

Automotive Radar: Open challenges from a research perspective

Thomas Dallmann, Technische Universität Ilmenau



Automated driving for individual transport

Degrees of automation and state of the art



Understanding and controlling the "long tail"

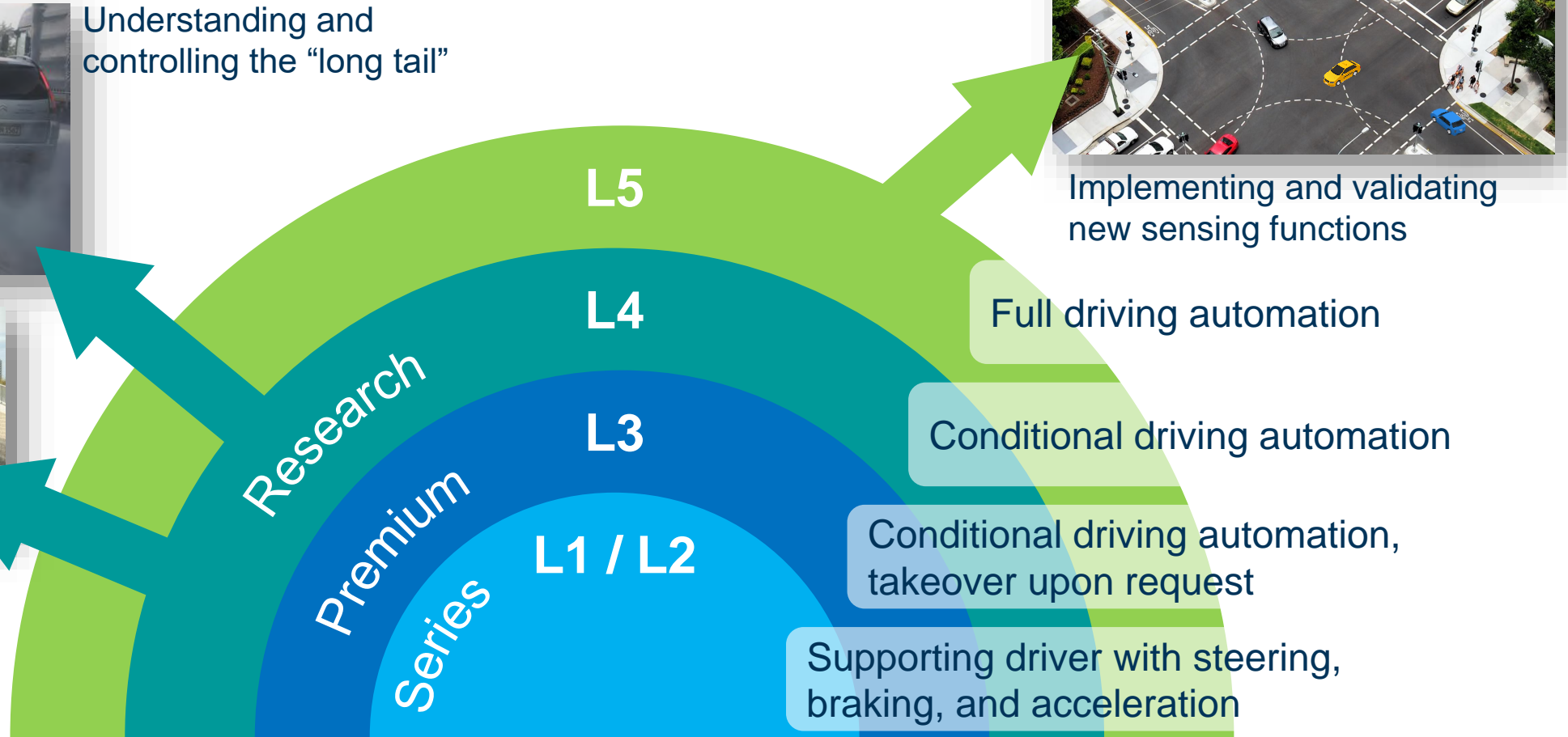


Improving sensor performance

Illustration credit: Deb Dowd, macrovector, Pixabay



