European Global Navigation Satellite Systems Agency

PRoPART
Precise and Robust Positioning for Automated Road Transports

European Global Navigation Satellite Systems Agency

HORIZON 2020

PROPART FINAL DEMONSTRATION EVENT

PRoPART Positioning Manager

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Katrin Dietmayer

AstaZero, 2019-11-21

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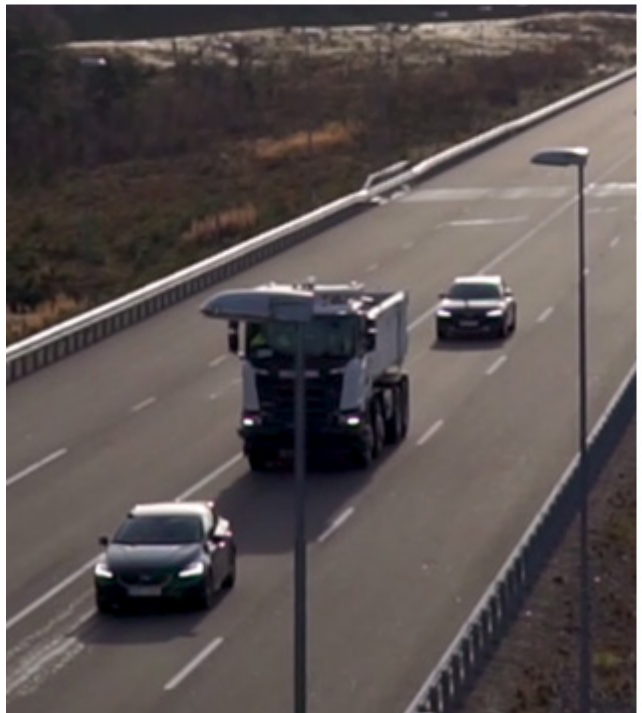
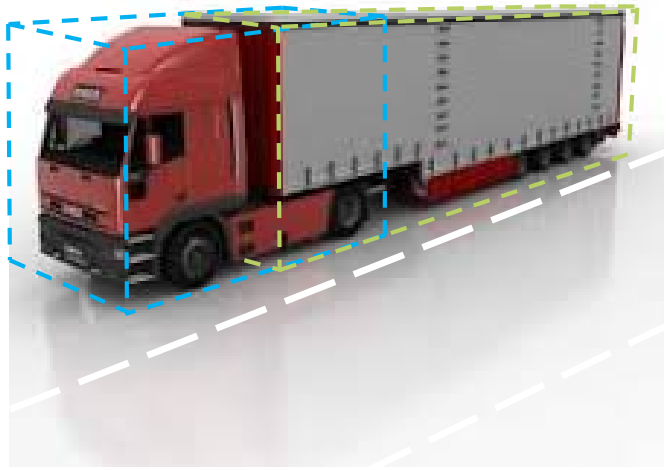


PRoPART Positioning Manager Overview

- The PPM is the central element which refines and combines the motion and position measurements in the platform.

- It has the responsibility to provide a single absolute position, velocity and orientation estimation for other parts of the system.

- The position must be relatable to
  - The extremities of the vehicle (bigger than cars!)
  - Other vehicles interpreting the position
  - Map data



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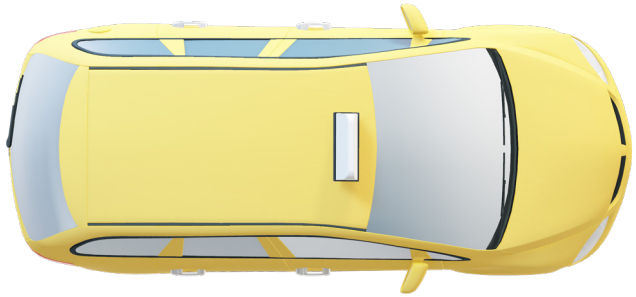
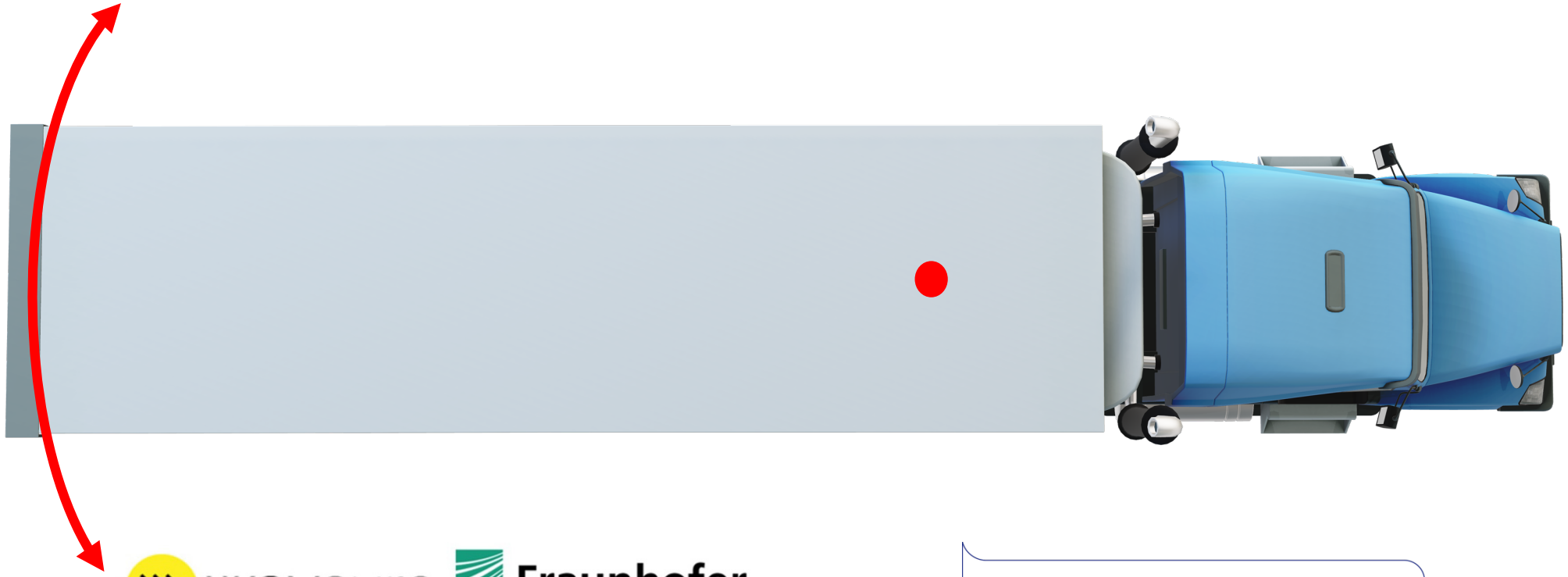
Comparison to cars

