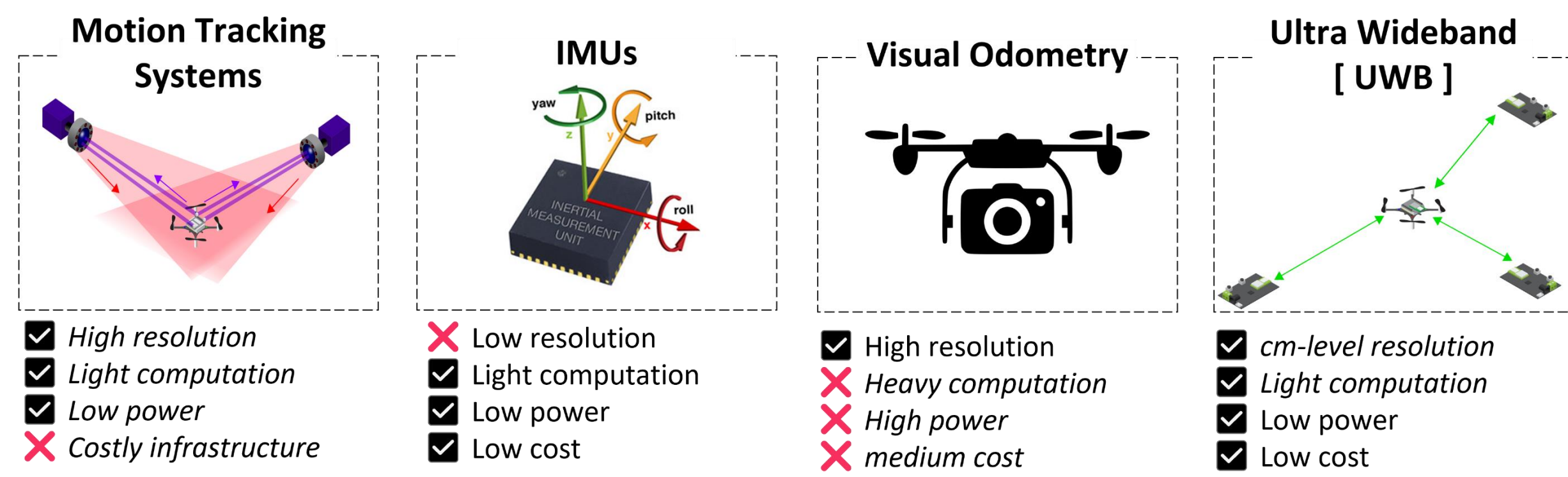
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## ABSTRACT

**Land & Localize** proposes a **dynamic infrastructure UWB localization system** enables positioning in any robotic swarm **without anticipating anchor infrastructure** installation. By varying the Anchors' position constraint, we develop **three alternative solutions with different trade-offs between flexibility and localization accuracy**. This work presents an onboard and real-time implementation of **self-localization method** to compute anchor drones' initial position to achieve the most flexible infrastructure setup. In addition, an **open-source UWB Software Library (USL)** has been released enabling fast prototype of UWB localization.