Implementing and validating new sensing functions



Improving sensor performance

The challenge

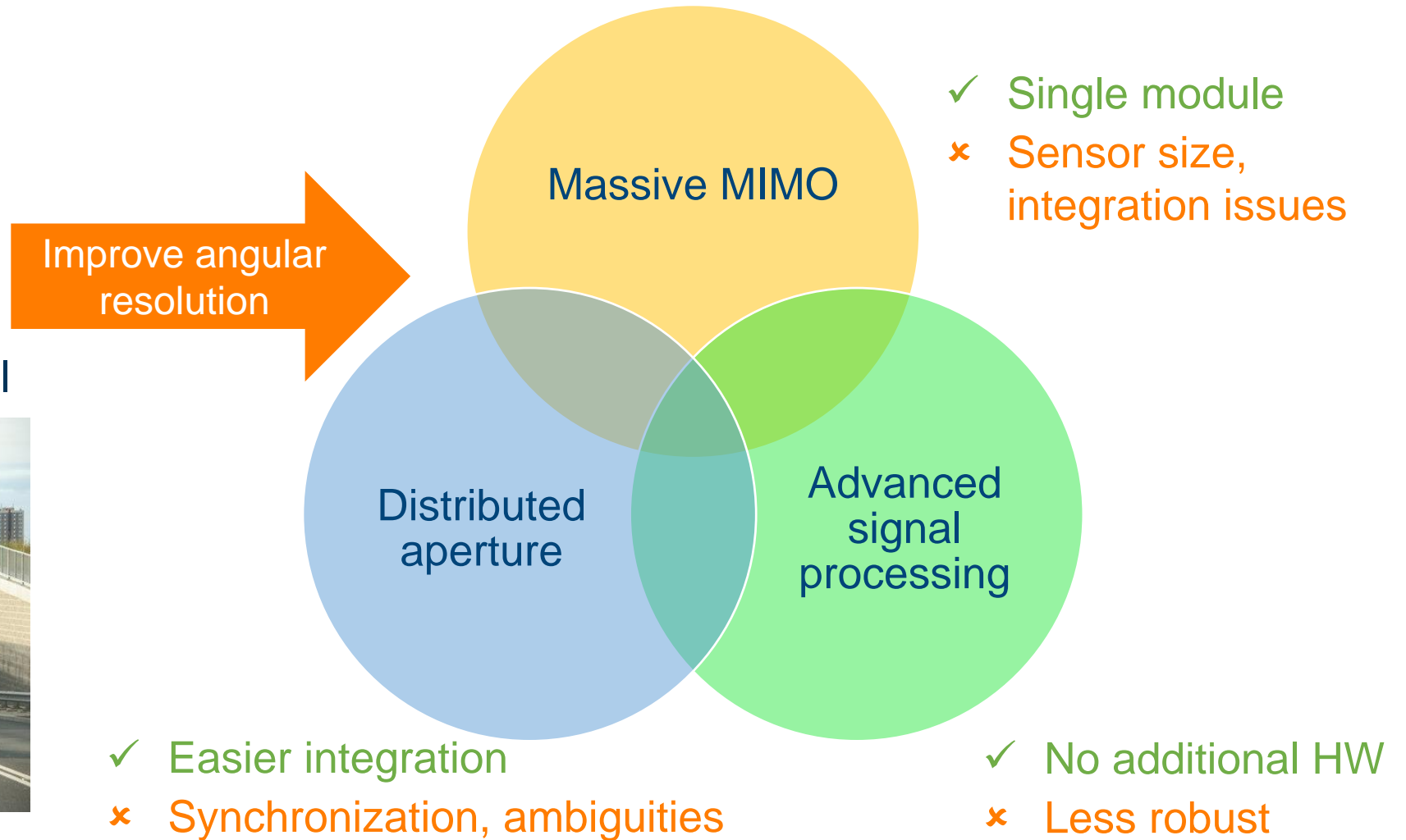
Distinguish objects in narrow passages:

A truck entering a tunnel should not be treated as wall



Photo credit: Unknown author, CC BY-SA

Improve angular resolution



Improving sensor performance

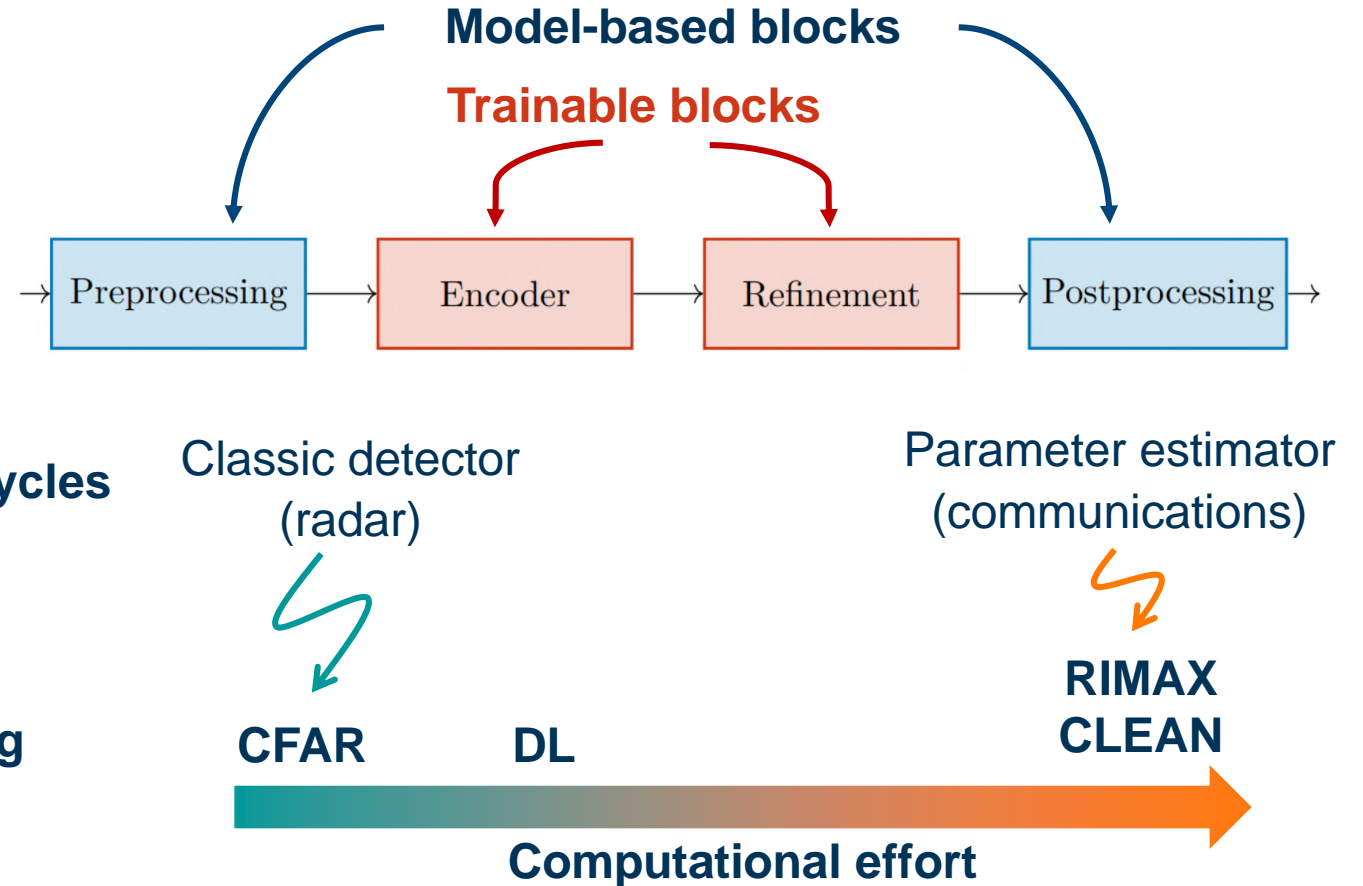
Advanced signal processing

Why Deep Learning?

