
AIOSAT
Autonomous Indoor/Outdoor Safety Tracking system

Autonomous Indoor Outdoor Safety Tracking system

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AIOSAT Overview

FIRES IN EUROPE PER YEAR:

- **2’000’000 fires**
- **5’000 fire-related deaths**
- **50’000 reported injuries**
- **10-20 firefighter deaths**

The overarching objective of AIOSAT system is to advance beyond the state of the art in tracking rescue workers by creating a high availability and high integrity team positioning and tracking system.

AIOSAT Overview

- Starting date: 01 December 2018
- Duration: 30 months (until 31 May 2020)
- Program: Horizon 2020-GALILEO-GSA-2017-1

  - Total Budget: 2,032,650.00 €
  - EU contribution: 1,764,262.50 €

  - Number of participants: 7 from 3 countries
  - Covering all areas:
    - Technology Providers (SAXION, CEIT-IK4, RMS-KMS)
    - Engineering service providers (INTEGRASYS)
    - Subsystem manufacturers (INERTIA)
    - End-users (TSC, FRS CENTRUM)

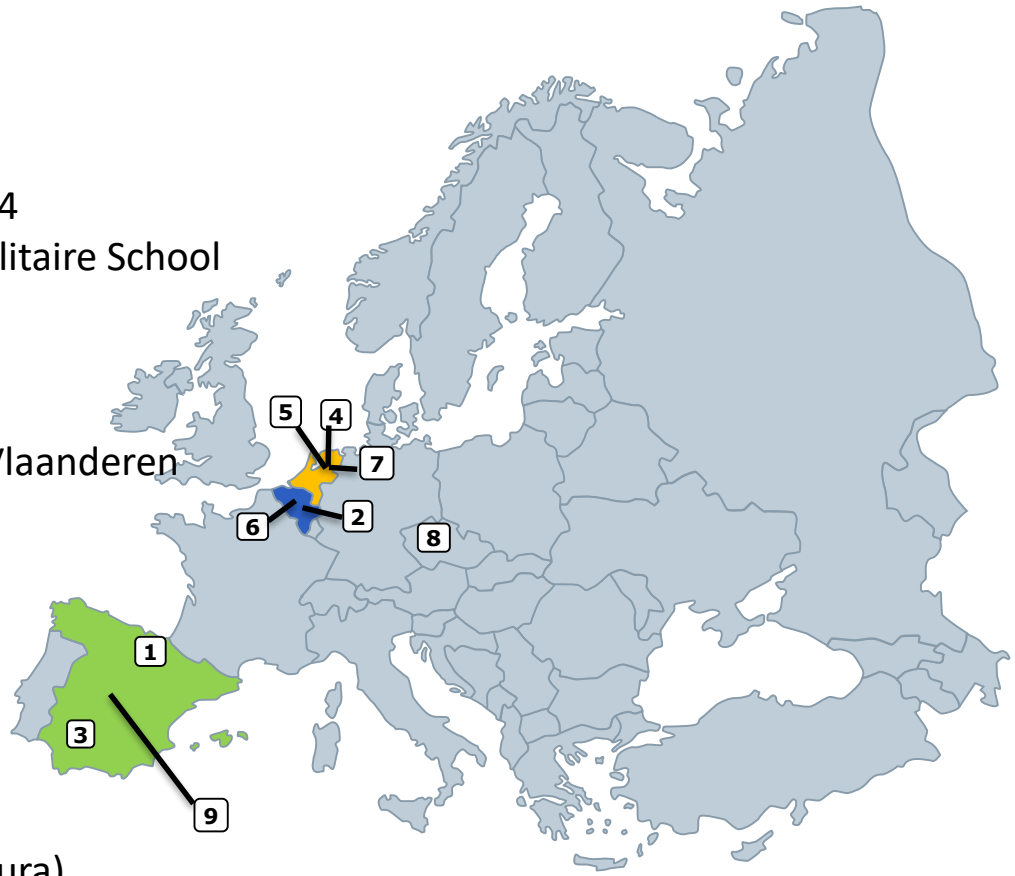
AIOSAT Overview

AIOSAT consortium members:

1. Asociación Centro Tecnológico Ceit-ik4
2. Ecole Royale Militaire - Koninklijke Militaire School
3. Integrasys S.A.
4. **Inertia Technology B.V.**
5. **Hogeschool Saxion**
6. Hulpverleningszone Centrum - Oost-Vlaanderen
7. **Veiligheidsregio Twente**

8. European GNSS Agency

9. Advisory Board:
   Faasa/Seilaf
   Valfirest
   Wildfire Extinction Service (Extremadura)
   San Sebastian City Firefighters