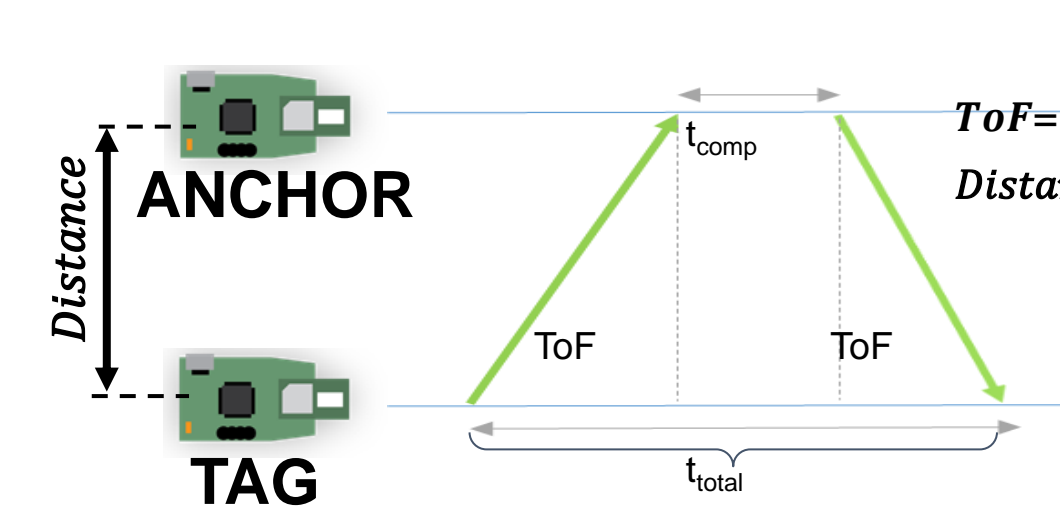
## Indoor positioning approaches



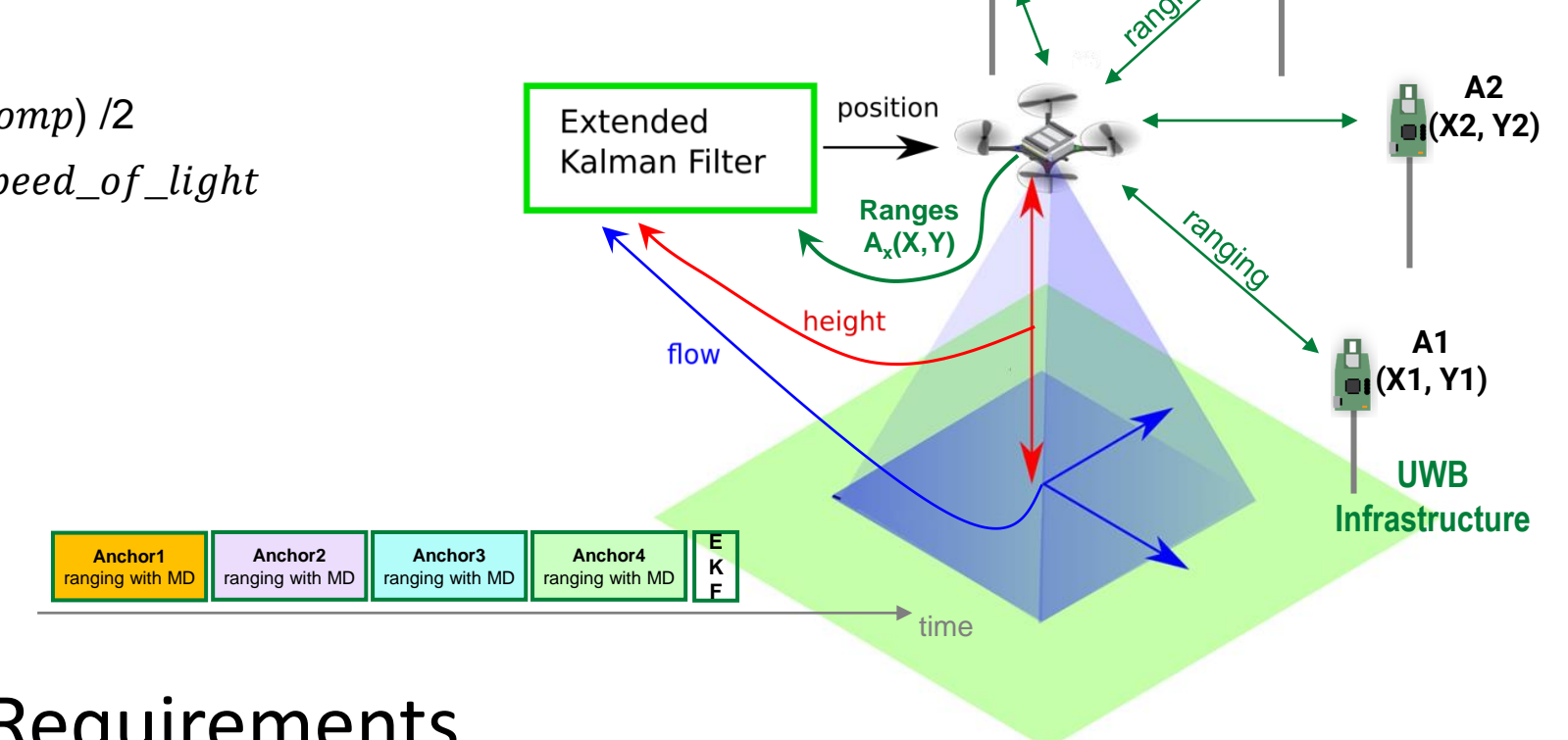
► Ultra Wideband is a tailored technology for indoor localization at **ultra-low power, low cost and high precision**.