- Real-time architecture (models known from computer vision)
- Simultaneous detection and parameter estimation possible:
 - Non-iterative, fixed number of clock cycles
 - Subsequent optimization possible

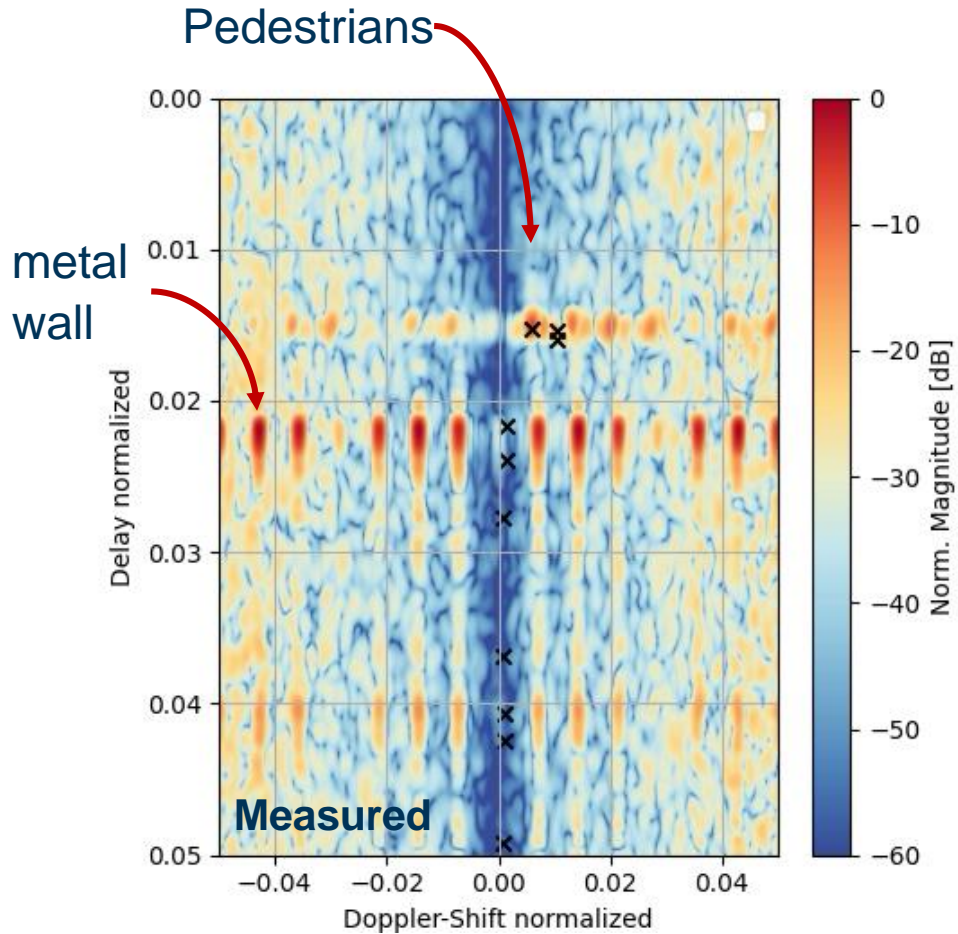
Why Physics-Informed Deep Learning?

- No measurement data required for training
- Known propagation models can be used

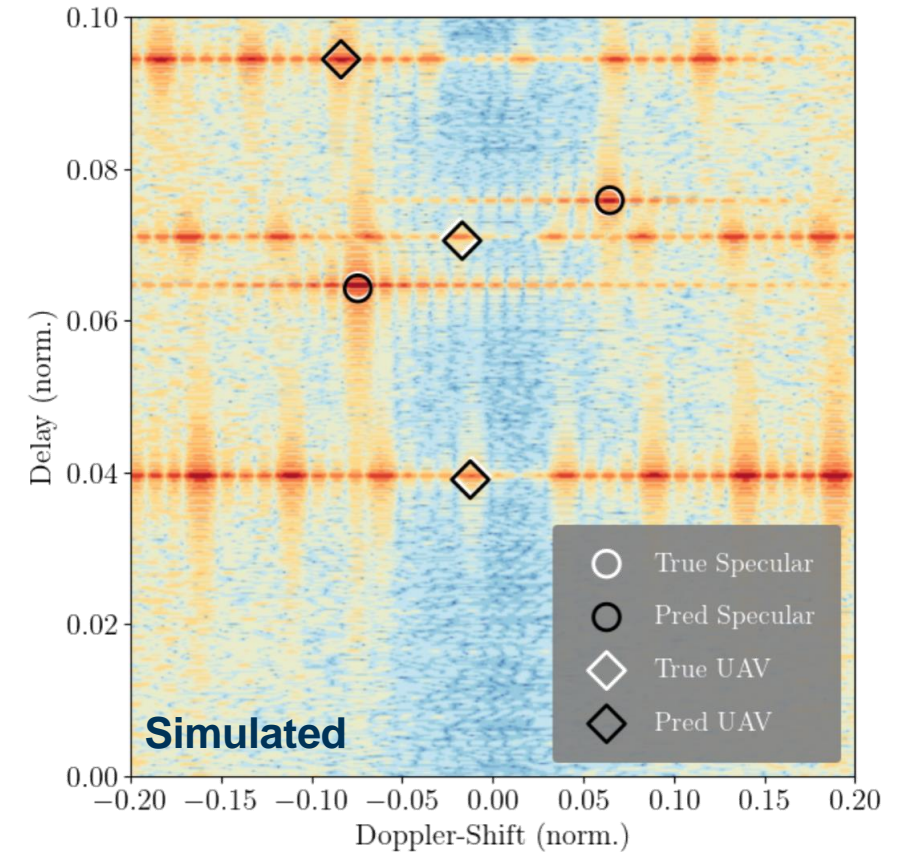


Improving sensor performance

High-res signal processing



- Simultaneous detection and estimation (left)
- Can handle ambiguities caused by sampling gaps (left)
- Can be extended to simultaneous classification (right)



