Leibniz Universität Hannover

2. i.loc Workshop

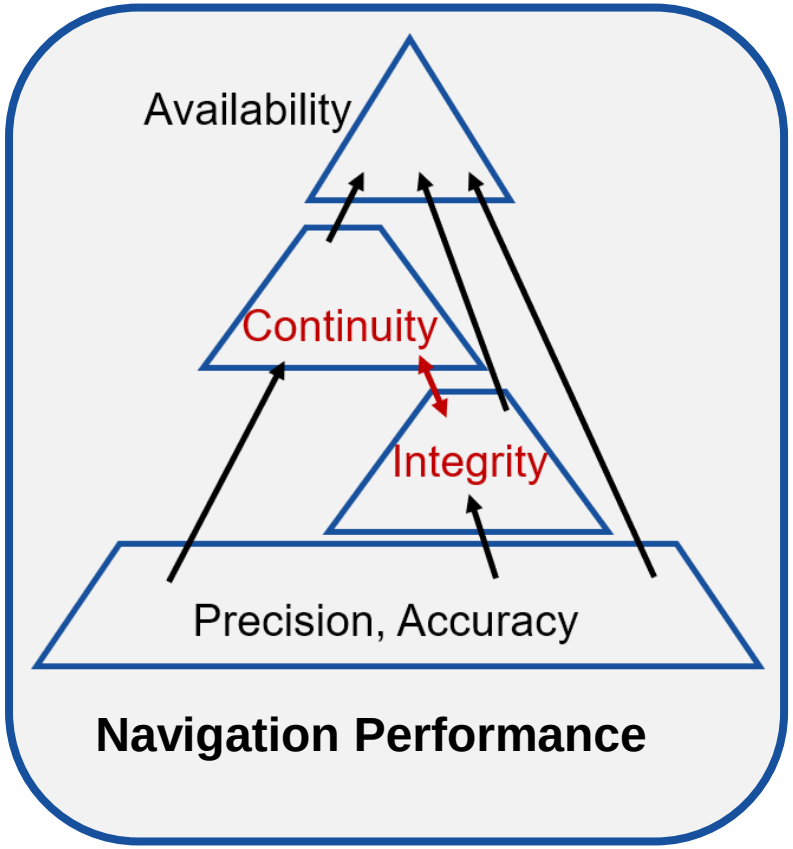
High-integrity Localization for Automated Vehicles