## UWB-Localization & challenges

### UWB Ranging



### Localization in Action

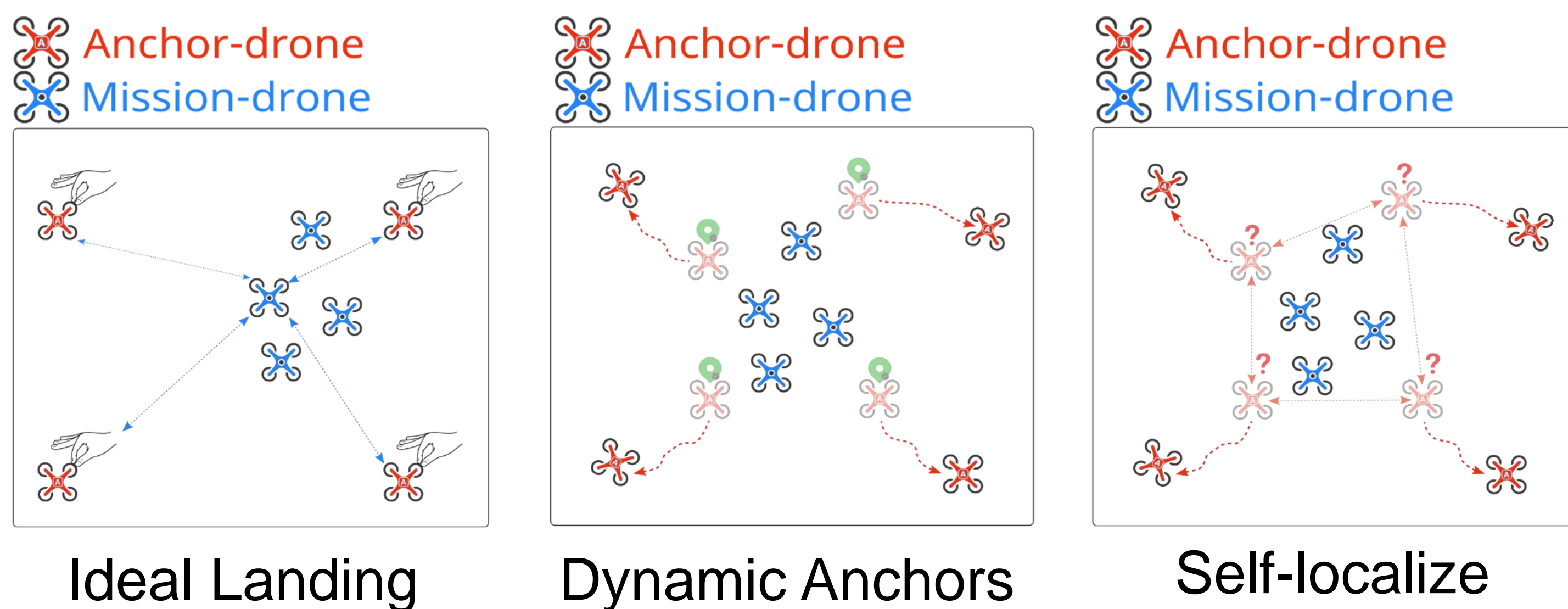


⚠️ **Limit usefulness due to need for in-advanced infrastructure setup**

### Requirements

1. Installation of Anchor modules infrastructure