- Size (width and length)
- Articulation



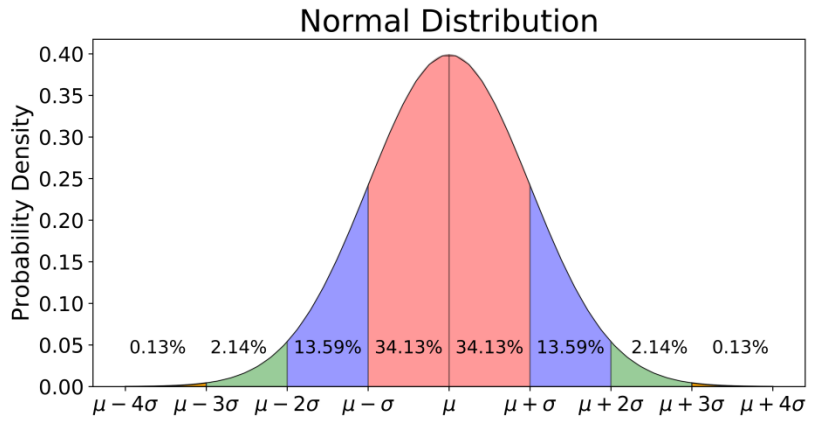


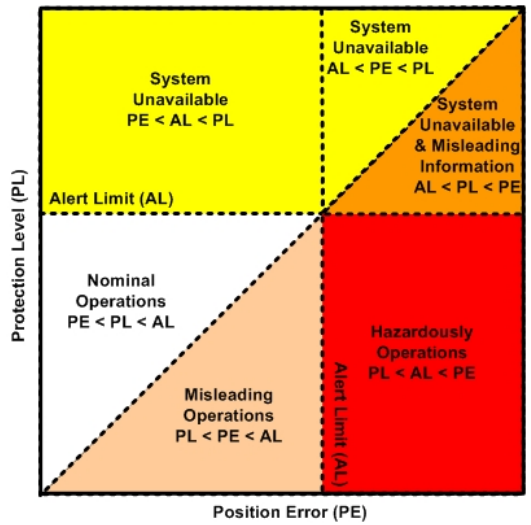
Articulated vehicle cases

Uncertainty and Integrity

- Uncertainty
  - For the system to be well tuned, the uncertainty estimates should model the errors across the population of estimates.
  - How to measure performance at this accuracy?

- Integrity
  - Whether the information provided can be trusted
  - Availability, Probability of False Alarm and Probability of Missed Detection
  - The PPM will flag when it does not believe that its uncertainty can reasonably represent the error.
    - This includes performance and robustness checks.





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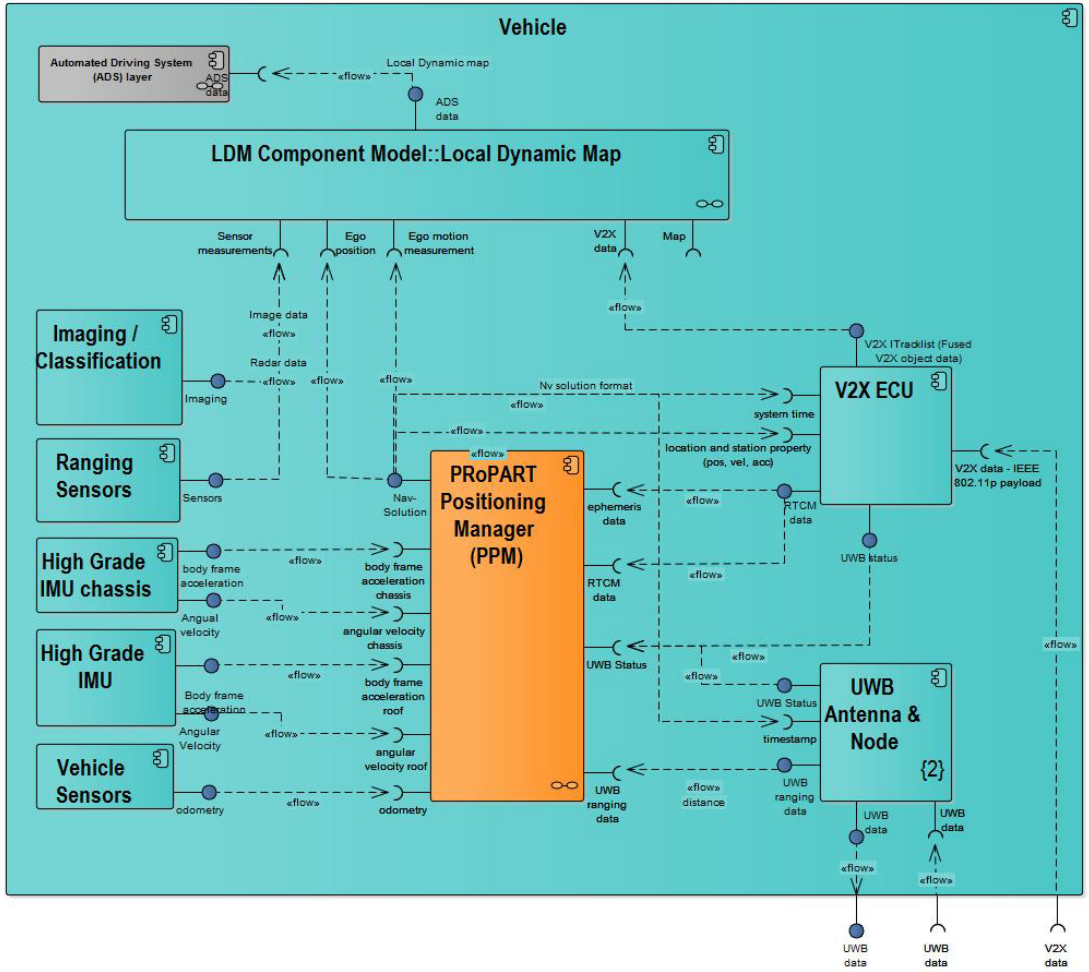
Robustness and Availability