Steffen Schön

Leibniz Universität Hannover

High Integrity Localisation

- Integrity measures the trust that we can put in the navigation solution



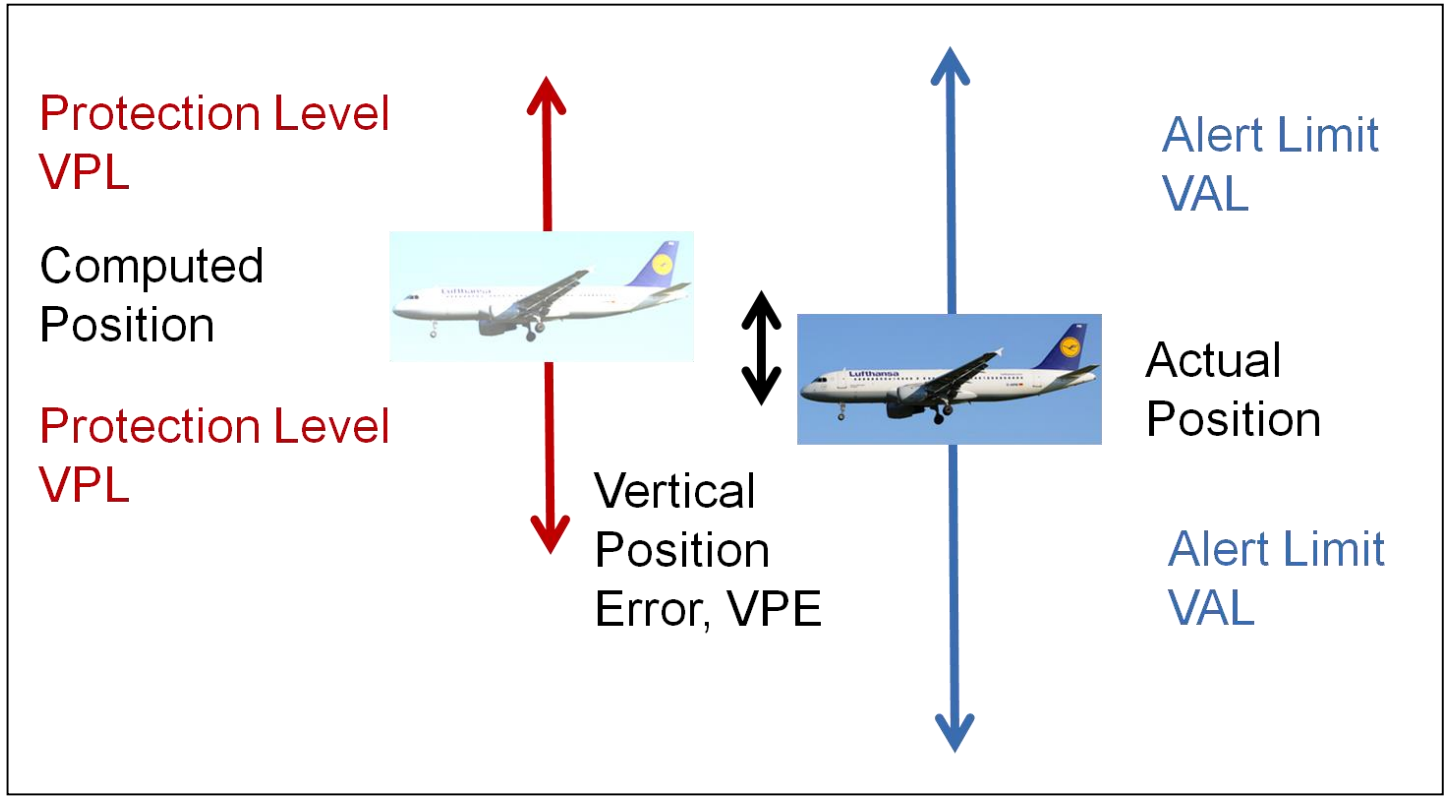
Landing in Skiathos

Landing in St Maarten, Wikipedia

Compromise between different parameters

Well-defined Set of Parameters for Aviation

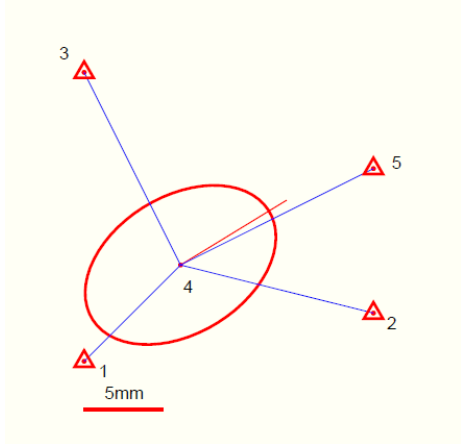
- Specifications:
  - Alert limits
  - Time to Alert
- Estimation result:
  - Computed position
  - Uncertainty
    => Protection levels
- Unknown:
  - Actual position
  - **Position error**