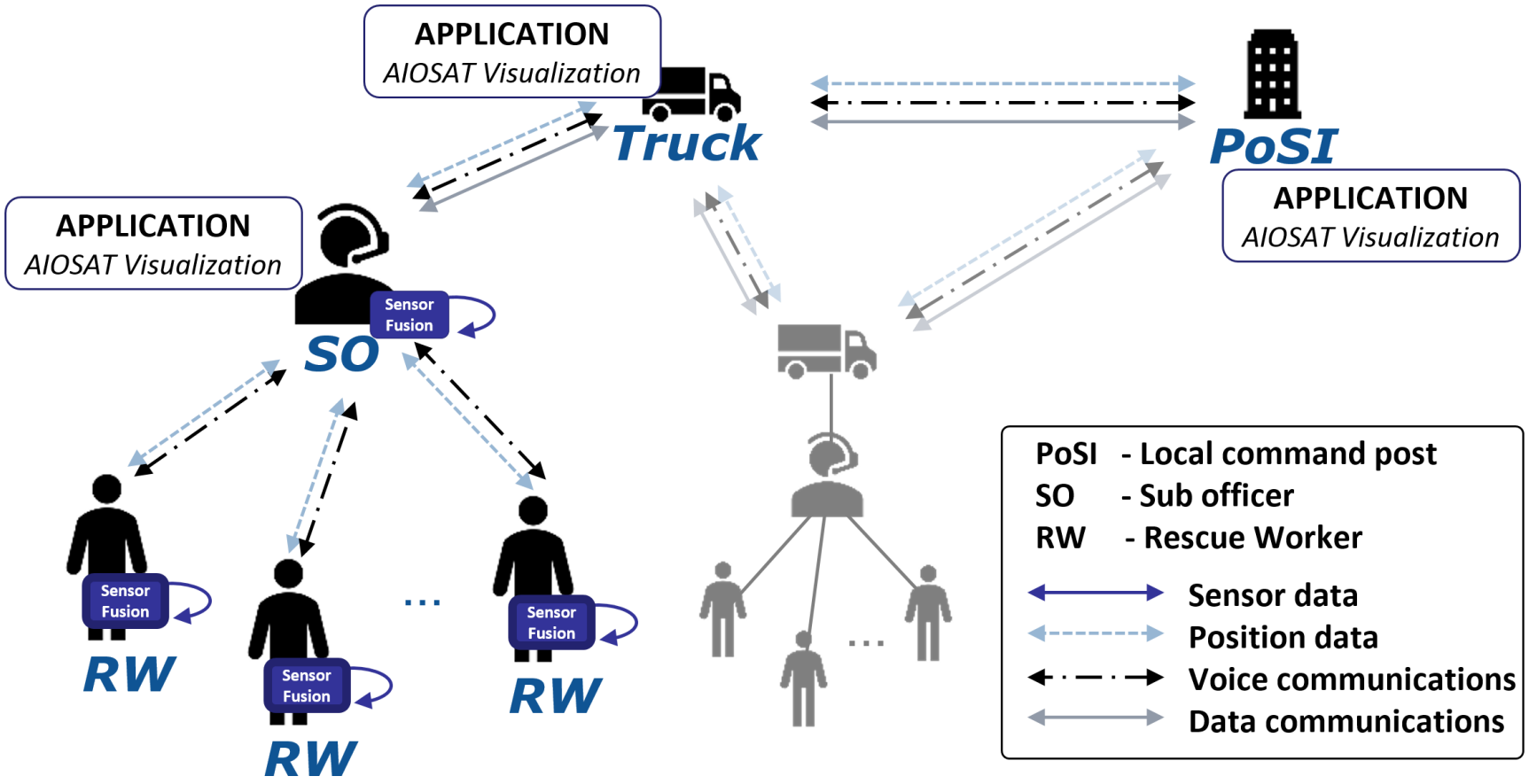


AIOSAT Overview

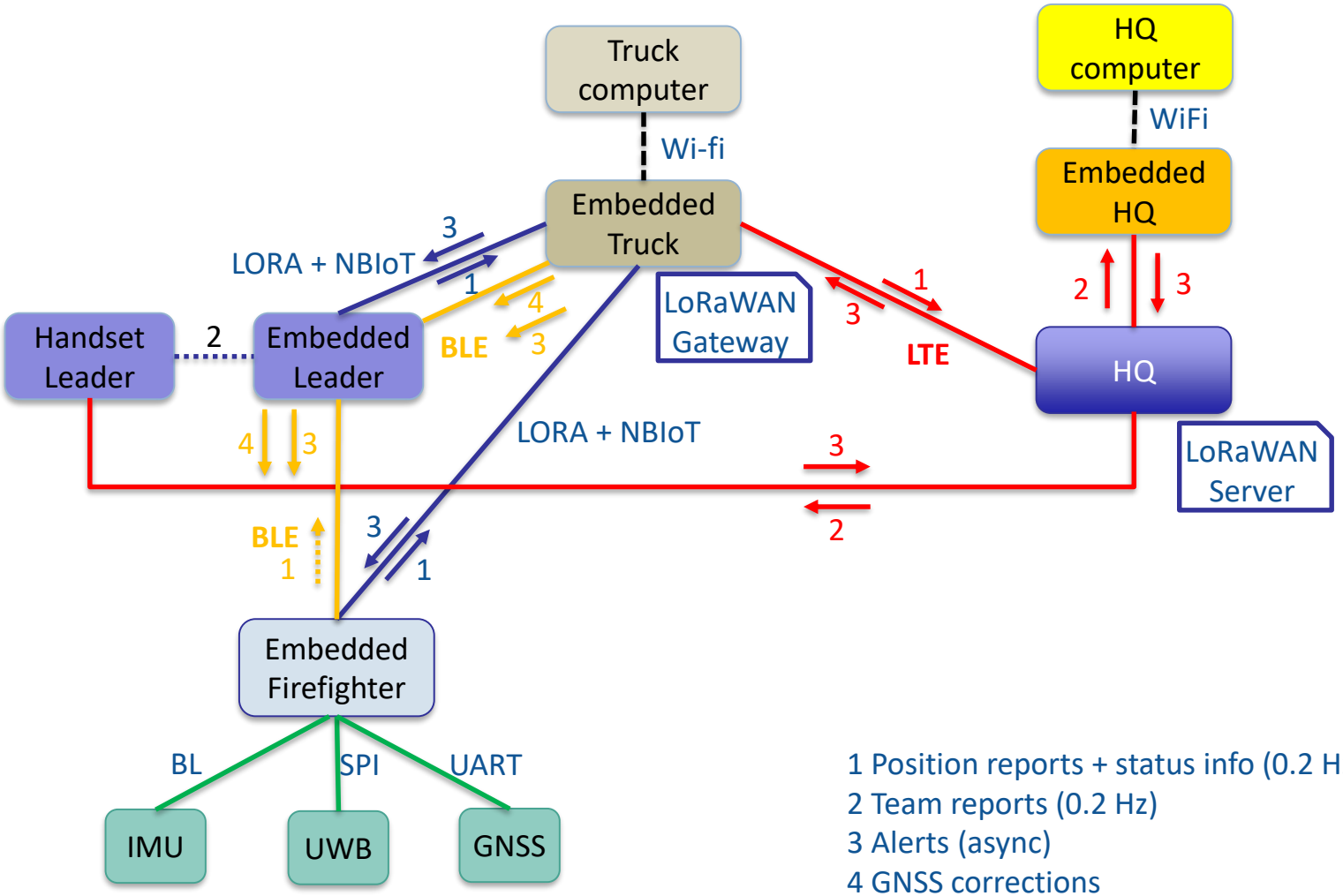
The AIOSAT system integrates:

- augmented **Global Navigation Satellite System** (**GNSS**) positioning,
- **Pedestrian Dead Reckoning** (**PDR**) based on inertial movement sensors,
- **Ultra-Wide Band** (**UWB**) distance measurements between the team members,
- map information,
- high availability communication system,
- sensor fusion,
- reliable application backend.

System Architecture

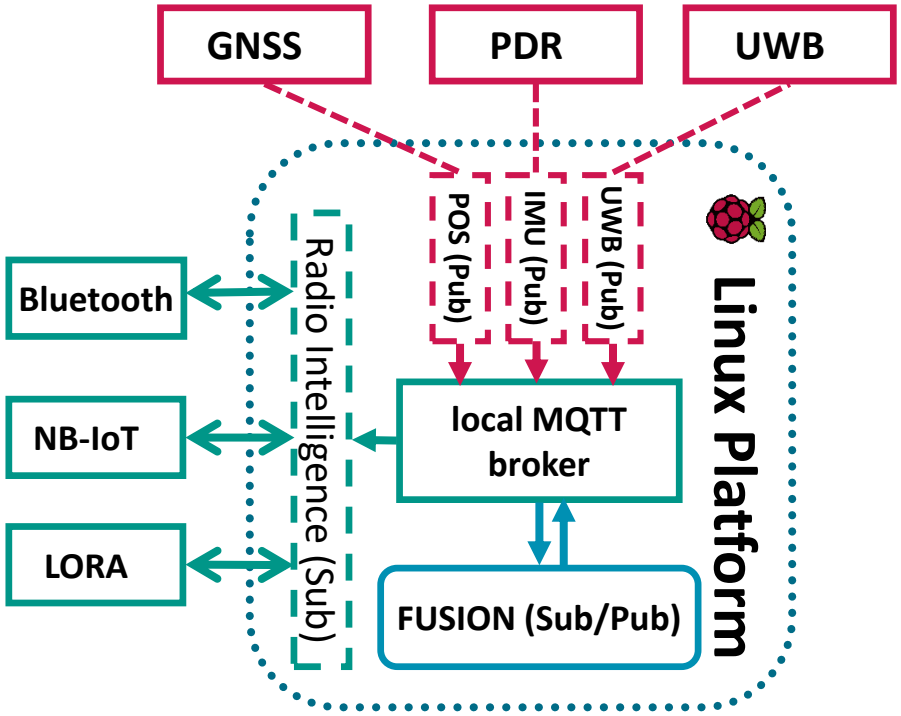


System Architecture: communication



1 Position reports + status info (0.2 Hz)
2 Team reports (0.2 Hz)
3 Alerts (async)
4 GNSS corrections

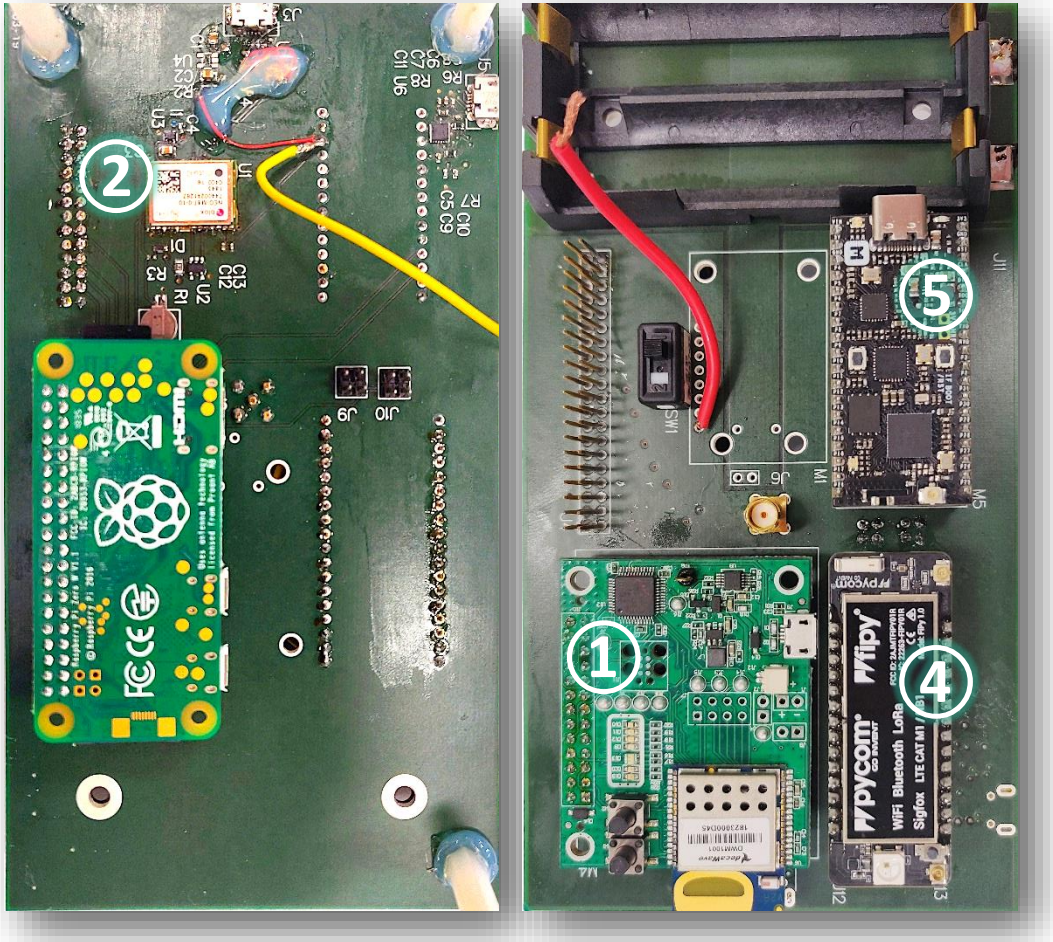
System Architecture: embedded



Raspberry Pi as development target:

- Microservice architectire
- MQTT (Mosquitto) for inter-process communication,
- Processes:
- GNSS
- PDR
- UWB
- Fusion
- Radio Intelligence (all external comm.)

System Architecture: prototype



① GNSS receiver (u-blox® NEO-M8T)

② UWB transciver

(Decawave® DWM1001)

③ PDR module (Inertia ProMove MINI)

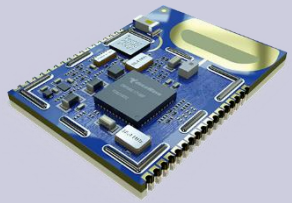
④ LORA/LTE module (pycom® fipy®)

⑤ Bluetooth 5 module

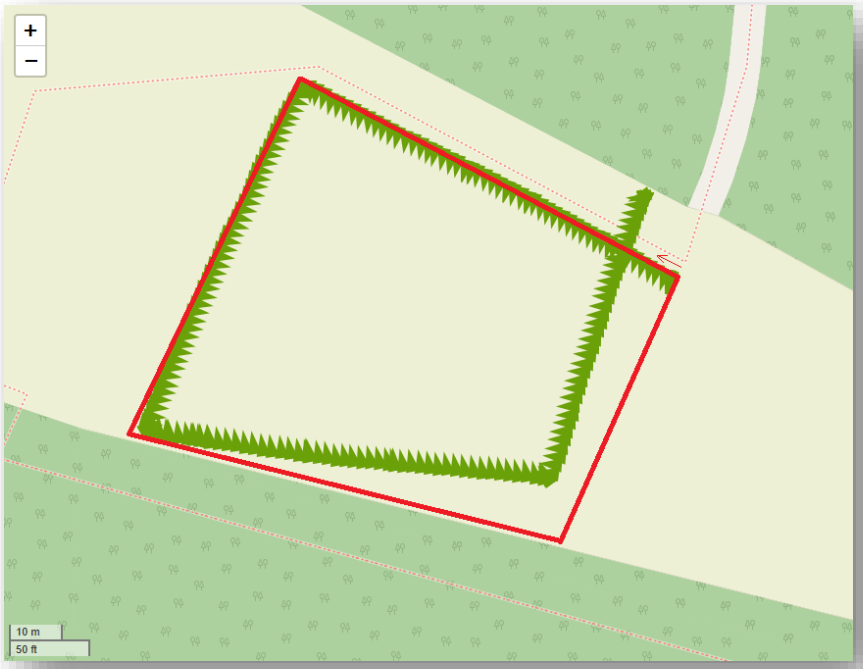
(Nordic® NRF52840)

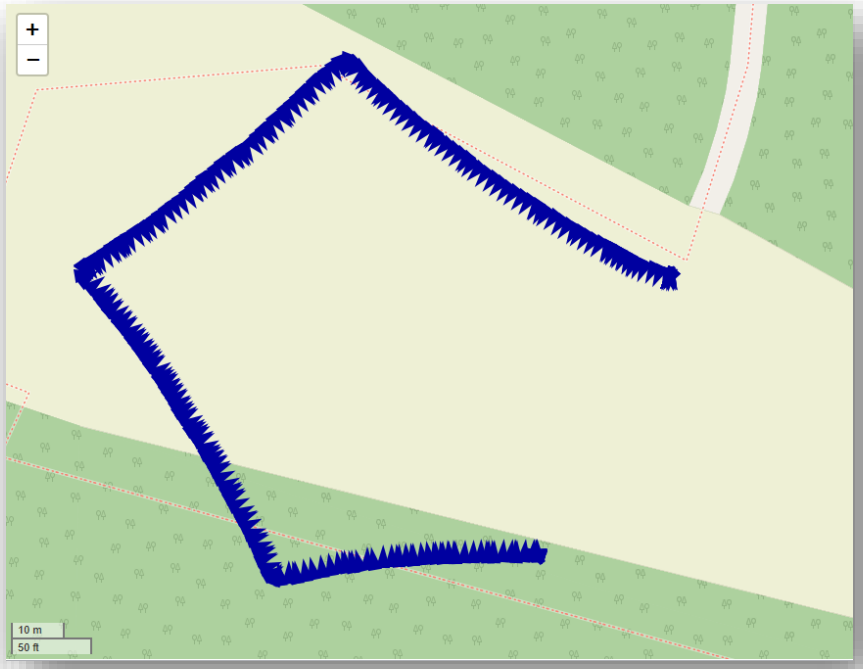
Tracking

Sources of positioning information

GNSS	PDR	UWB
		
Individual node absolute position	Individual node relative displacement	Distance between a pair of nodes
• Noisy • No indoor signal • Conditions-sensitive	• Bearing bias • Bearing drift	• Low-range • Dependent values • Transmission medium