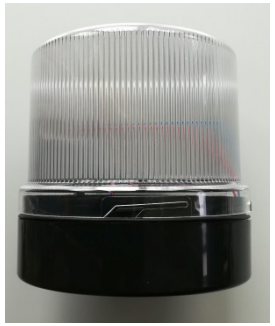
- Robustness
  - GNSS for accuracy, UWB for coverage, inertial for low latency, fusion for robustness
  - The fusion of different sensing technologies provides robustness against any single technology failing
    - Environmental
    - System error
    - Malicious attack
  - Performance improvements
    - Limiting ambiguity search space through accurate ranging
    - Error compensation/separation for safety
- Availability
  - Rapid Time to First/ Reacquisition of (Ambiguity Resolved) Fix (TTF/R(AR)F)
  - Gradual degradation of performance through fallback positioning modes

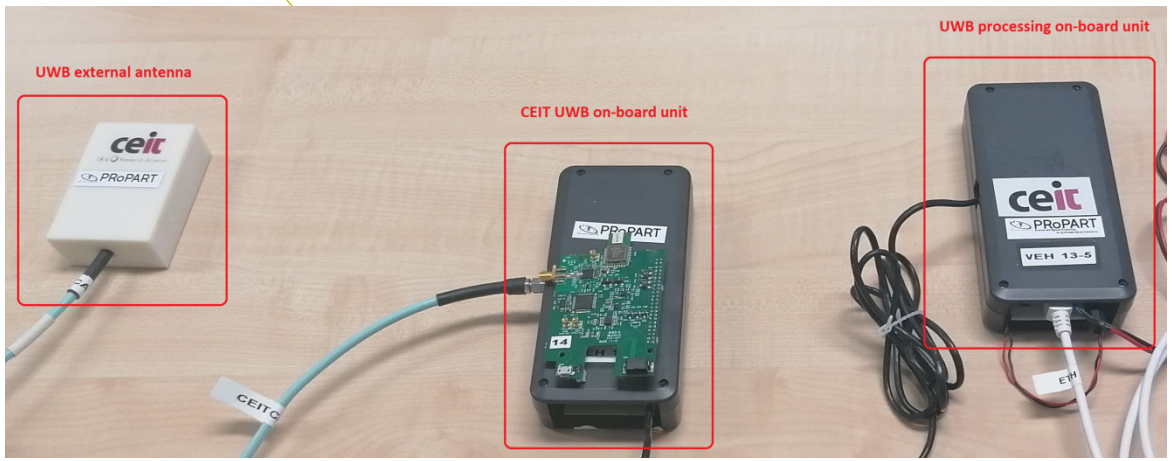
PRoPART Positioning Manager

- The role of the PRoPART positioning manager is to deliver absolute position, velocity and orientation to the perception layer.
- The PPM takes in all positioning measurements to provide a single source.
- These estimates should be accurate, robust, authenticated, and have high integrity.