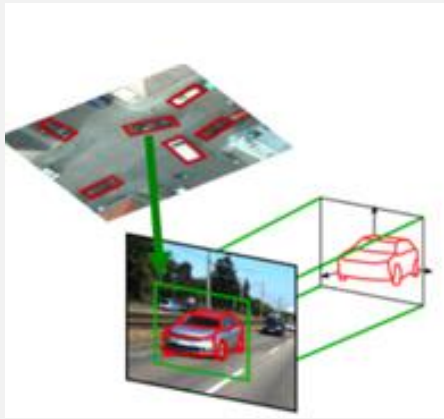


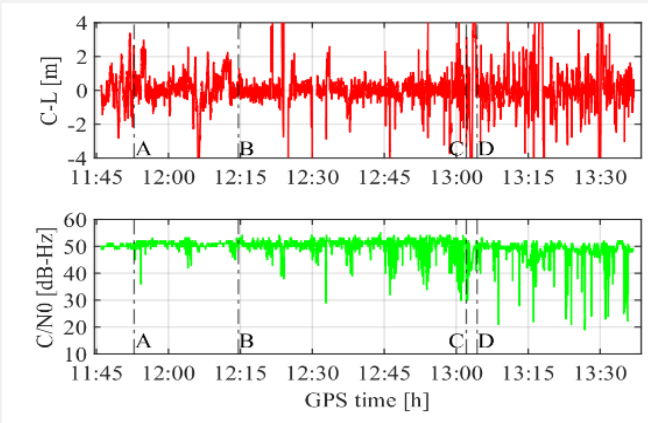
Reduce and/or bound the position error

Magnitude of the Position Error

- Reduction of the position error
  - Quality of observations (GNSS, IMU, LiDAR, Camera, maps, 3D models, features,…)
  - Geometry of navigation
- Truthworthy bounding of uncertainty

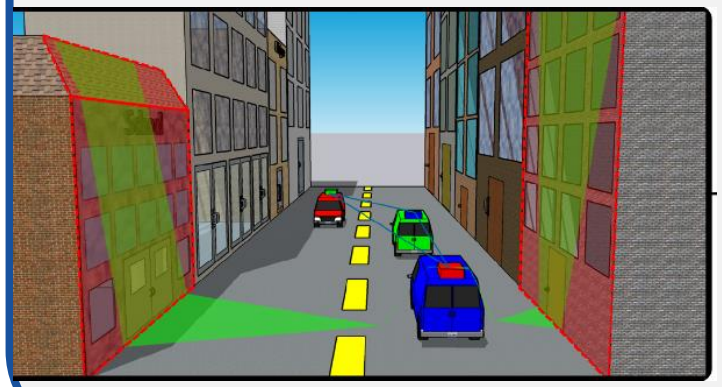


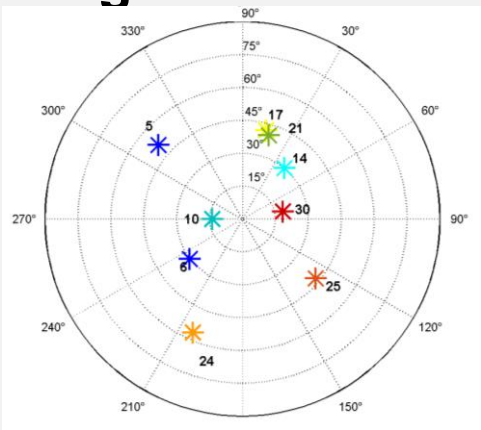




Quality of Observations

“Geometry of Navigation”





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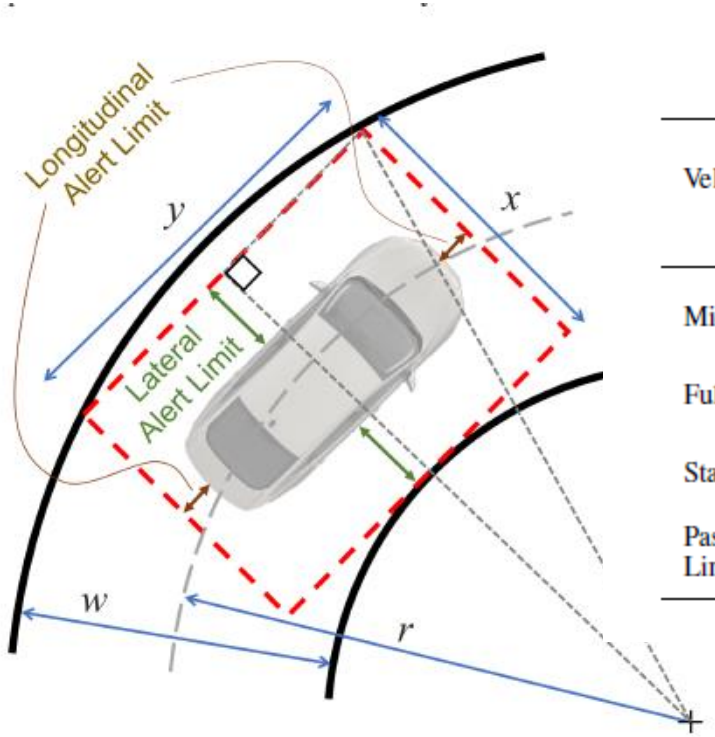
Simple Transfer to Automatic Vehicles?