2. Anchors' positions must be known

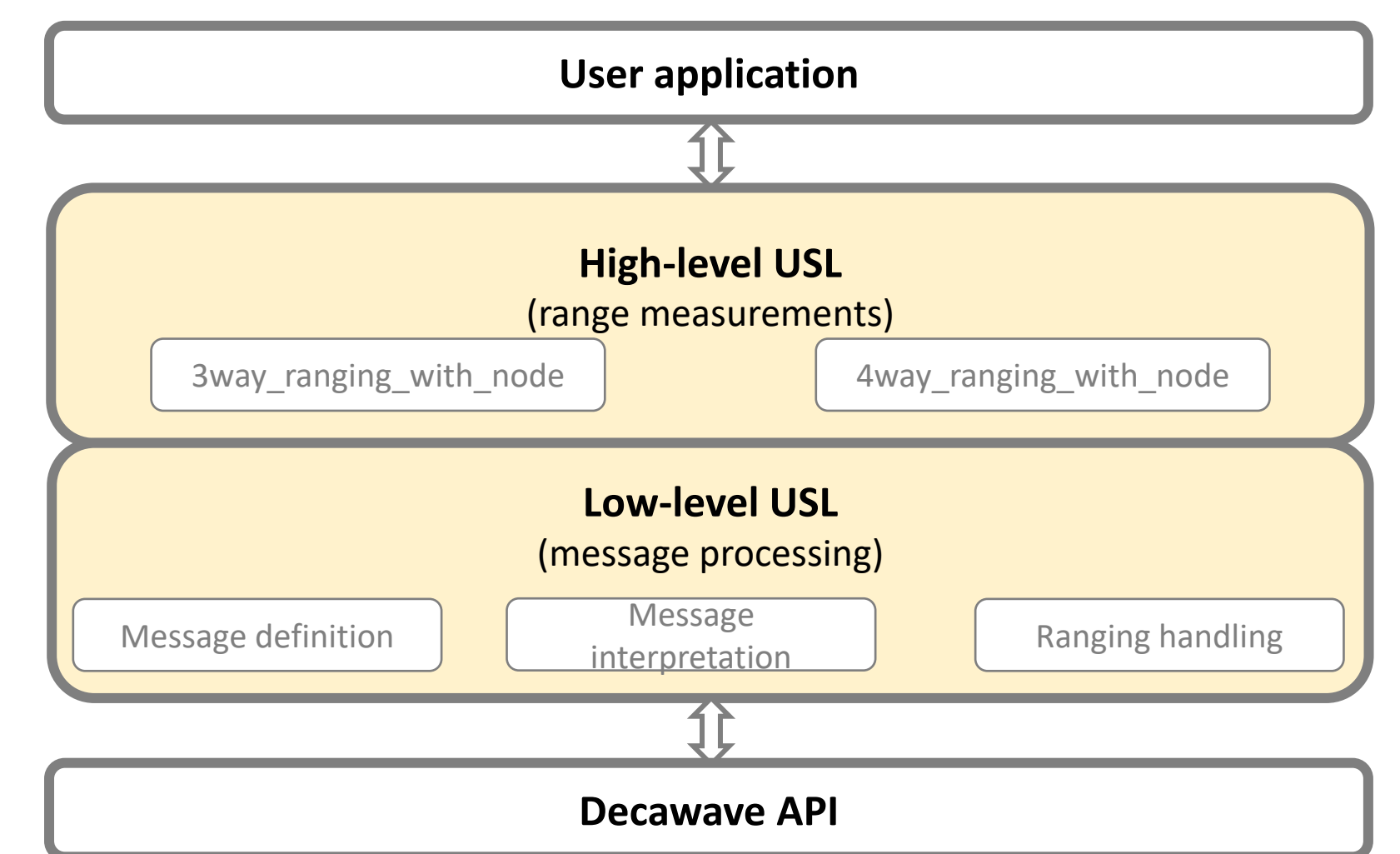
## Dynamic Anchor Systems



More Flexible Systems

## Dynamic Anchor Systems

- An open-source Library
- High-level API
- Enable Fast prototyping
- Minimal HW-level interaction