Physical Representation





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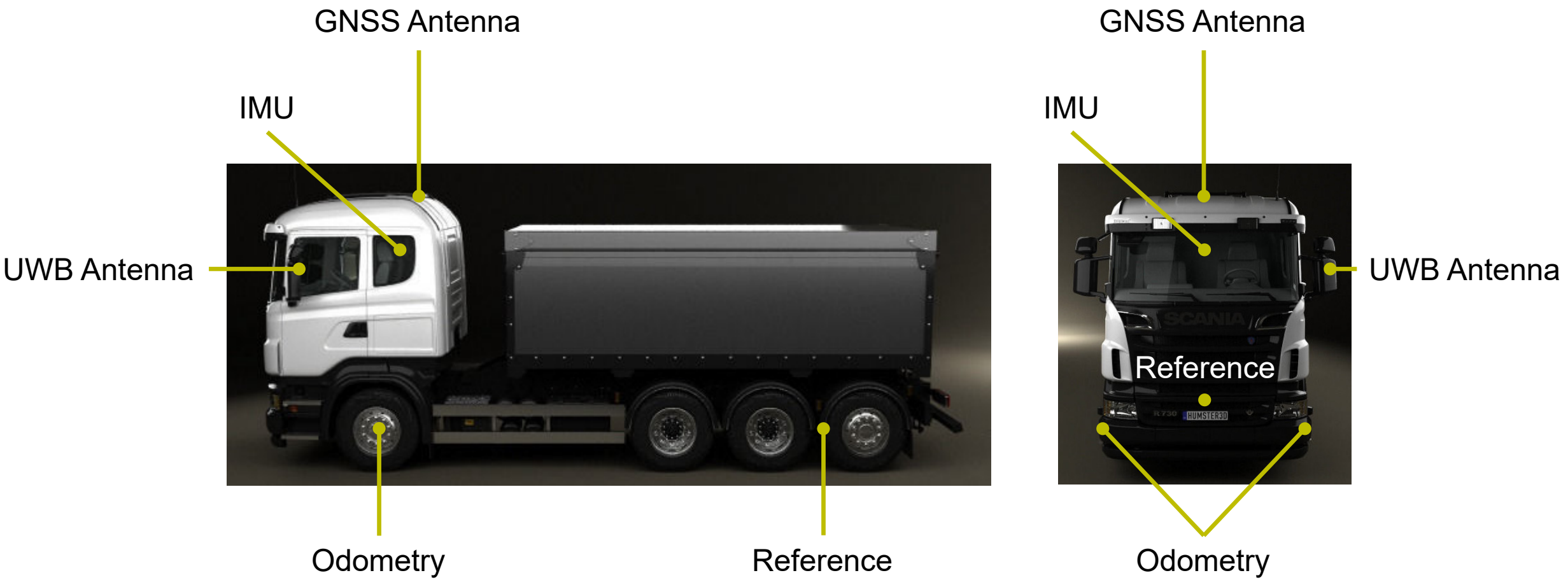
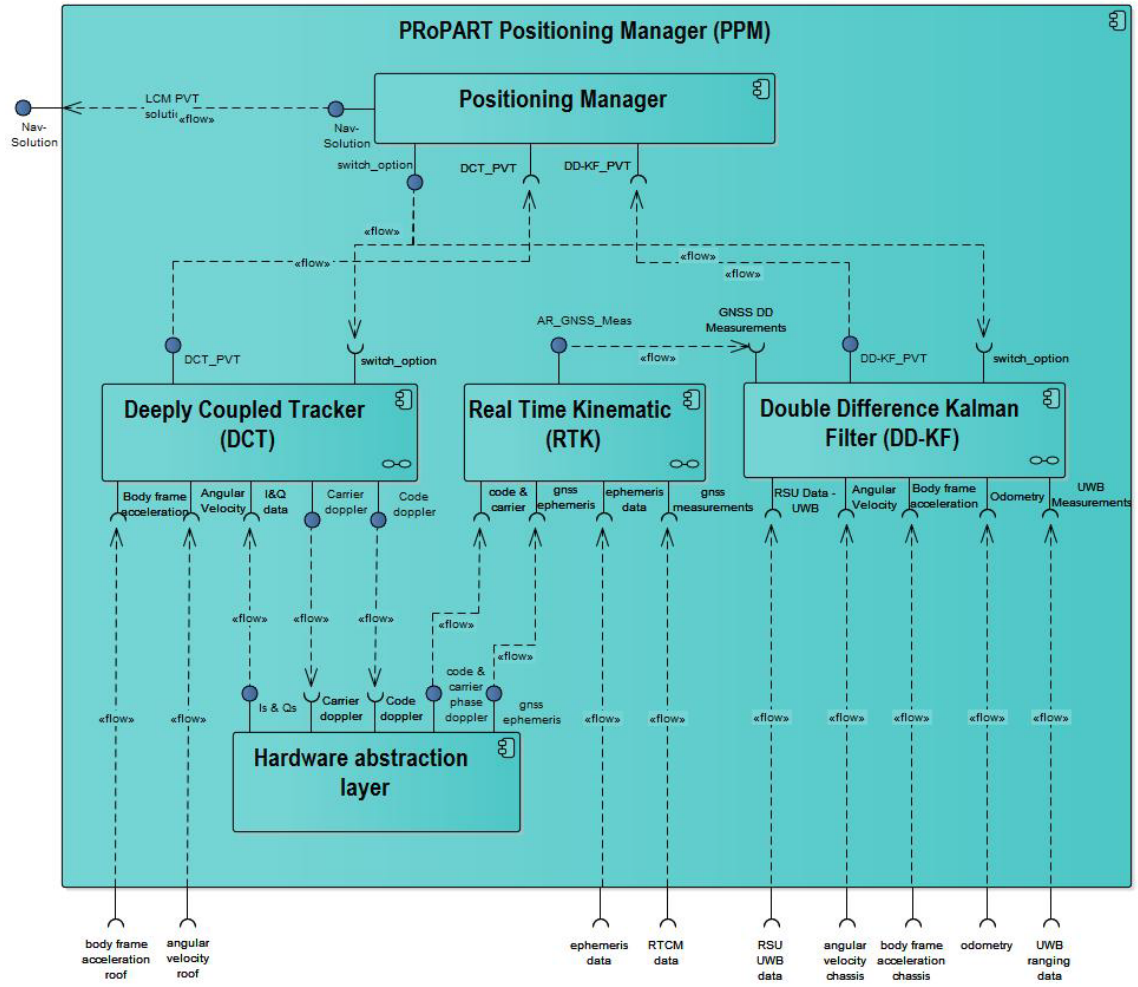
Installation



PRoPART Positioning Manager

- The PPM runs on the Goose platform
- It is separated into two key positioning methods
  - A high accuracy hybridised solution
  - A high availability deeply coupled solution
- Both share the same GNSS measurements engine (HAL)