Improving sensor performance

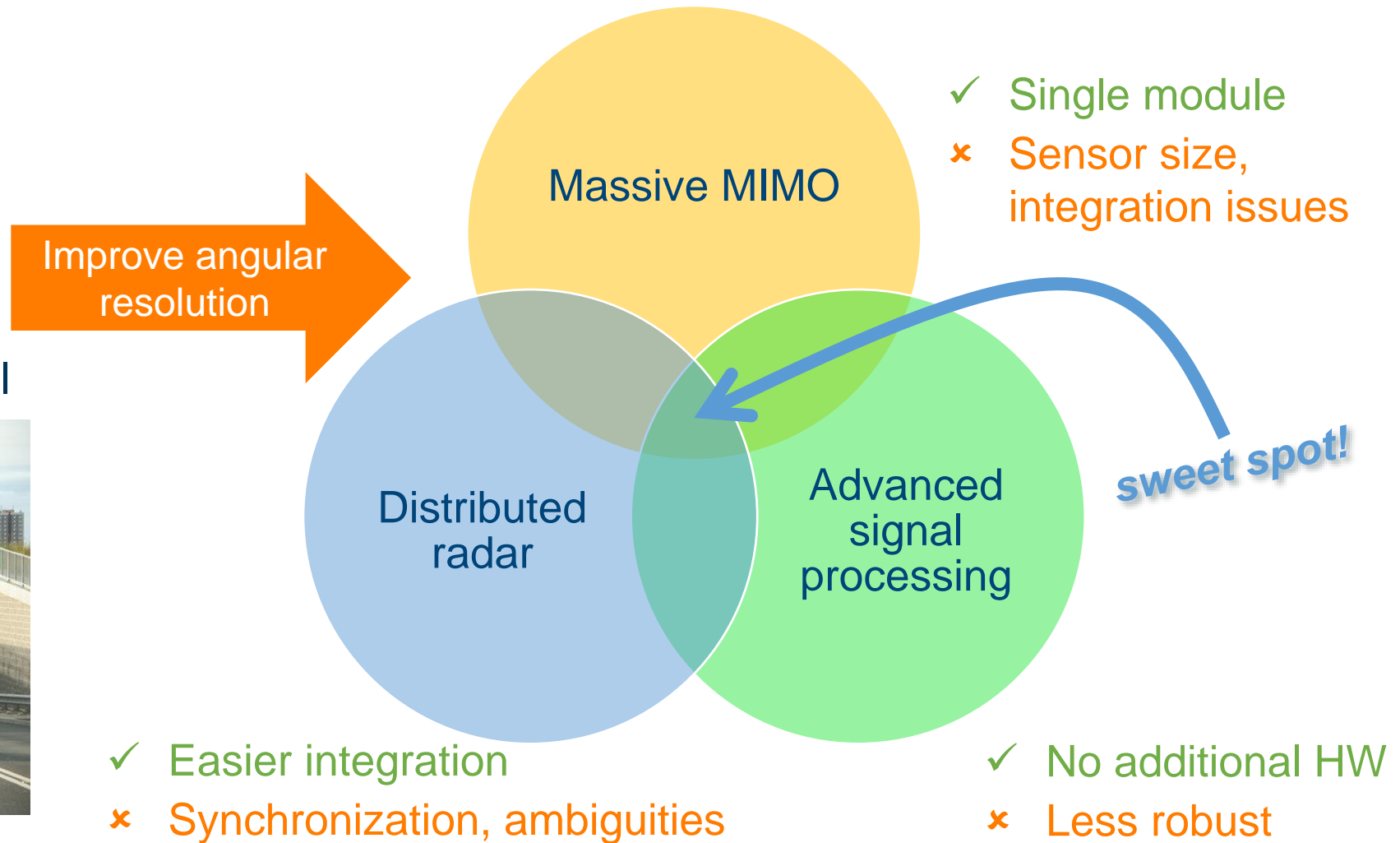
The challenge

Distinguish objects in narrow passages:

A truck entering a tunnel should not be treated as wall



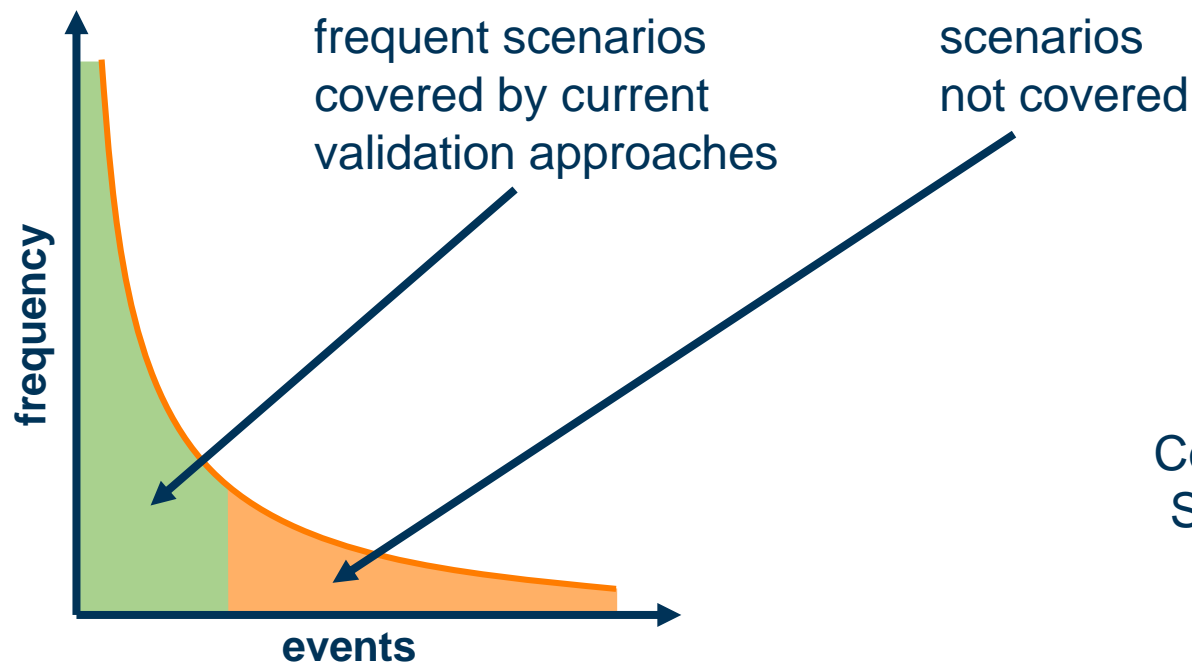
Photo credit: Unknown author, CC BY-SA



Understanding and controlling the “long tail”

The challenge

Limitations in testing driving functions:



- Precipitation (rain, snow, hail, fog)
- Environmental clutter (multipath)
- Variability of targets
- Rare, unexpected events

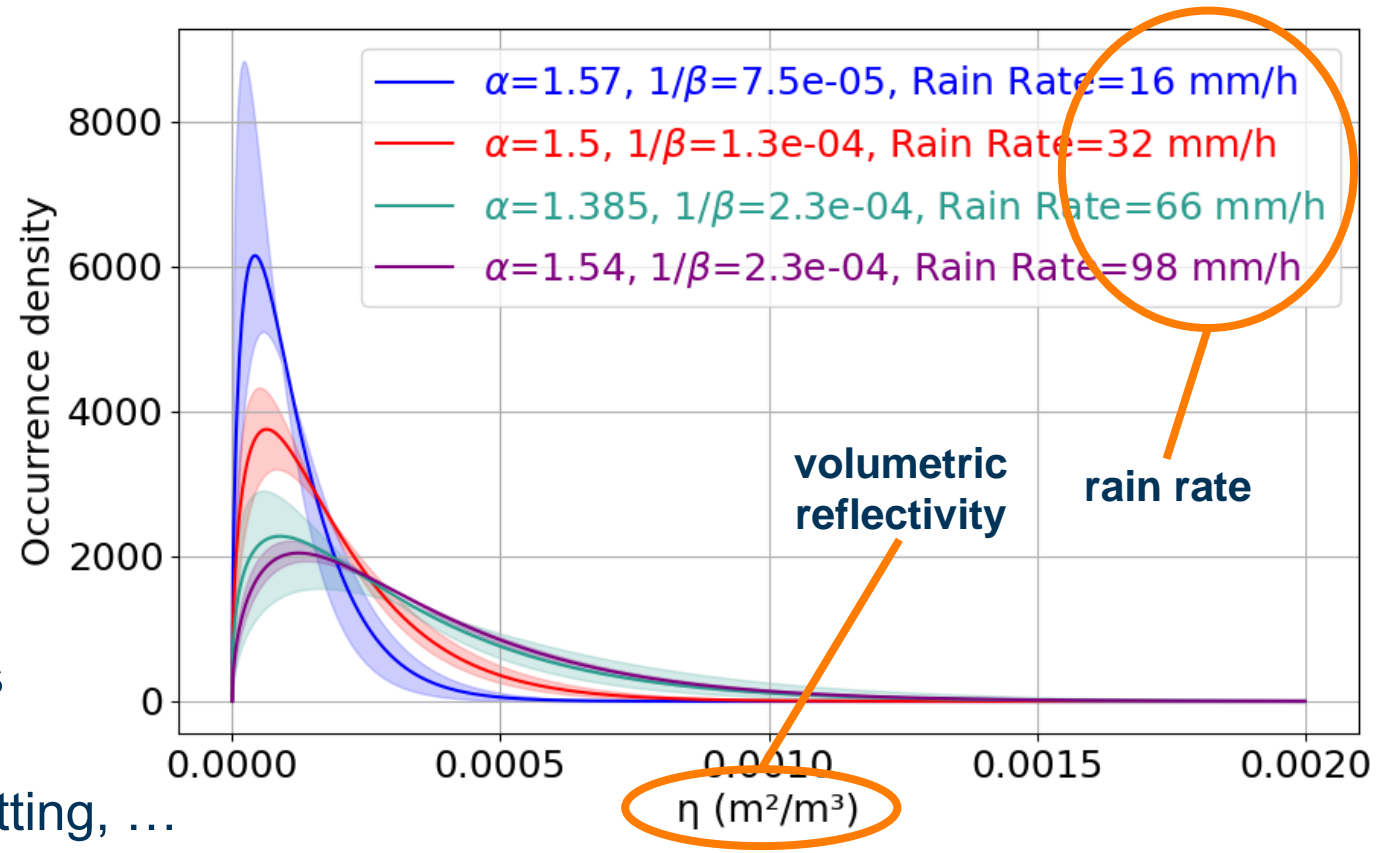


Controlling Risk for Highly Automated Transportation Systems Operating in Complex Open Environments

BMW funded project with 26 partners from industry and academia

Understanding and controlling the “long tail”