Tracking: PDR example



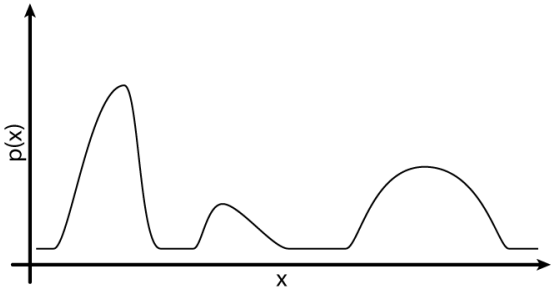


Ground truth path

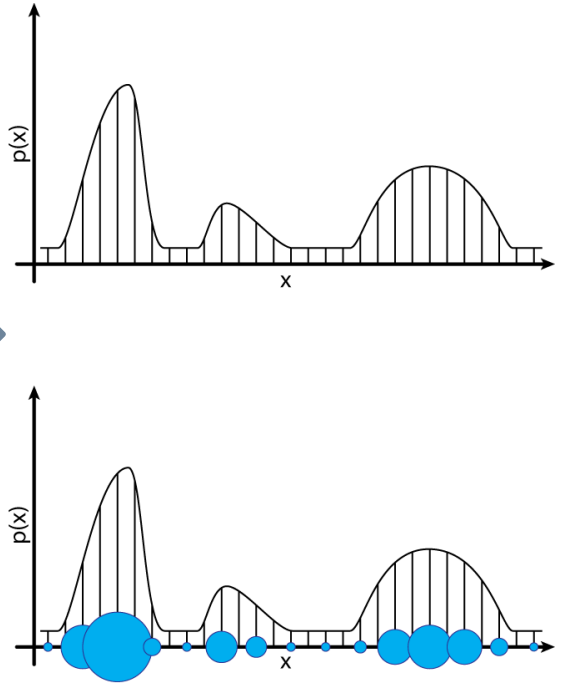
Left foot measurement

Right foot measurement

Sensor fusion: Particle Filters

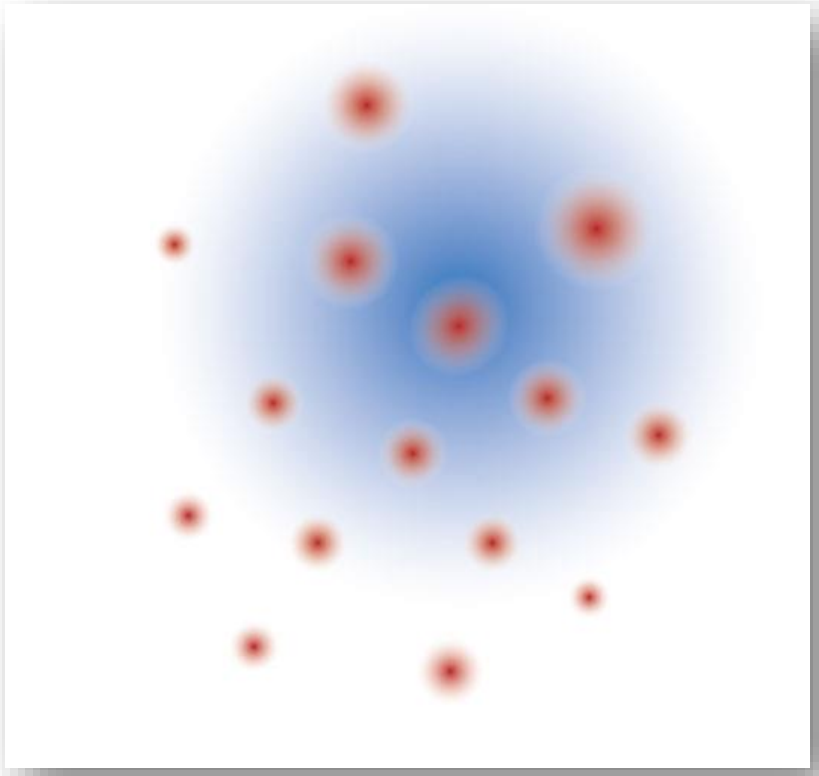


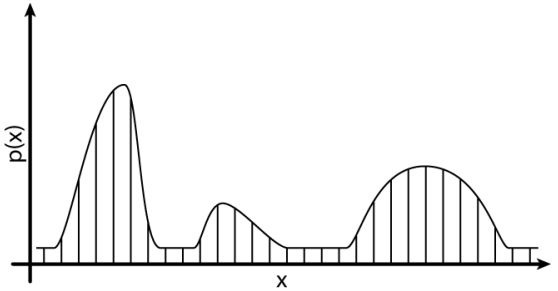
Continuous probability density function of a state variable