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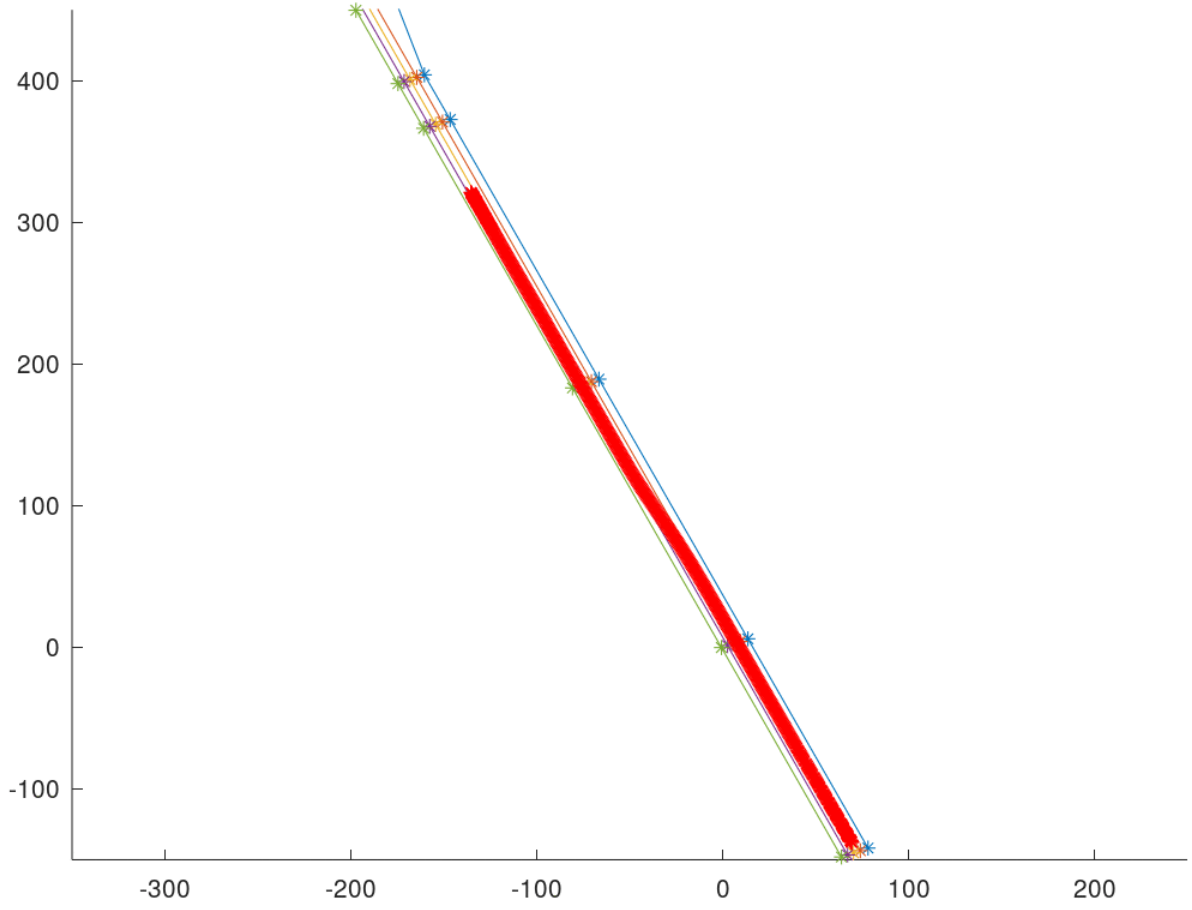
Summary of subsystems

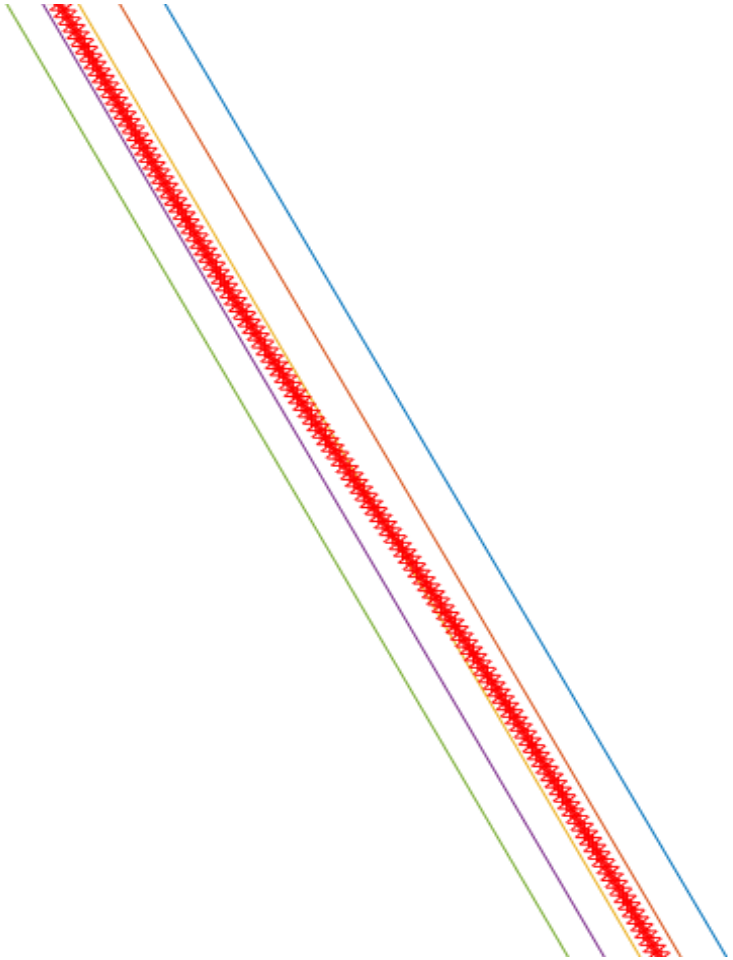
- Hardware Abstraction Layer
  - Acquisition and tracking measurement engine
  - It generates the GNSS code and carrier measurements.
- Real Time Kinematic
  - Ambiguity resolution and preparation of GNSS measurements for filtering
- **Double Difference-Kalman Filter**
  - The DD-KF fuses all measurements for consumption by the rest of the system, and also feedback to enable rapid integer ambiguity resolving.
- **Deeply Coupled Tracker**
  - This component implements a deeply integrated inertial/code phase tracking solution for generating a navigation solution.