Precipitation effects

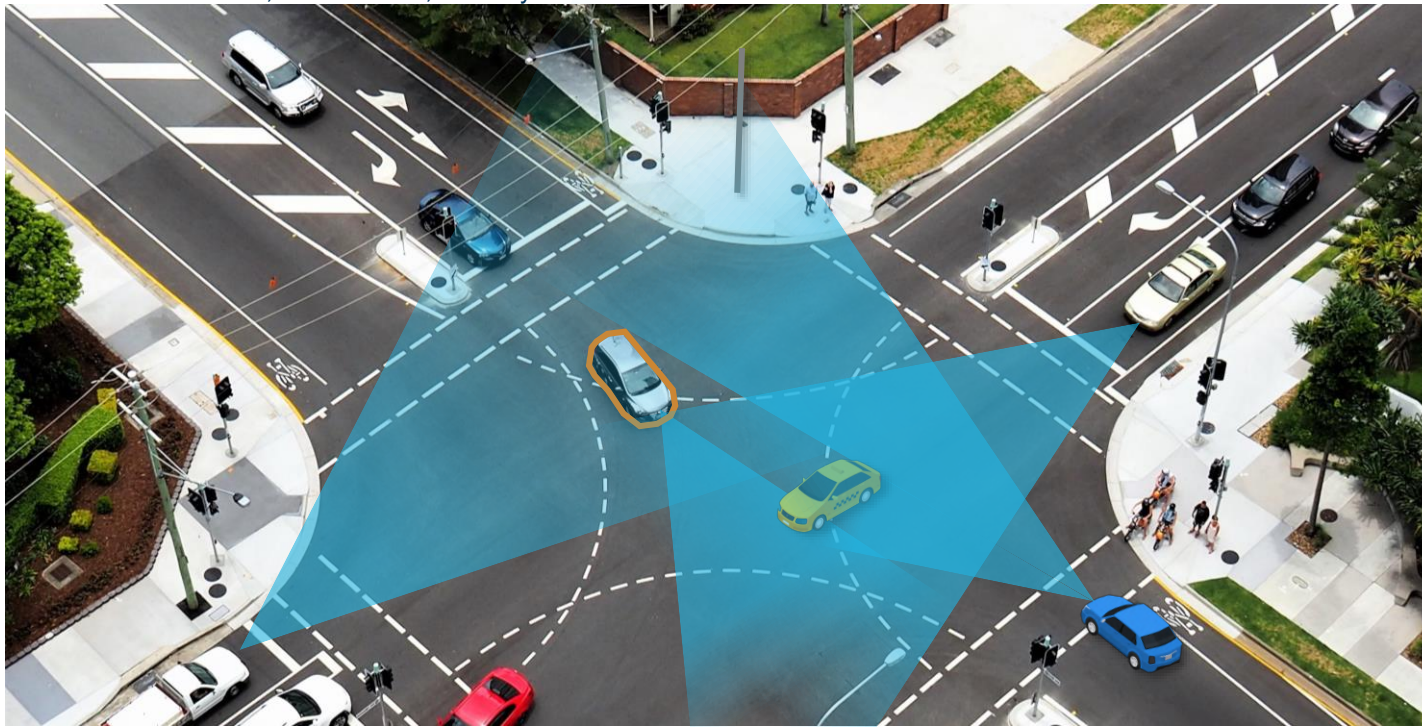


- Parametrized scattering models
- Enables quantification of false alarms caused by scattering (SiL, HiL, ViL)
- More effects: wind, spray, surface wetting, ...

Implementing and validating new sensor functions

Improved perception via cooperation

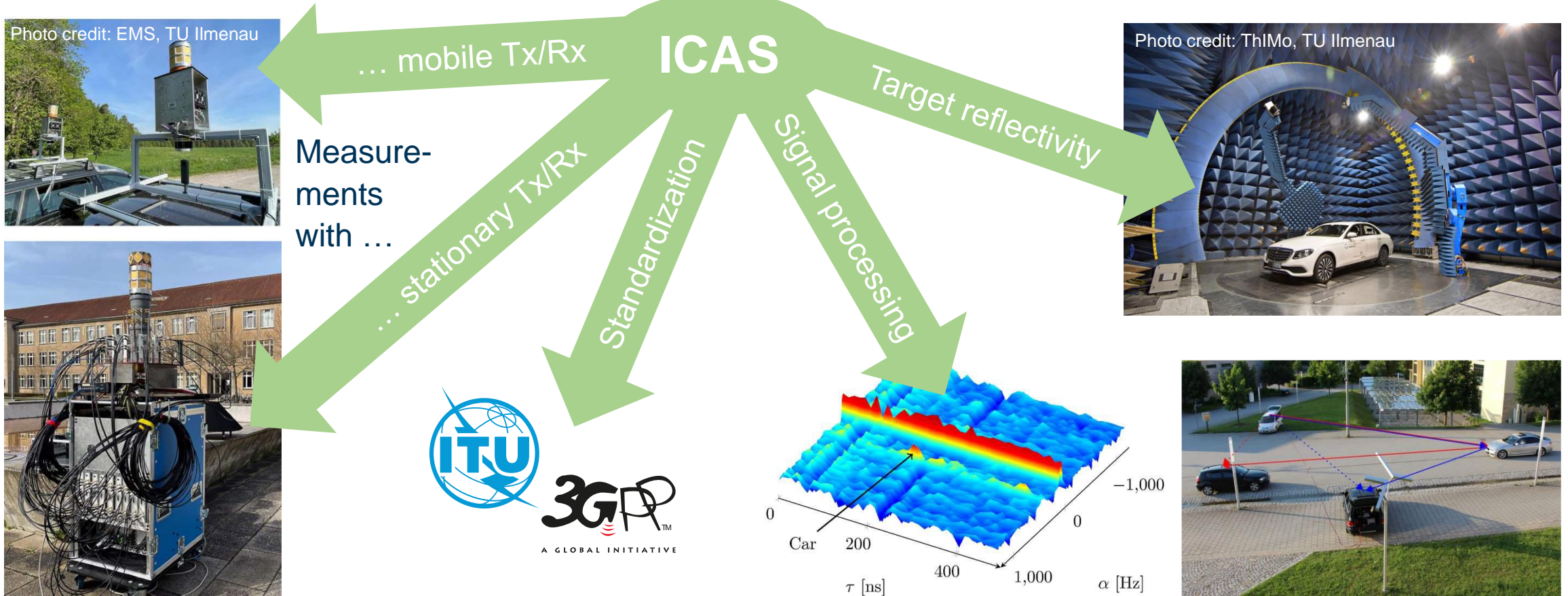
Illustration: Deb Dowd, macrovector, Pixabay