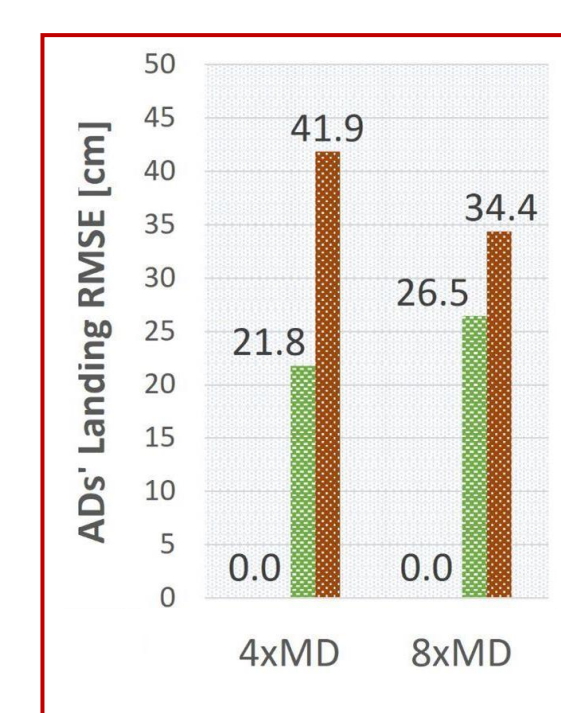
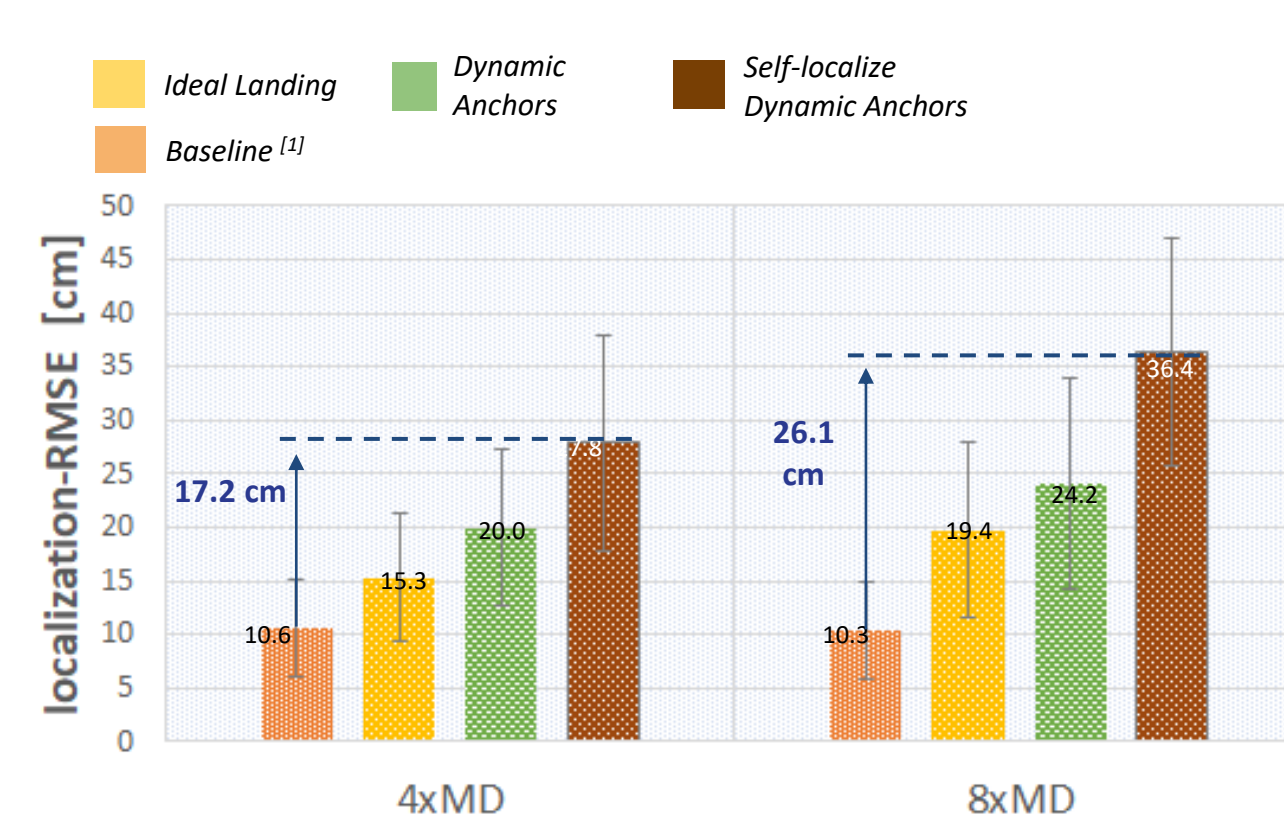
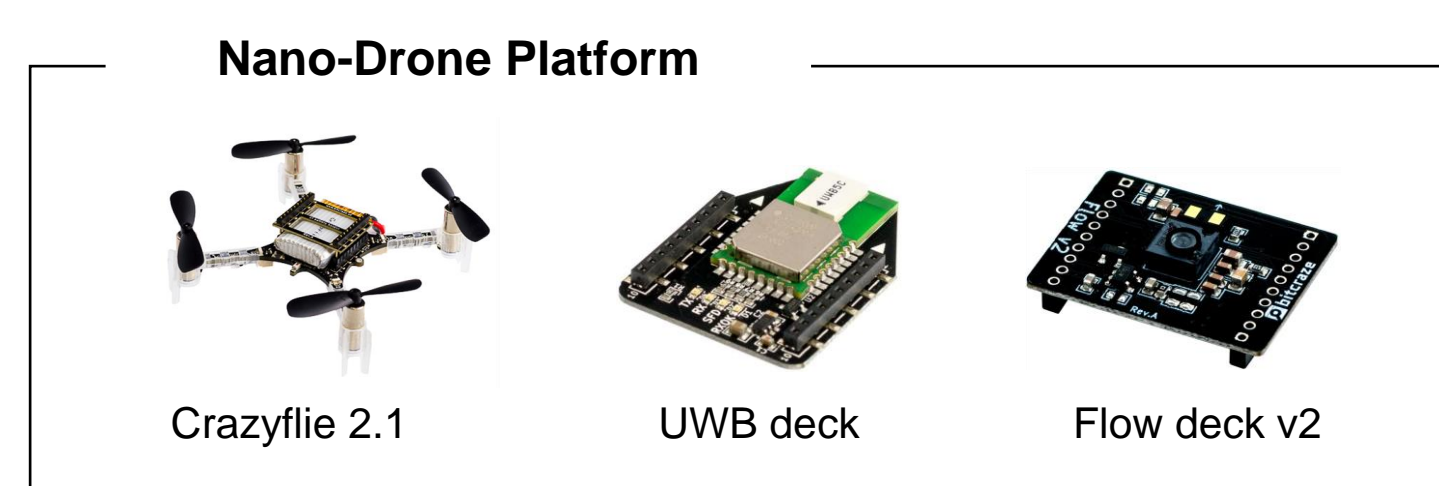