- Specification (e.g. Reid et al. 2019) based on assessment of fatalities and road geometry



Vehicle Type	Accuracy (95%)				Alert Limit				Prob. of Failure (Integrity)
	Lateral [m]	Long. [m]	Vertical [m]	Attitude* [deg]	Lateral [m]	Long. [m]	Vertical [m]	Attitude* [deg]	
Mid-Size	0.15	0.15	0.48	0.17	0.44	0.44	1.40	0.50	10^{-9} / mile (10^{-8} / hour)
Full-Size	0.13	0.13	0.48	0.17	0.38	0.38	1.40	0.50	10^{-9} / mile (10^{-8} / hour)
Standard Pickup	0.12	0.12	0.48	0.17	0.34	0.34	1.40	0.50	10^{-9} / mile (10^{-8} / hour)
Passenger Vehicle Limits	0.10	0.10	0.48	0.17	0.29	0.29	1.40	0.50	10^{-9} / mile (10^{-8} / hour)

*Error in each direction (roll, pitch, and heading).

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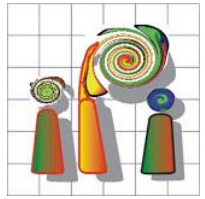
i.c.sens and i.loc
Integrity and collaboration in dynamic sensor networks
(RTG2159 funded by DFG)
www.icsens.uni-hannover.de/en/



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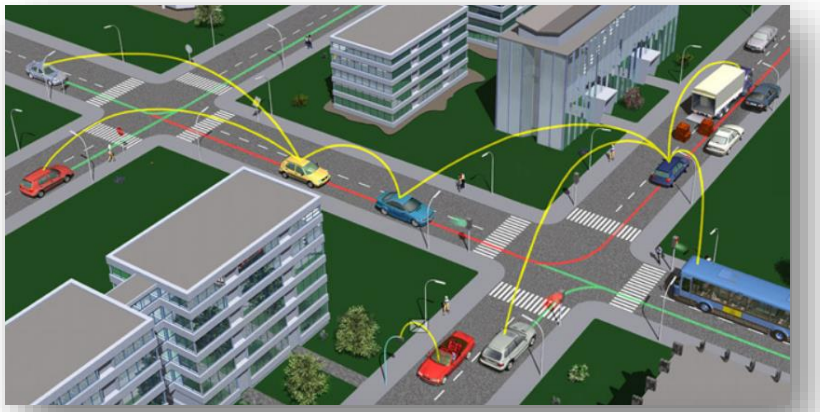
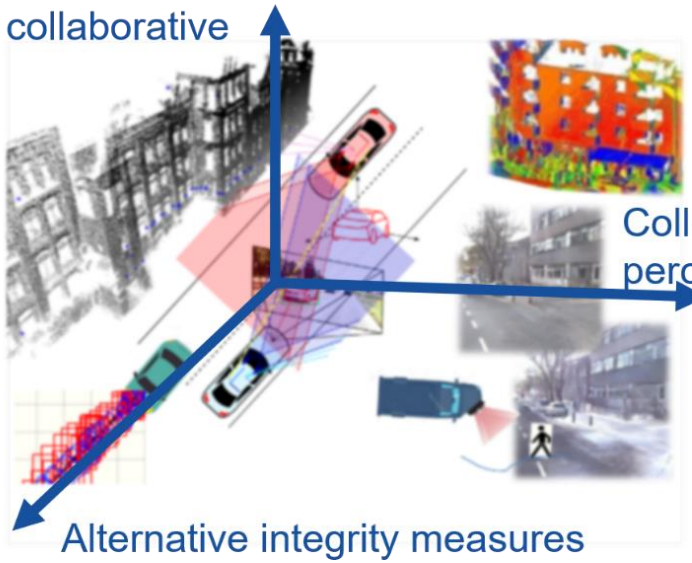
Research Directions