- Automotive radars limited to single perspective onto traffic scenario
- Integrated Communications and Sensing (ICAS): Use same radio and resources (frequency, time, space) for radar and communication
- Network operation:
 - Capture wider field-of-view
 - Detect vehicles despite shadowing
 - More reliable detection due to diverse perspectives onto target

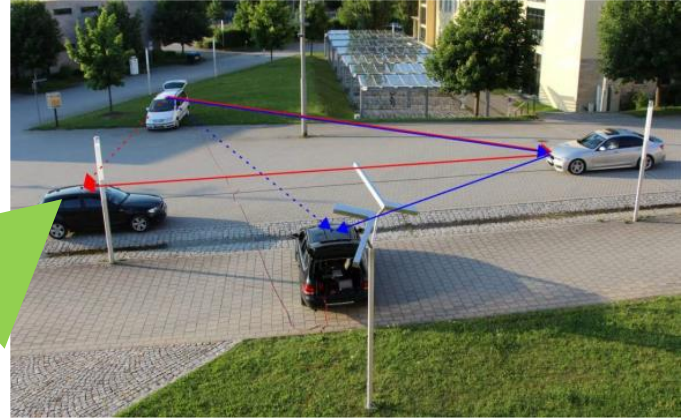
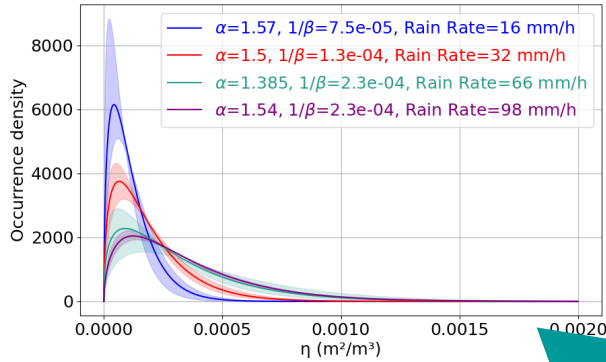
Implementing and validating new sensor functions

The way forward



Automated driving for individual transport

Our vision



Thank you for your attention!

thomas.dallmann@tu-ilmenau.de | www.tu-ilmenau.de/favf | www.tu-ilmenau.de/ems

Bildnachweis: Folie 1: Chris Liebold, Folie 2,5,6,9: Michael Reichel, Folie 10: helibild