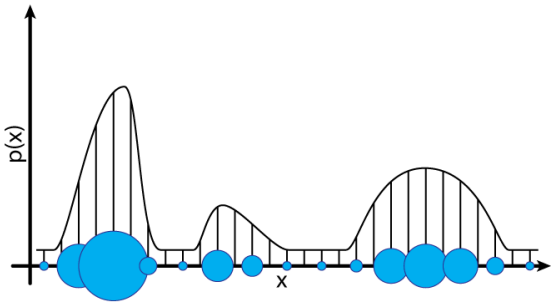


Particle representation of the pdf

Sensor fusion: Particle Filters

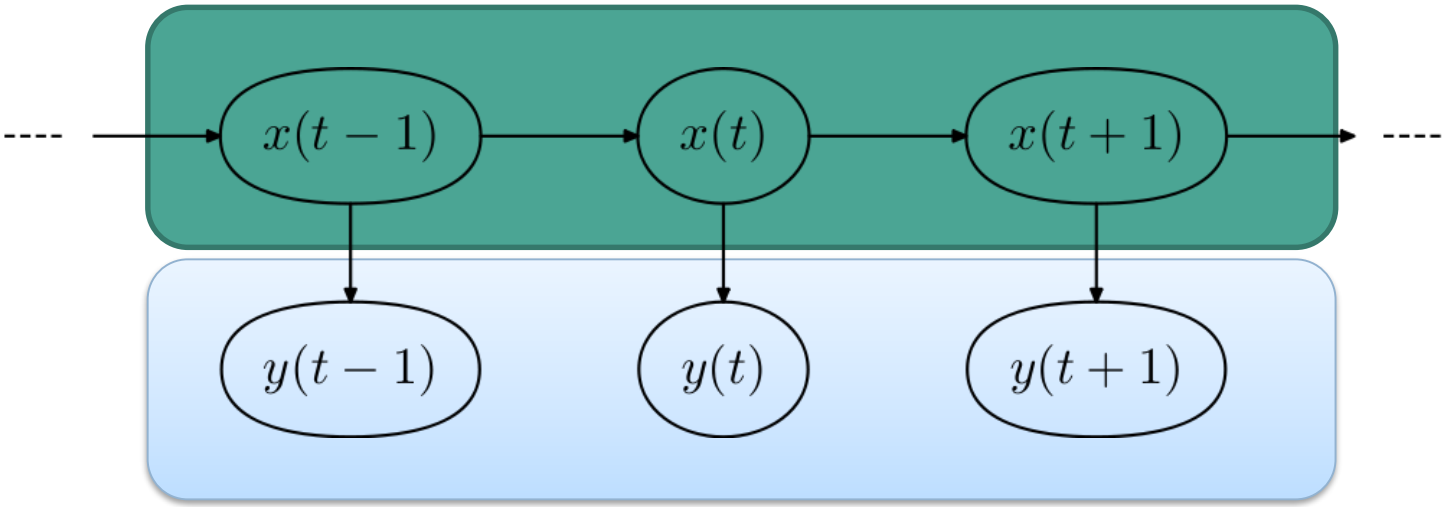




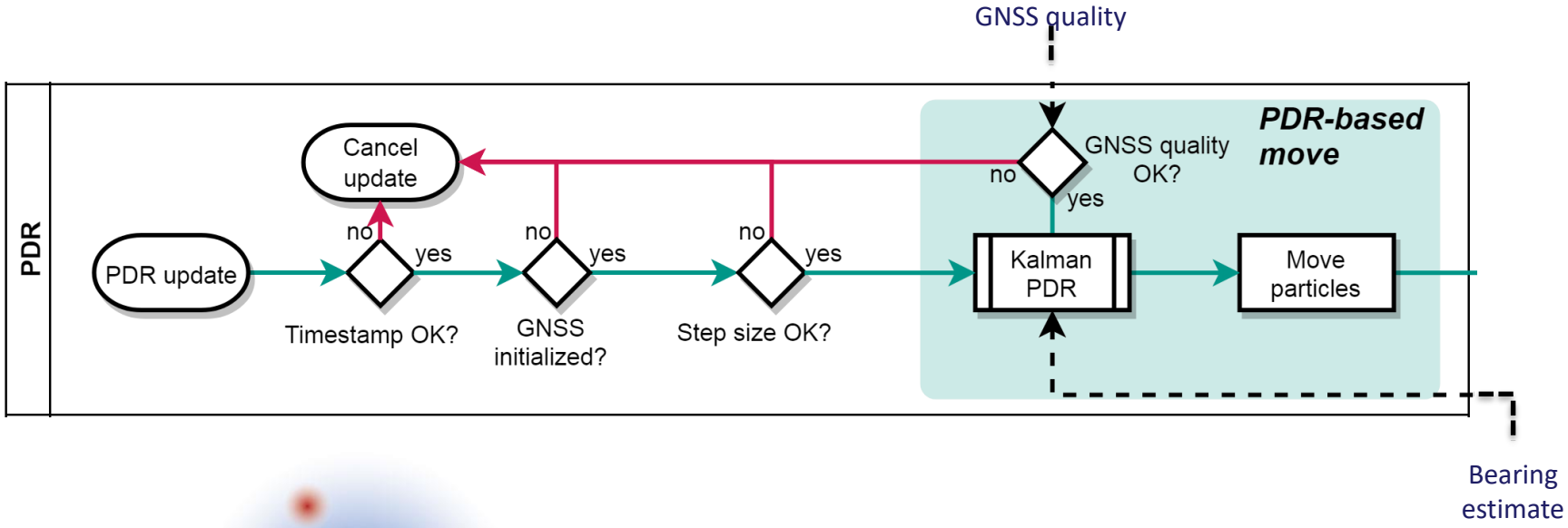


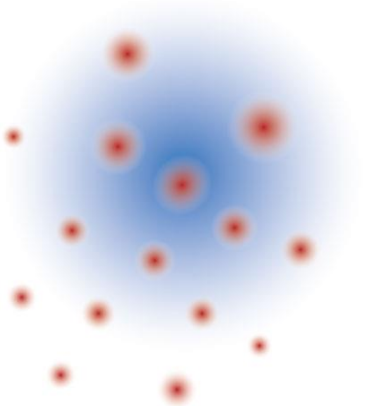
Particle representation of the pdf

Sensor fusion: MCMC

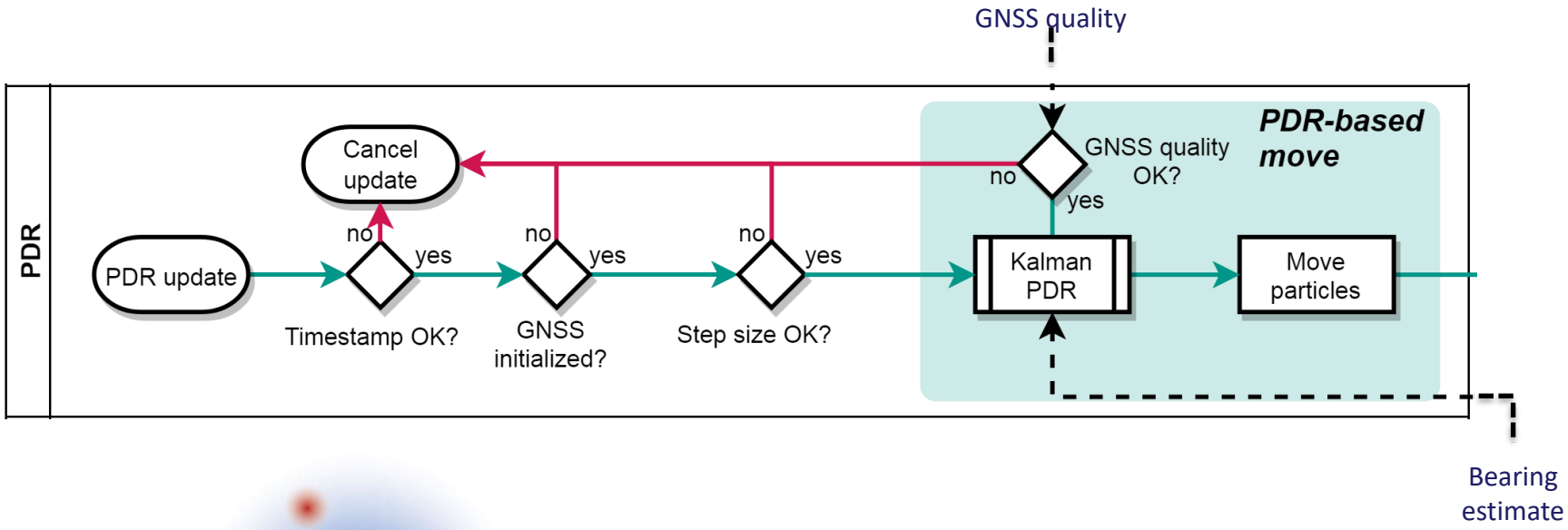