RTK and DD-KF Performance

- Time to First (Ambiguity Resolved) Fix
  - TTF(AR)F in good conditions varies between 3 to 10 seconds
- Time to Reacquisition (AR)
  - Instantaneous in good conditions after short outage
  - 3 to 10 seconds in good conditions
- Reference station handover between RSU data streams
- Positioning accuracy at RTK levels (circa 2cm horizontal by comparison to other RTK systems)
- Available throughout test scenarios

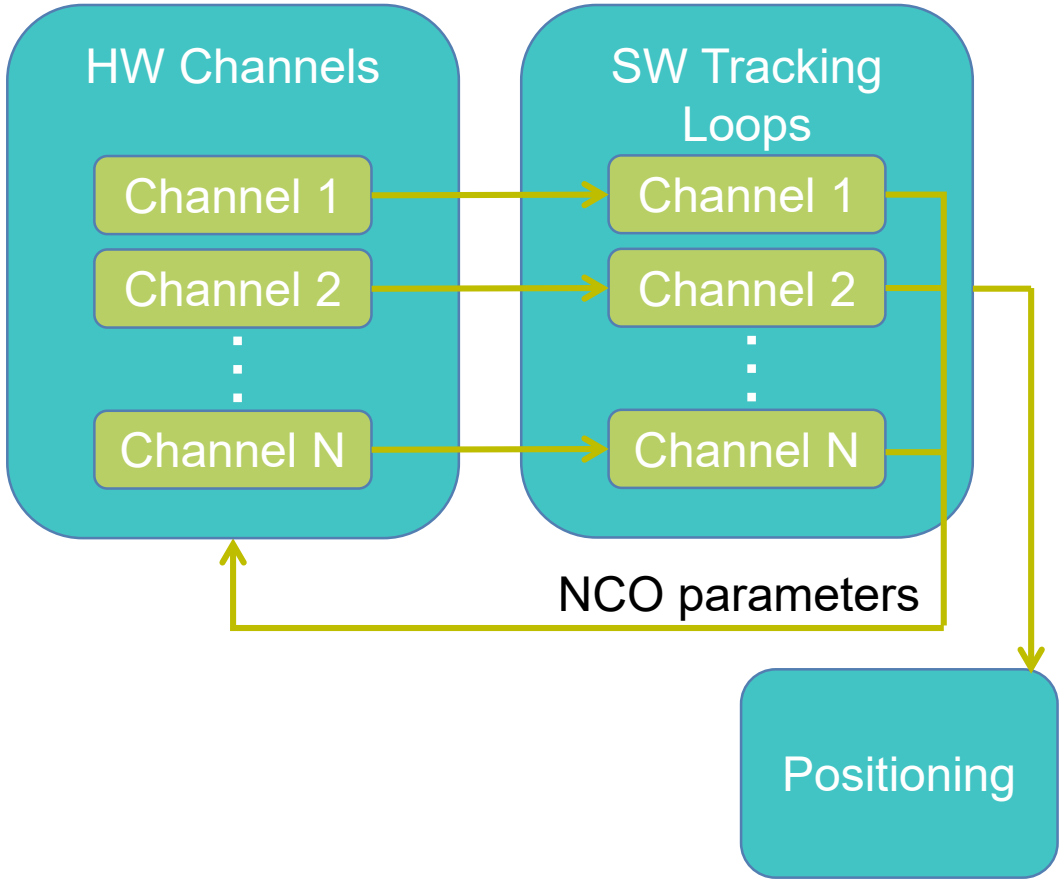
Lane change



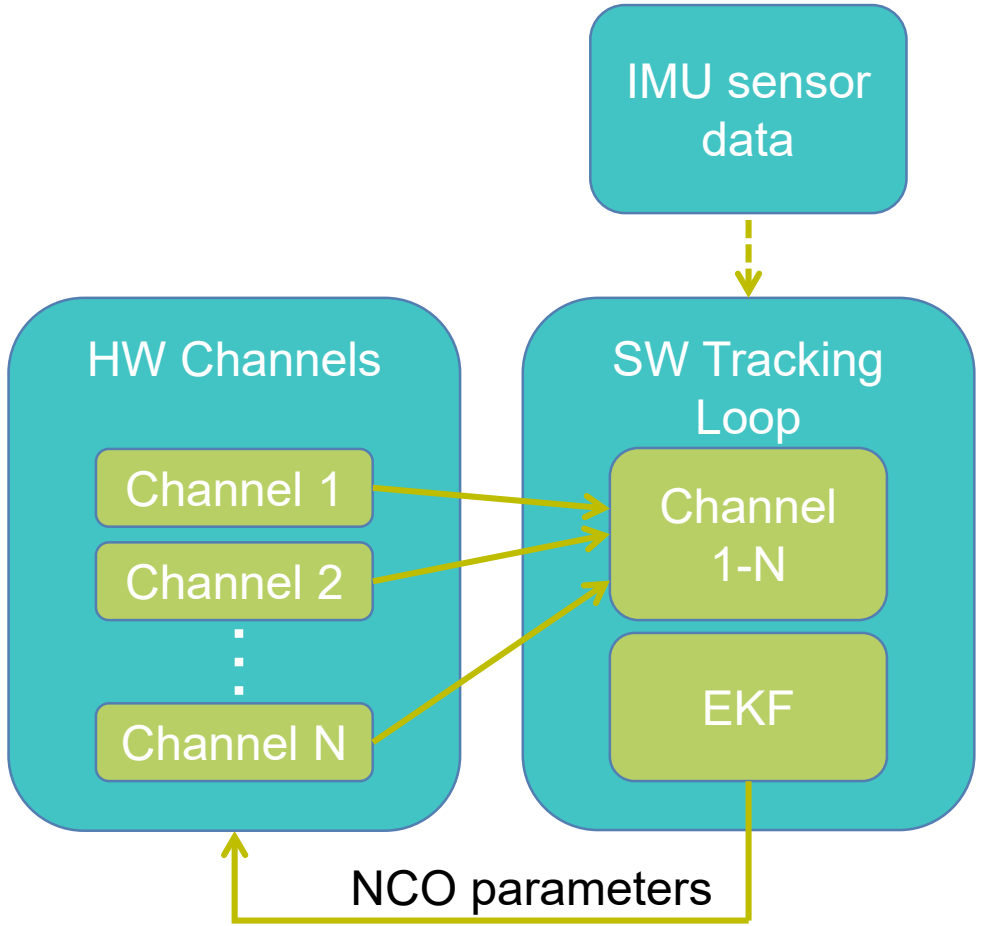


Deeply Coupled Tracker

Standard Tracking



Vector Tracking



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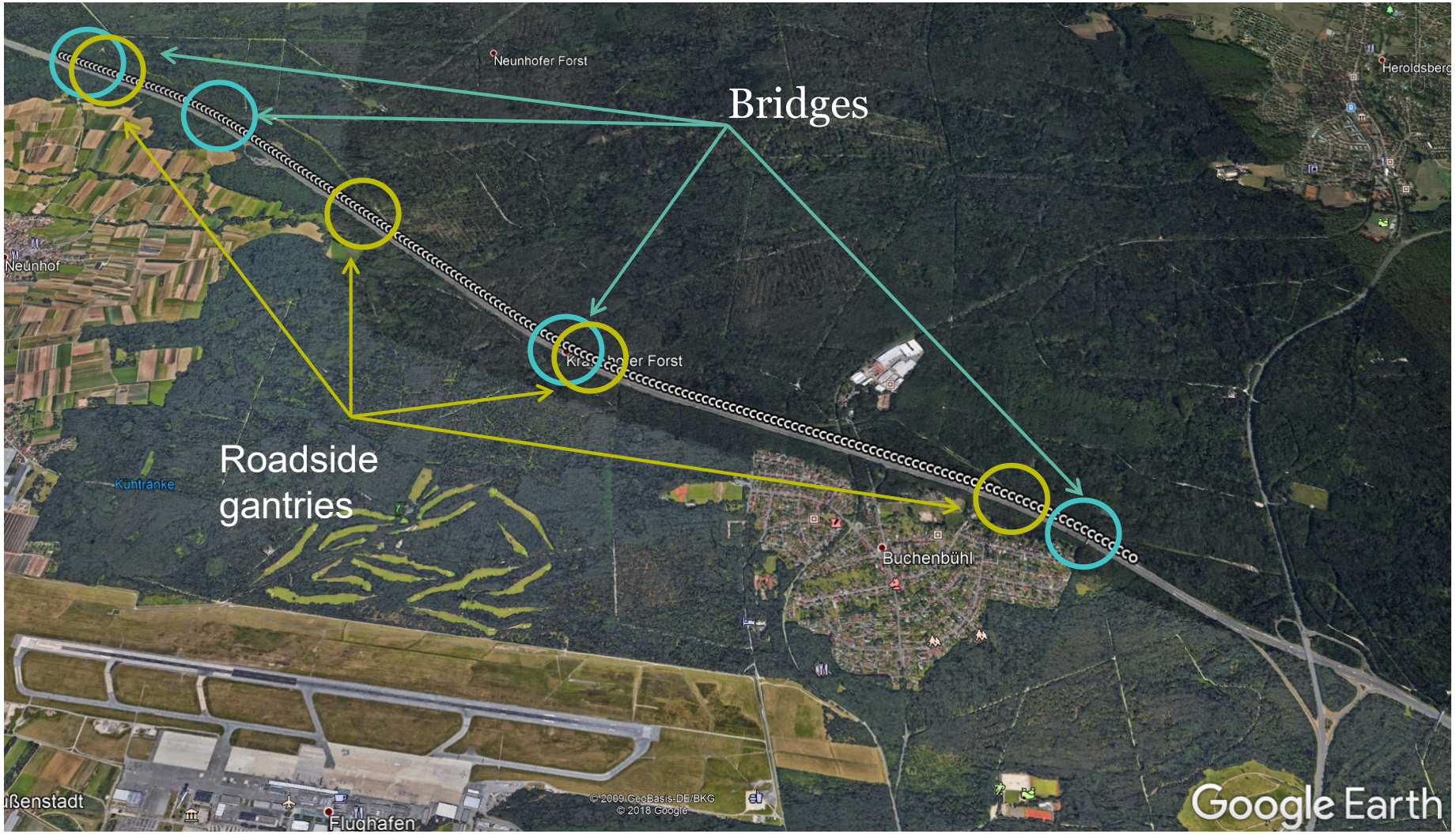
DCT Vector Tracking test drive path



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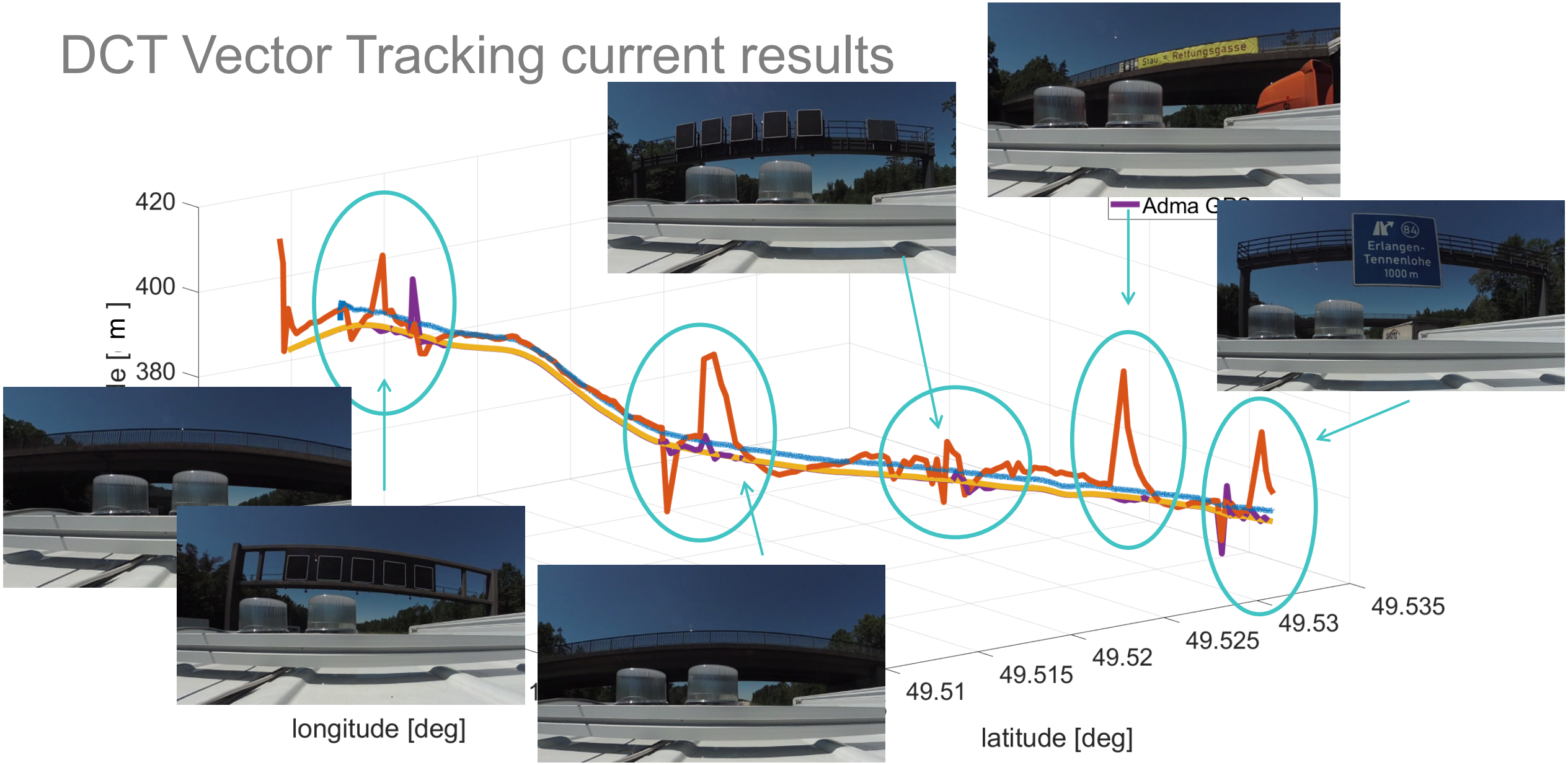
DCT Vector Tracking current results