GitHub: <https://github.com/vladniculescu/uwb-software-library>

## In-field Experiment

### Experiment Setup

- 4 Anchor Drones
- 4-8 Mission Drones
- Circular Trajectory
- 1 m/s velocity

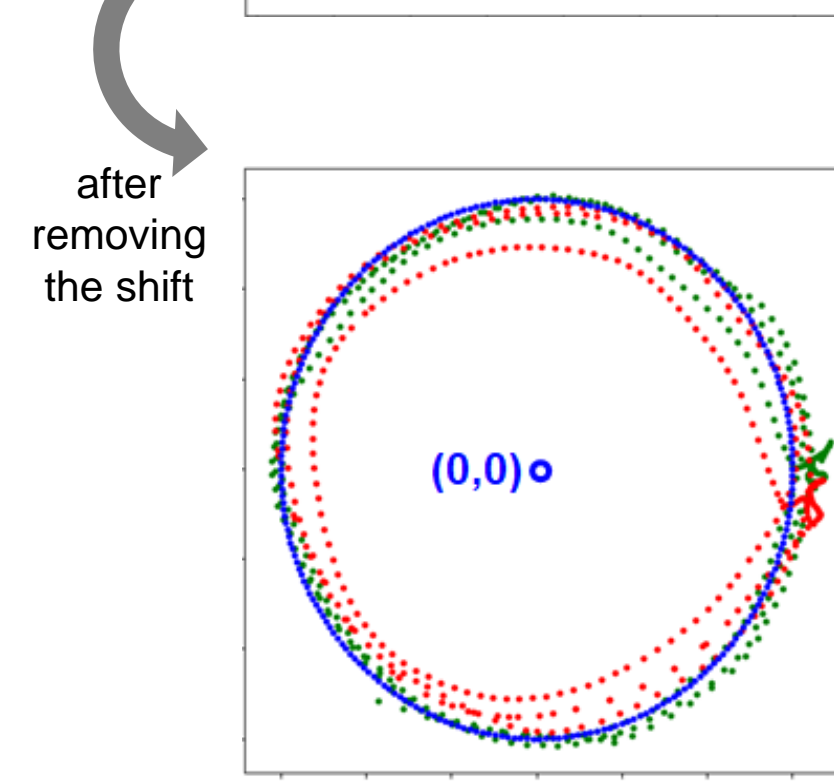
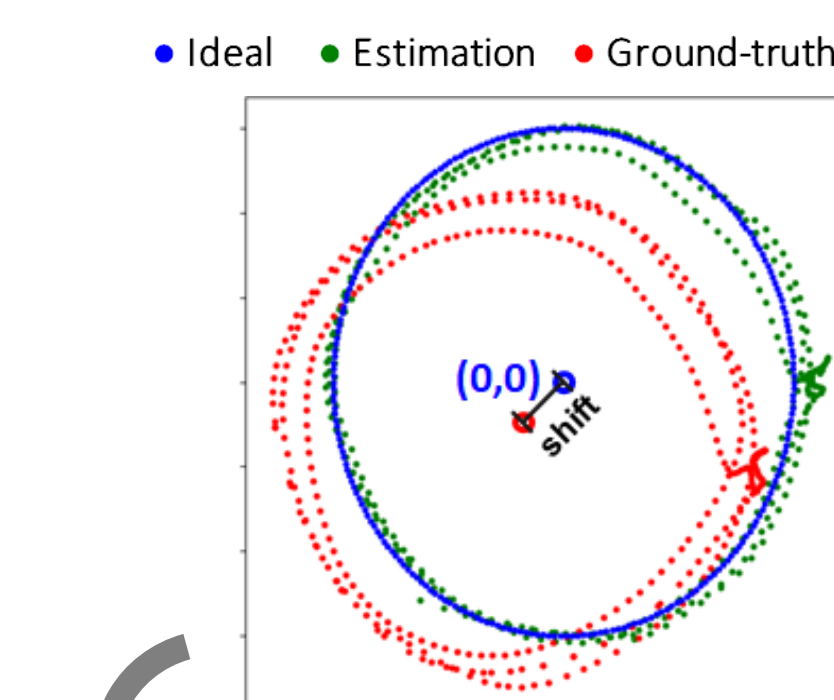
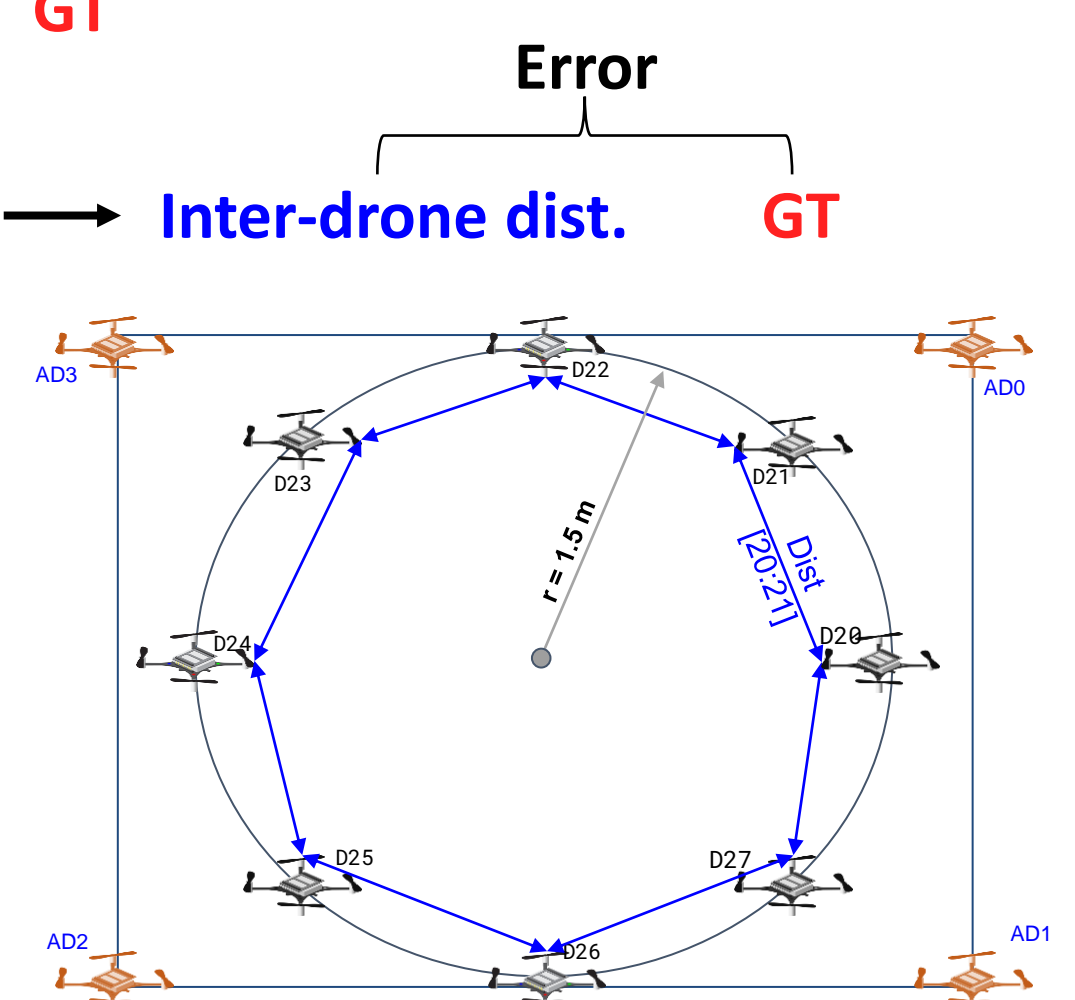
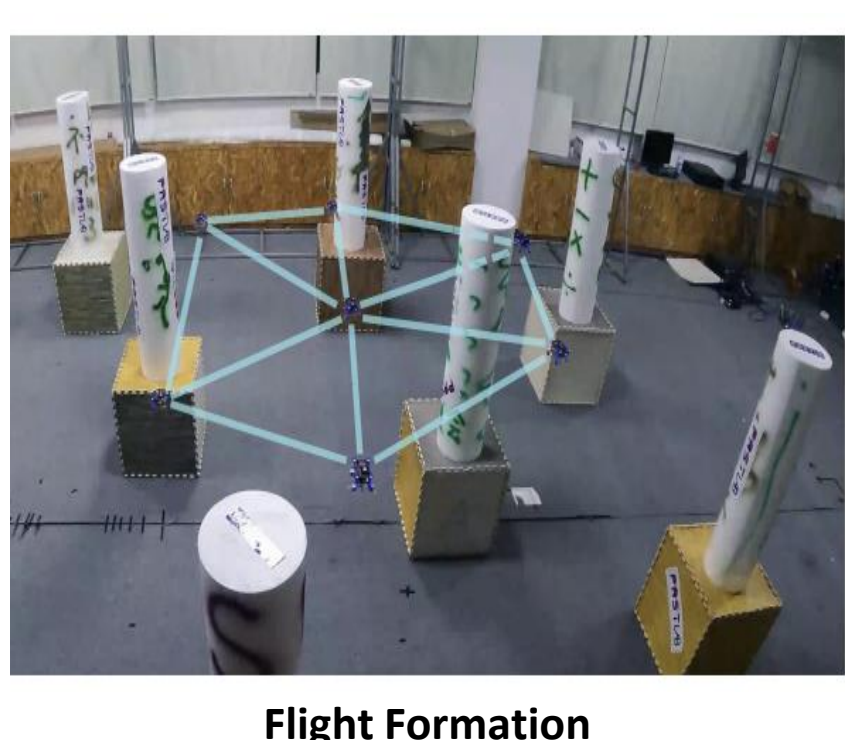