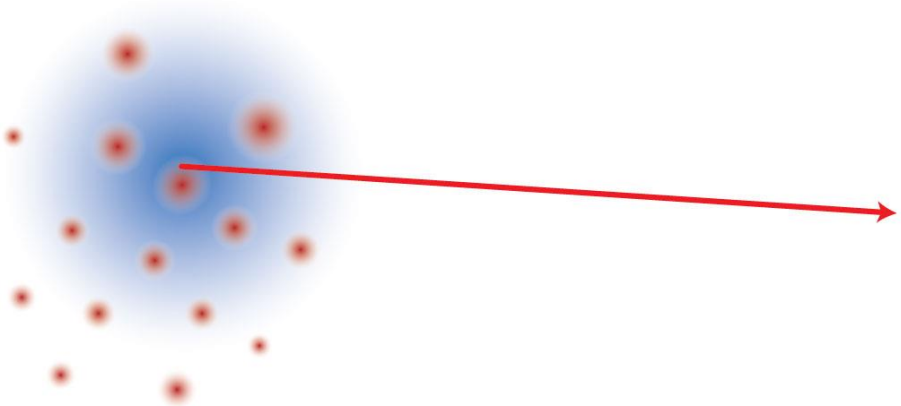
PDR processing pipeline





PDR processing pipeline





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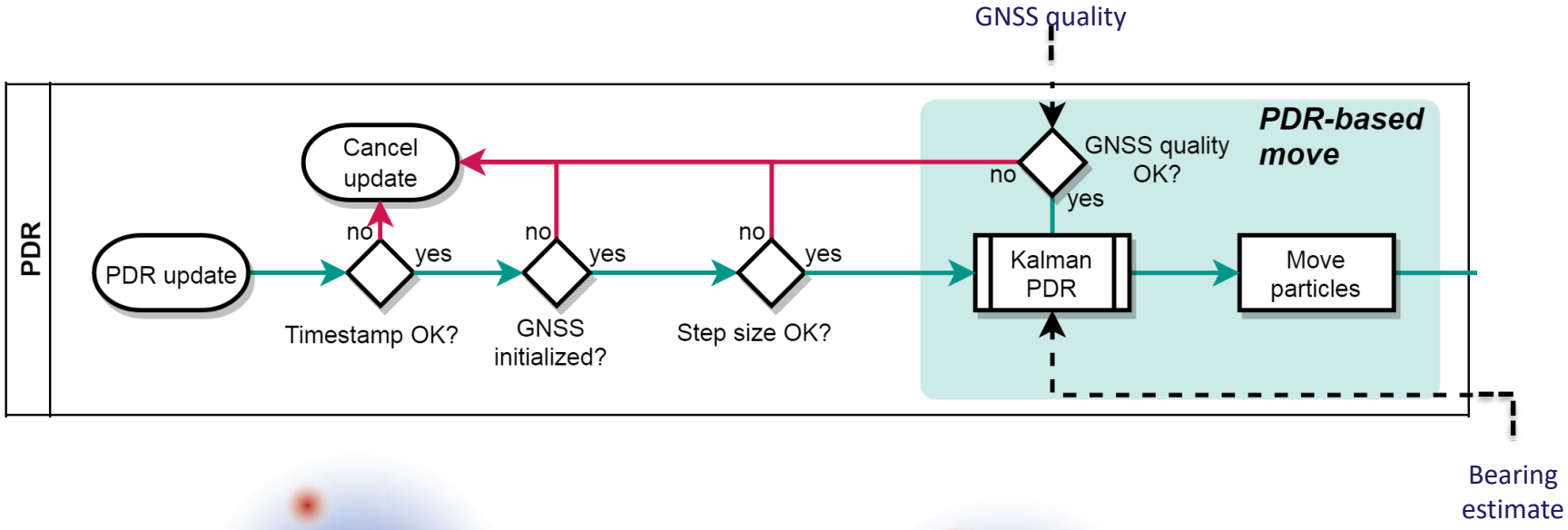
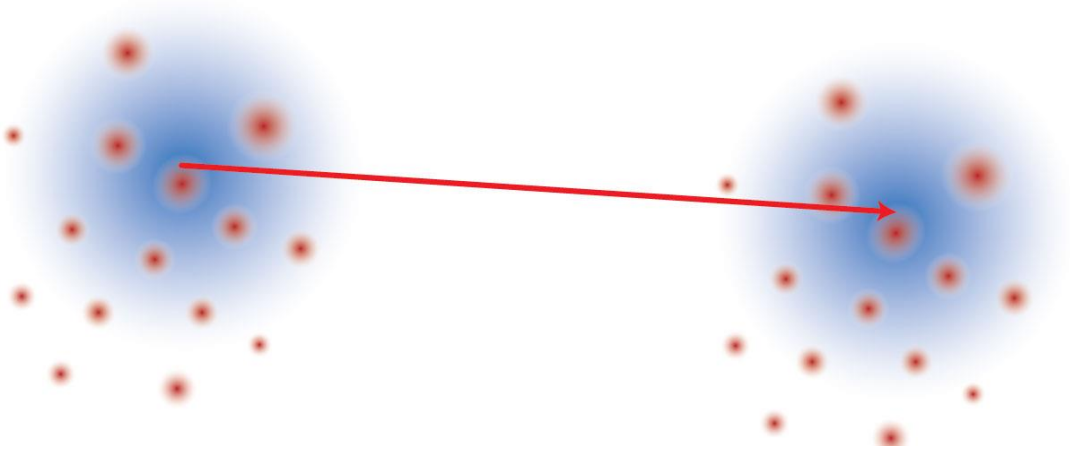
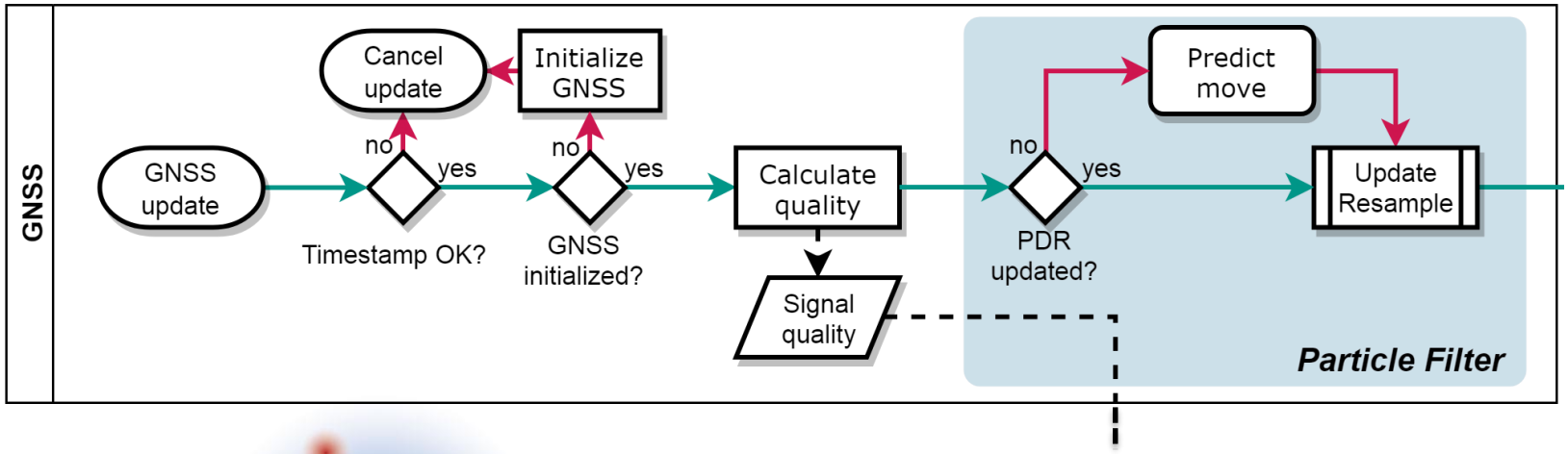
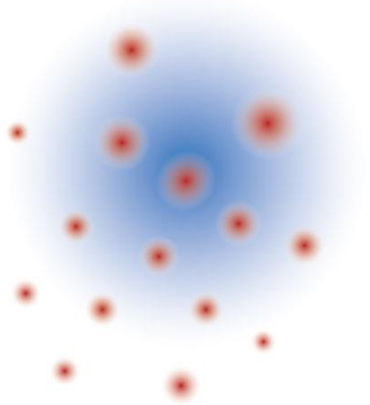