Robust and collaborative positioning



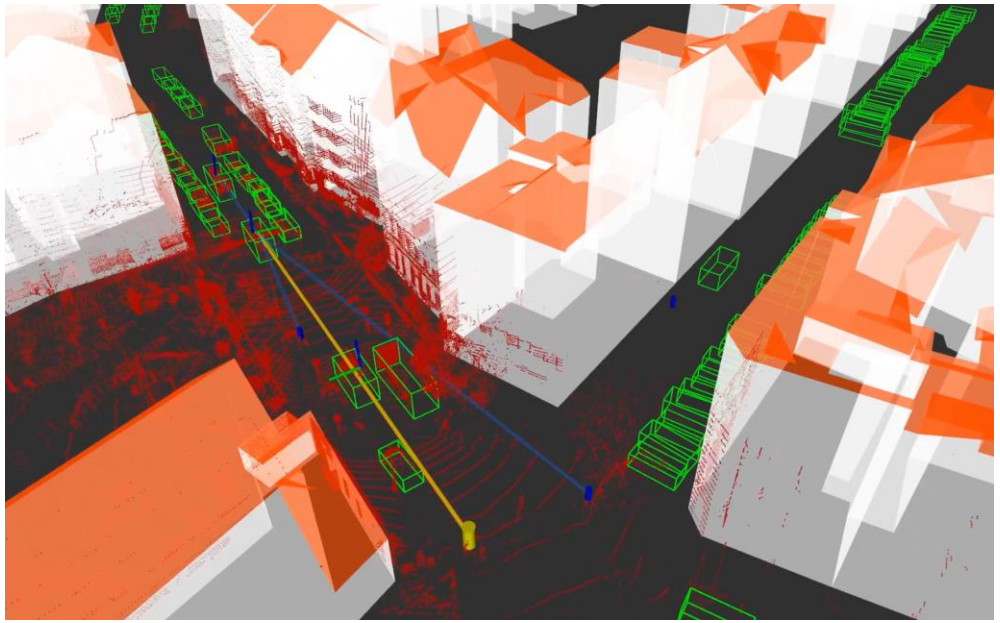
Collobarative environment perception with integrity

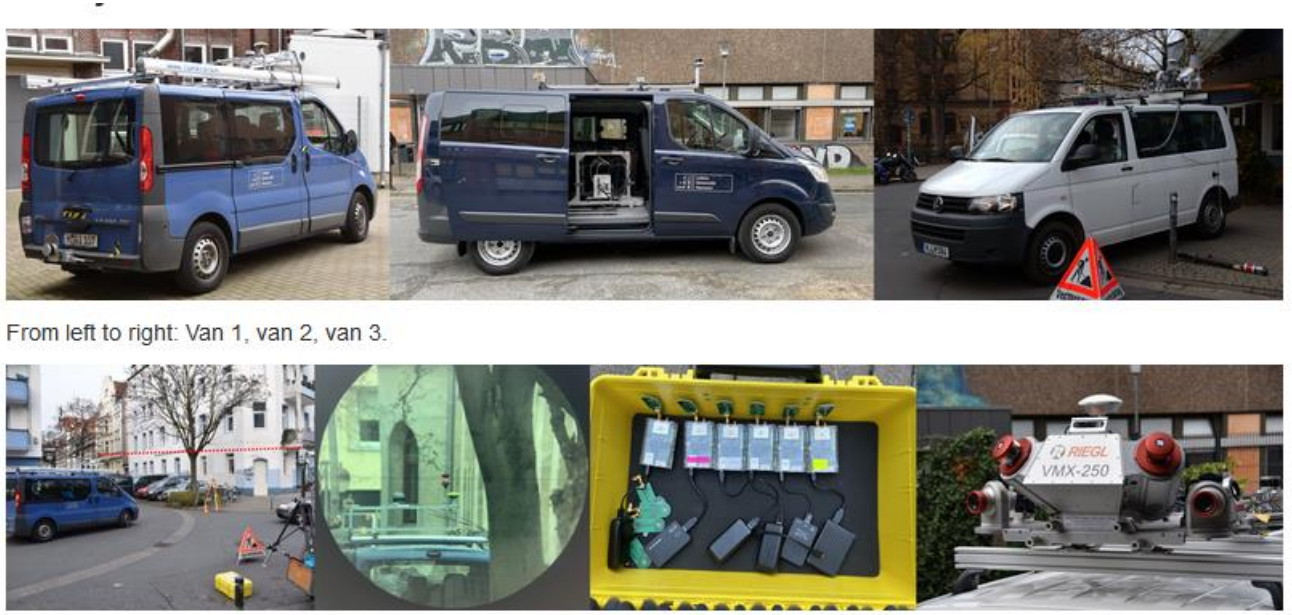
Alternative integrity measures and their predictability:

www.icsens.uni-hannover.de/en/

LUCOOP: Leibniz University Cooperative Perception and Urban Navigation Dataset

- A real-world multi-vehicle multi-modal V2V and V2X dataset (Axmann et al., 2023)





- https://data.uni-hannover.de/dataset/lucoop-leibniz-university-cooperative-perception-and-urban-navigation-dataset

Program

2nd iLoc Workshop – High-integrity Localization for Automated Vehicles

14:00 - 19:00

14:30 - 15:00 | WS15.01
Invited Talk: Reliable RF Navigation in Degraded using Advanced Signal Processing
Scott Martin

15:00 - 15:30 | WS15.02
Invited Talk: Perception error modelling for autonomous driving
Justin Dauwels

15:30 - 15:50 | WS15.03 |
Workshop Paper: Vision and Map-Based Non-Line-of-Sight Satellites Hybridized Processing
David Bétaille • Cyril Meurie • Yann Cocheril

15:50 - 16:10 | WS15.04 |
Workshop Paper: GNSS Feature Map Aided RTK Positioning in Urban Trenches
Fabian Ruwisch • Steffen Schön

16:10 - 16:30 | WS15.05 |
Workshop Paper: Maximum Consensus Based Localization and Protection Level Estimation Using Synthetic LiDAR Range Images
Jeldrik Axmann • Claus Brenner

17:30 - 18:00 | WS15.06
Invited Talk: Multi-Sensor High Accuracy and Integrity Navigation in ERASMO Intelligent Vehicle
Enrique Dominguez

18:00 - 18:30 | WS15.07
Invited Talk: Localization of Railway Vehicles using the Ferromagnetic Fingerprint of Rails
Bernd Kröper

18:30 - 18:50 | WS15.08 |
Workshop Paper: A Study of Different Observation Models for Cooperative Localization in Platoons
Elwan Héry • Philippe Xu • Philippe Bonnifait

<<Poster Session

Chen Zhu, Omar Garcia Crespillo, Daniel Gerbeth, Young-Hee Lee, Maximilian Simonetti, Wenhan Hao:
Towards Navigation System Integrity for Urban Air Mobility – Concept Design and Preliminary Validation [poster]
German Aerospace Center (DLR), Institute of Communications and Navigation

Zekun Zhang, Penghui Xu, Guohao Zhang, Li-Ta Hsu:
A Deep Learning Approach for GNSS-based Environment Detection in Urban Navigation [poster]
Department of Aeronautical and Aviation Engineering, the Hong Kong Polytechnic University

Anat Schaper, Steffen Schön:
Multi-Agent Collaboration for High-Integrity Urban Navigation [poster]
Institut für Erdmssung (IfE), Leibniz Universität Hannover

Maxime Noizet, Philippe Xu, Philippe Bonnifait:
Multi-sensor localization integrity for autonomous navigation of intelligent vehicles [poster]
Université de technologie de Compiègne

Yunshuang Yuan, Hao Cheng, Michael Ying Yang, Monika Sester:
Generating Evidential BEV Maps in Continuous Driving Space [poster]
Leibniz University Hannover & University of Twente

Other topics to be confirmed