Localization Error is contributed by

- Anchors' Landing Error
- UWB Instinct Error

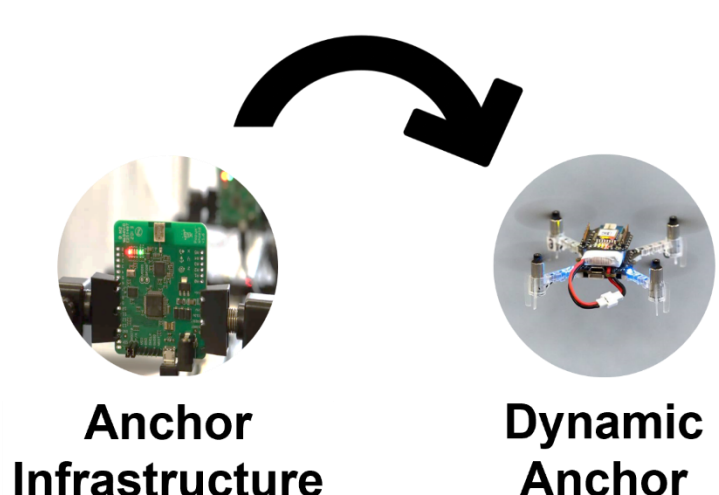
### Evaluation metrics

- Localization RMSE → Estimate GT
- Control RMSE → Ideal GT
- Longitude inter-drone distance → Inter-drone dist. GT



- Higher localization error impacted by the **shift vector**.
- Control error **remains low** in all system setup, enabling drones for precise trajectory following.
- Flight formation error is always **bounded below 13.7% i.e., ±15.6 cm**

## Conclusion



	Most challenging configuration 8x MD		
	IDEAL LAND	DYNAMIC ANCHOR	SELF LOCALIZE
I-RMSE	19.4	24.2	36.4
c-RMSE	13.1	11.0	12.1

Longitude inter-drone distance always **<15.6 [cm]**

## Future Work

- Multi-sensory Anti-Collision System for Autonomous Nano-Swarm Exploration and visual target detection

- Completely anchorless localization system
- Dual-CNN design to add robustness to collision-avoidance