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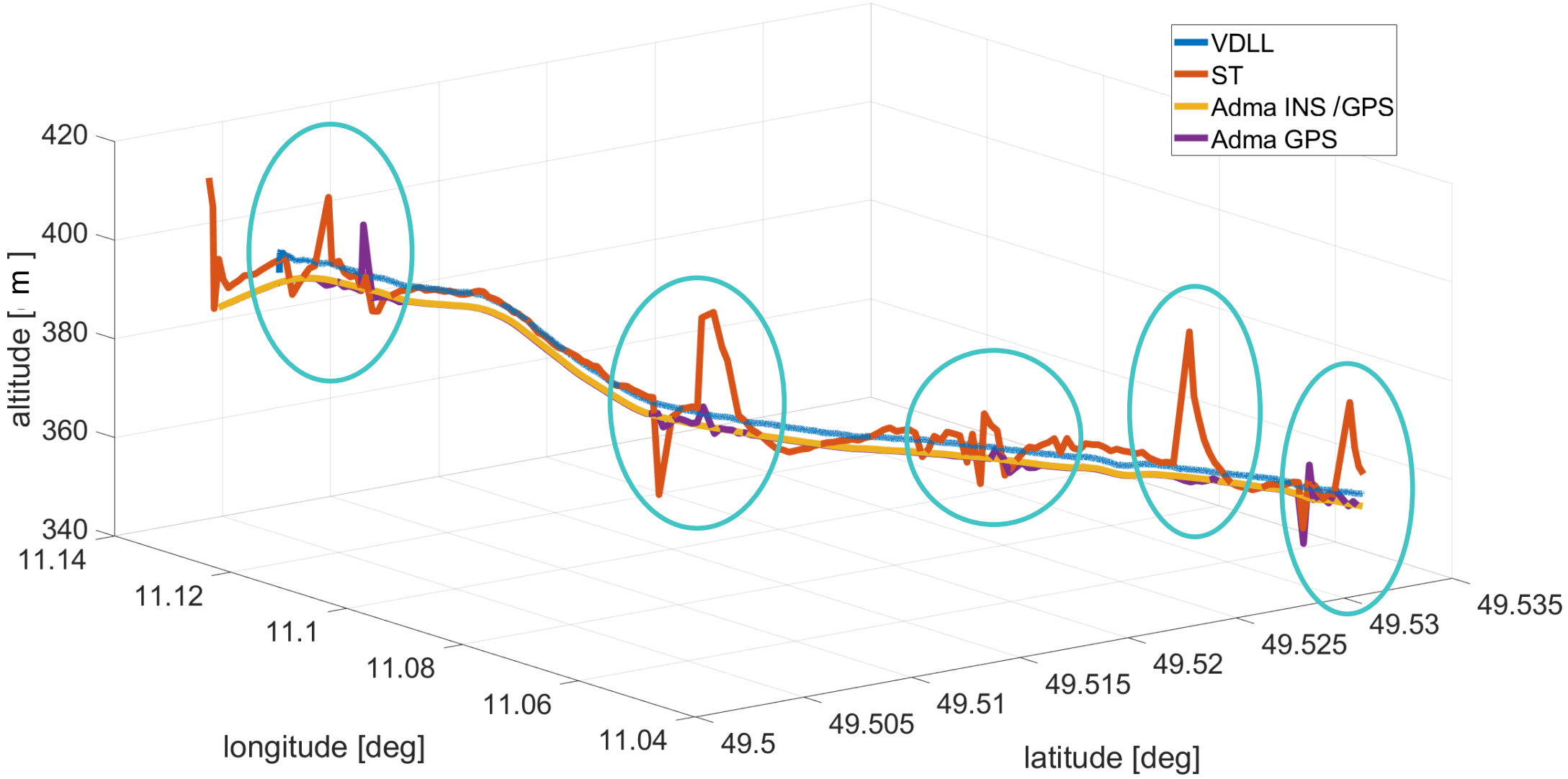
DCT Vector Tracking current results



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THANK YOU

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