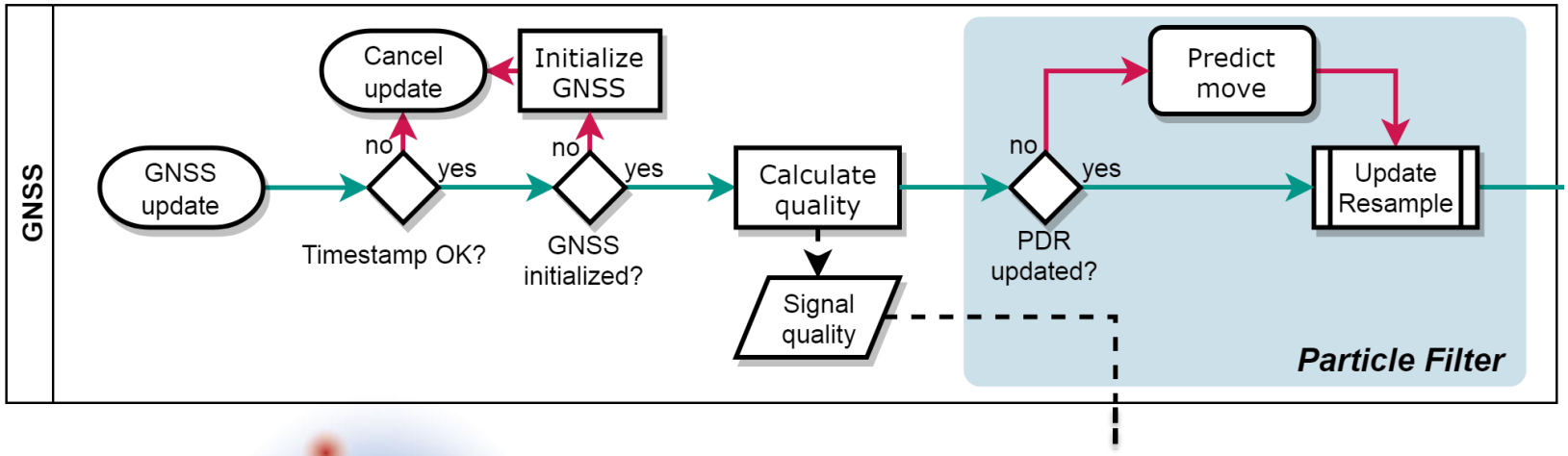


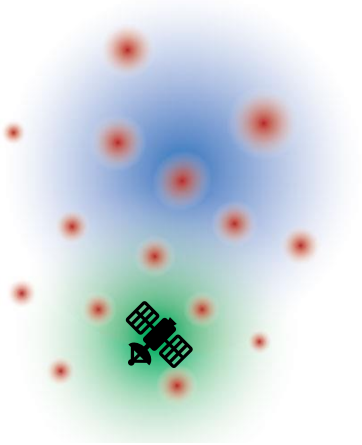
GNSS processing pipeline



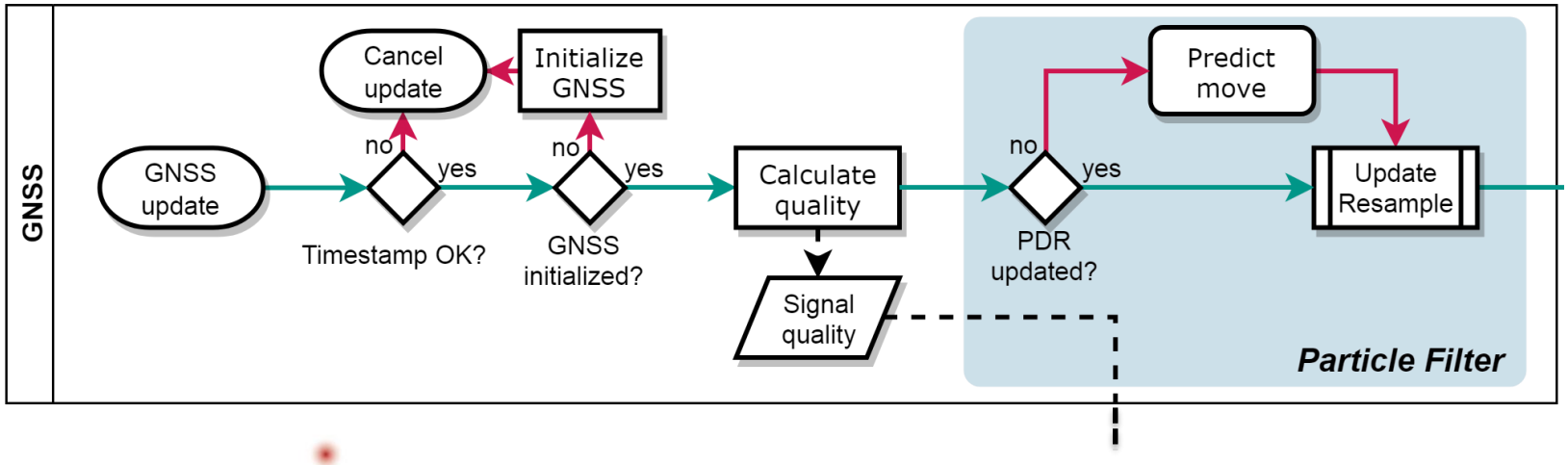


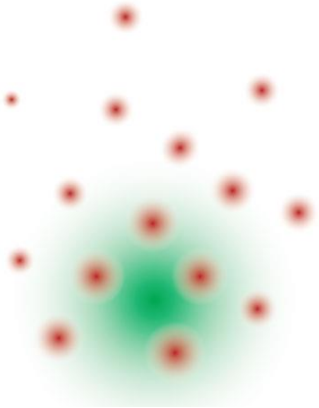
GNSS processing pipeline



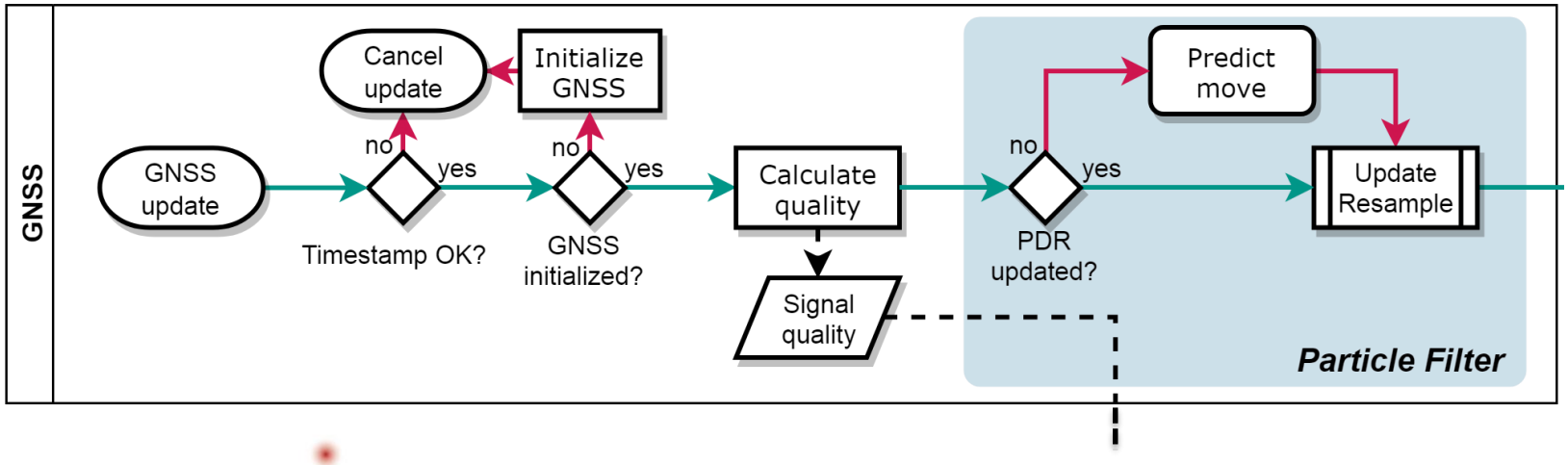


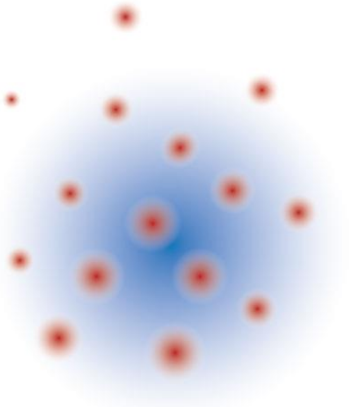
GNSS processing pipeline



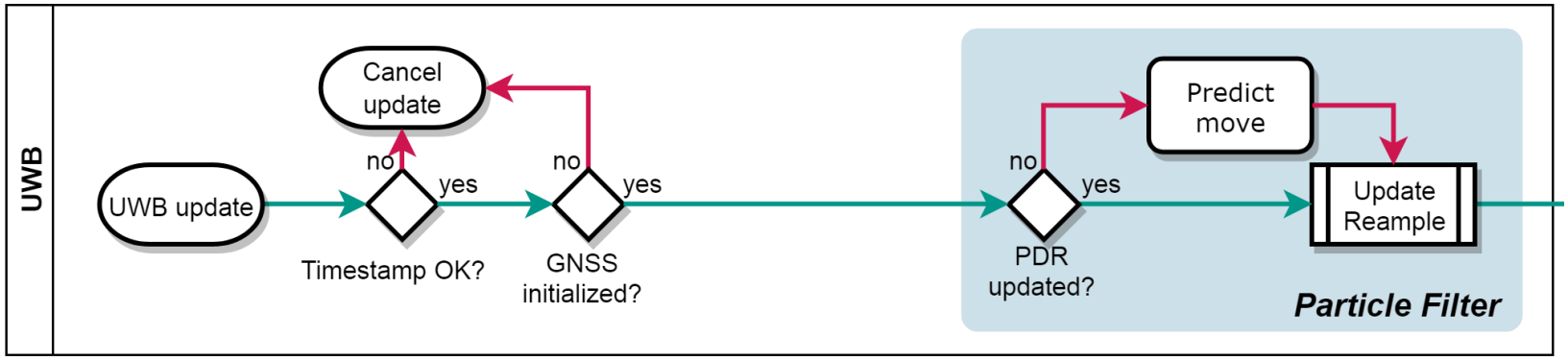


GNSS processing pipeline

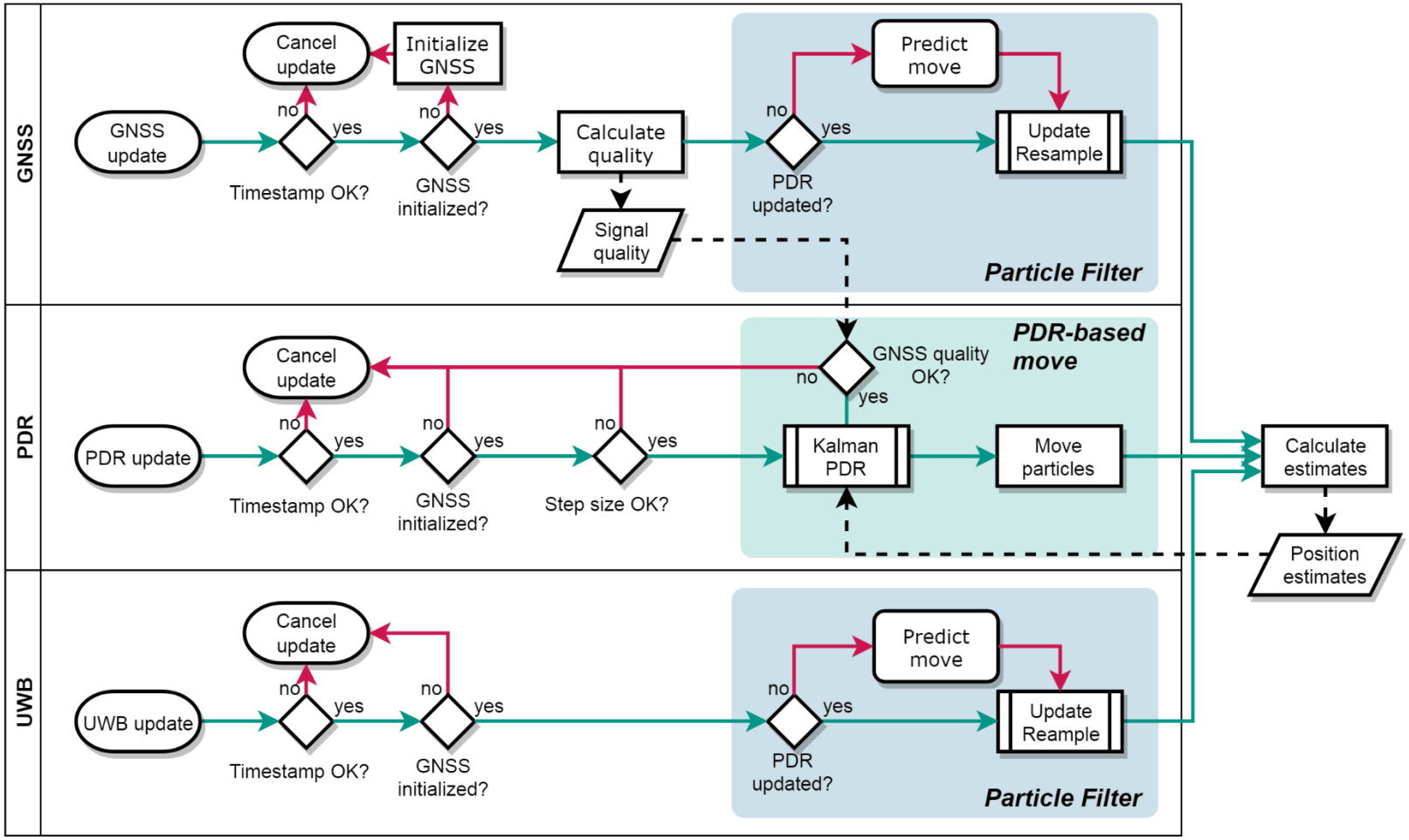




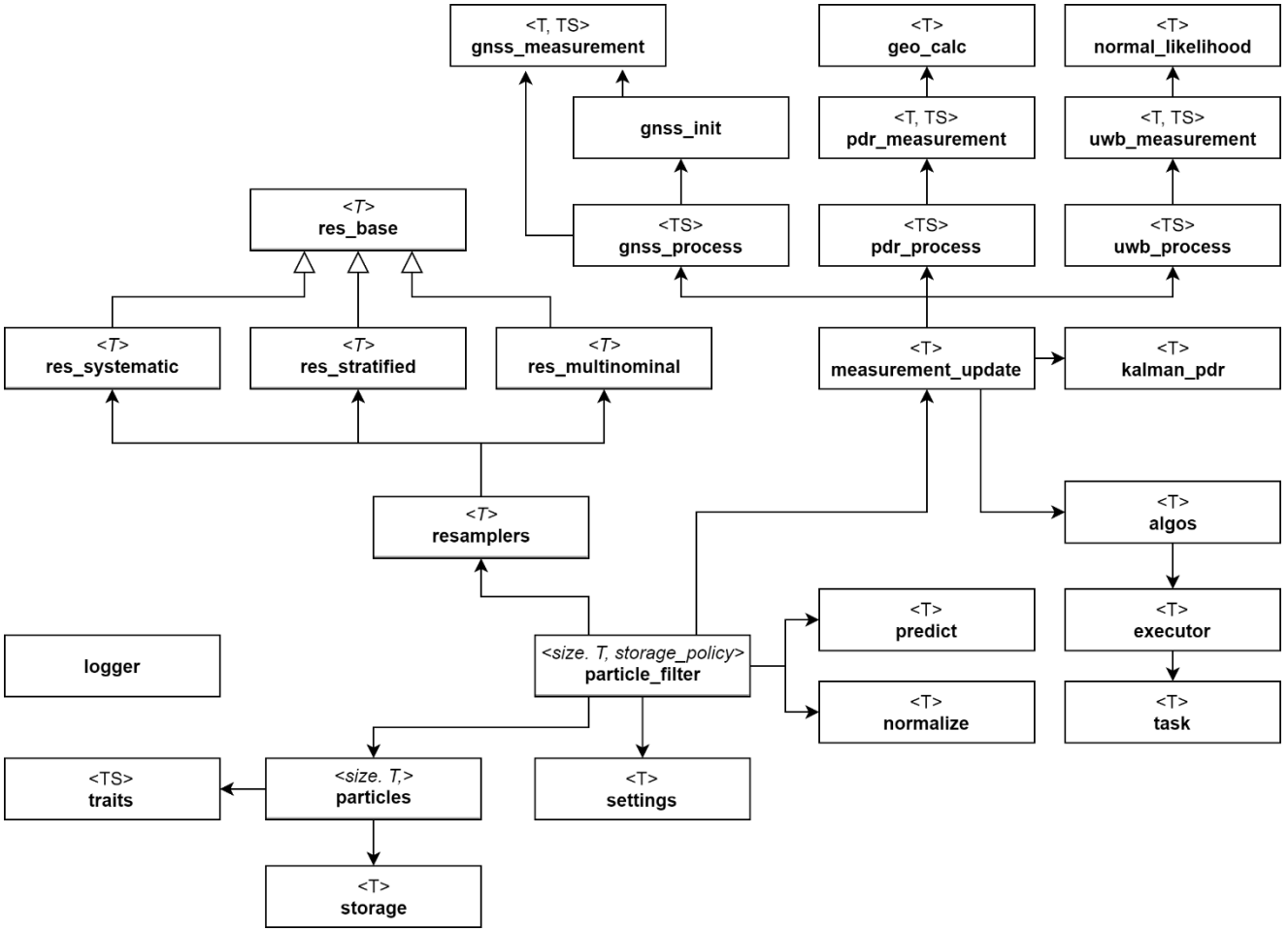
UWB processing pipeline



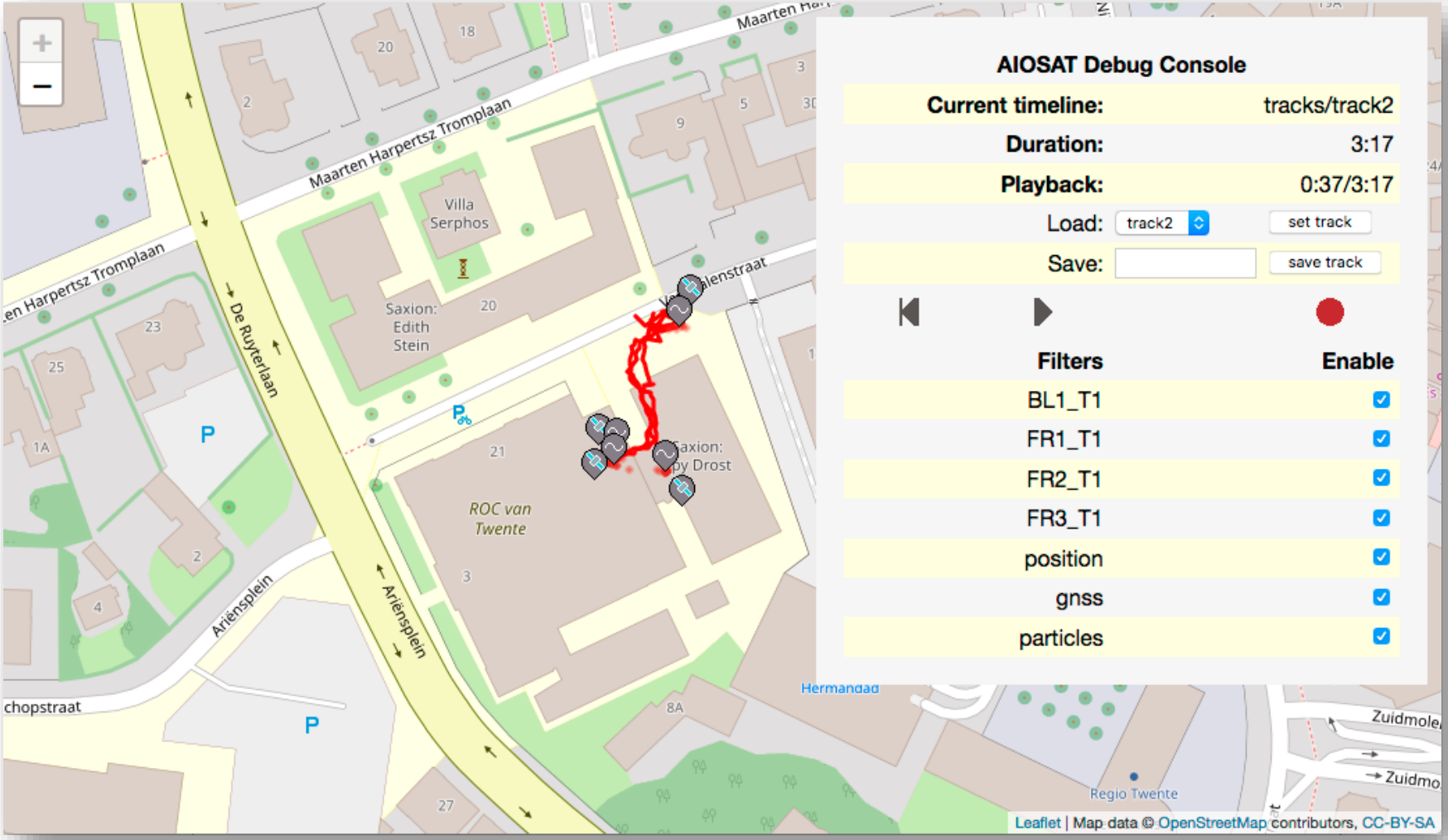
Sensor Fusion at a Glance



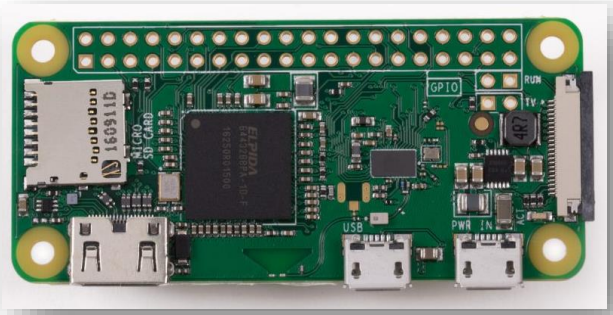
Sensor Fusion Component Design



Sensor Fusion



Sensor Fusion: work-in-progress



More ports
ARMv6 vs. ARMv7
1 core vs. 4 cores

Summary

- Safety of rescue workers can be greatly improved with new technologies, among them position tracking.
- GNSS is insufficient for seamless outdoor/indoor tracking.
- Augmenting GNSS with additional positioning sources (PDR, UWB) extends its usability.
- Sensor fusion with particle & Kalman filters enables integration and smooth transition between signal sources.
- Adaptive filtering strategies enhance the raw filtering results.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