Elektronische
Messtechnik und
Signalverarbeitung

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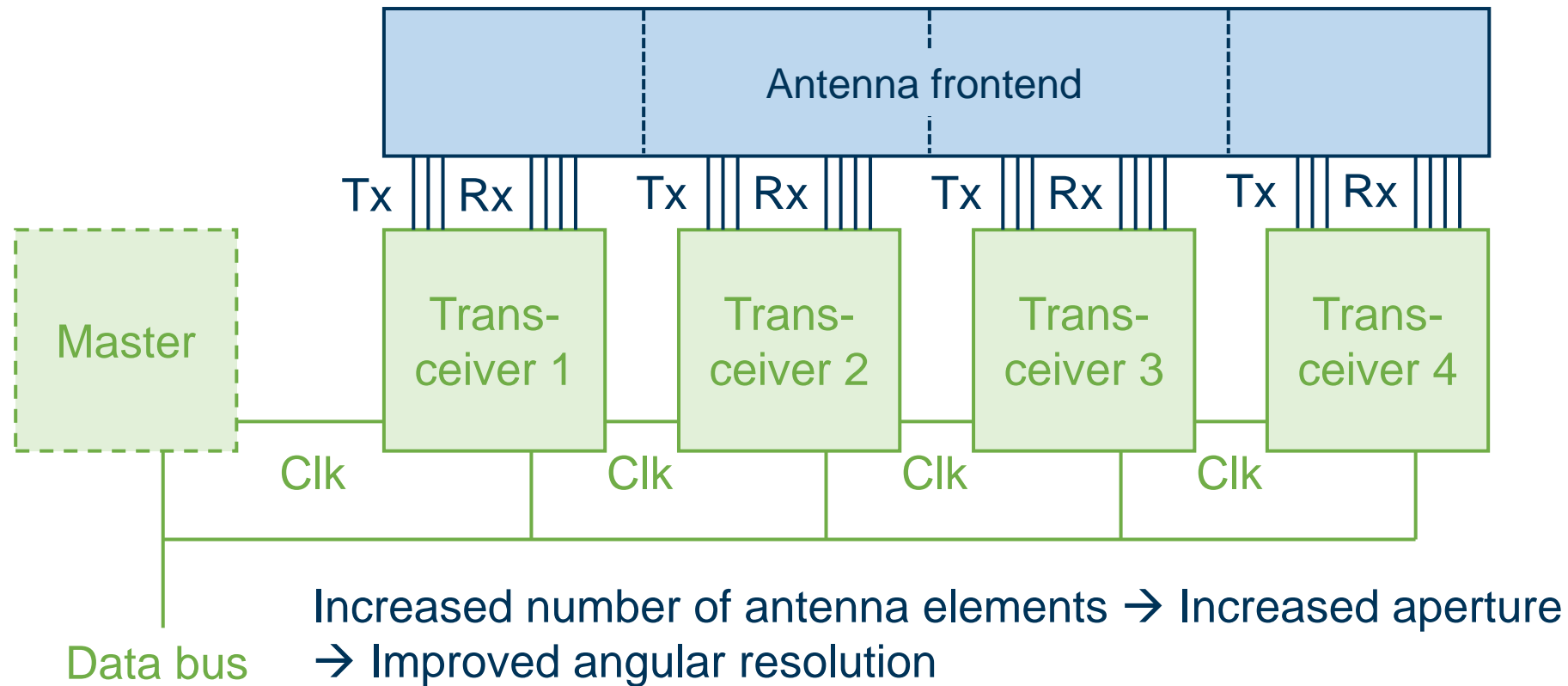
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The **SPiRiT**
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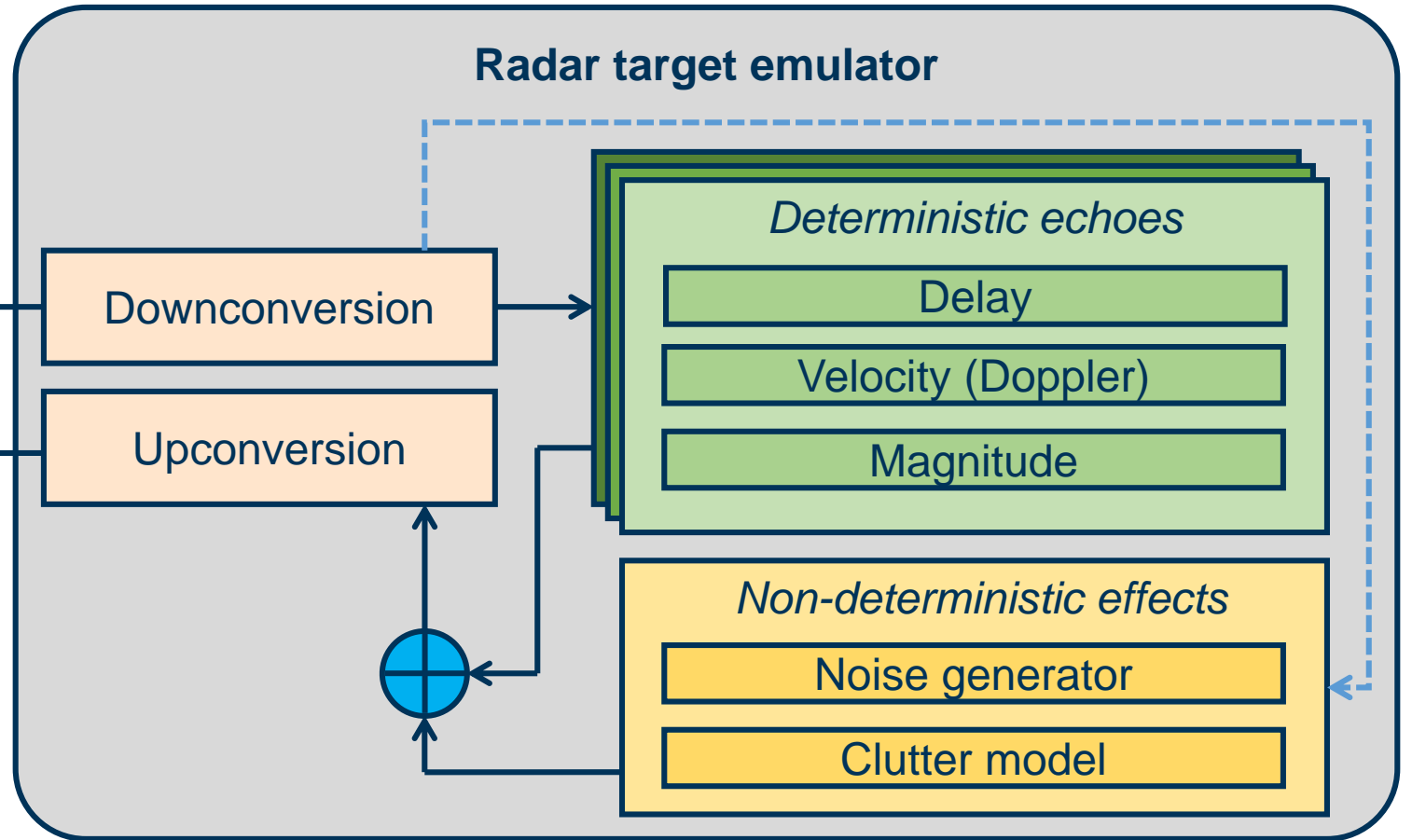
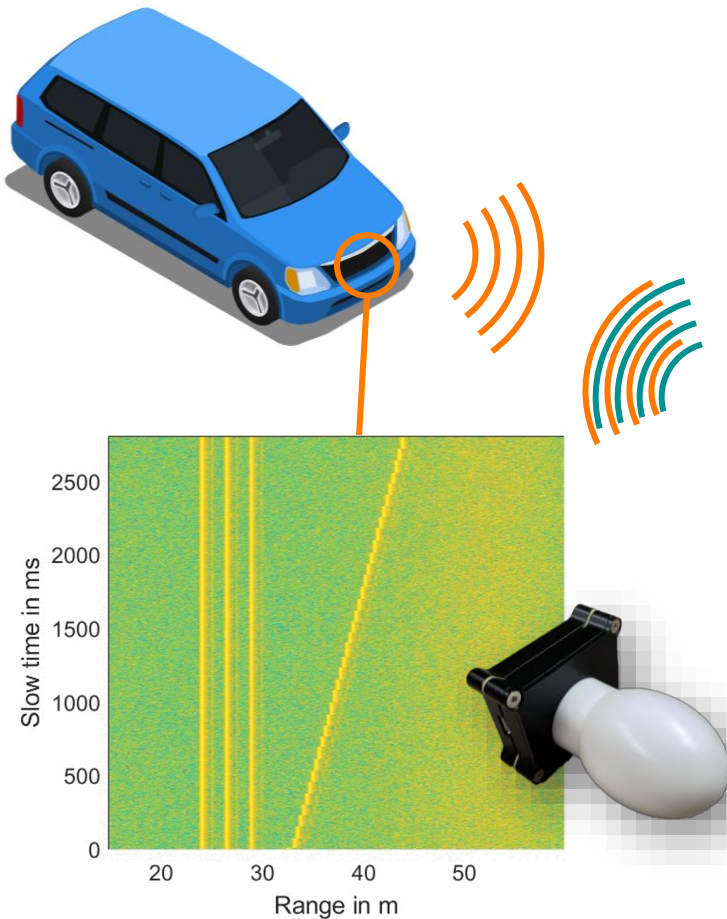
Improving sensor performance

Architecture for massive MIMO / distributed aperture



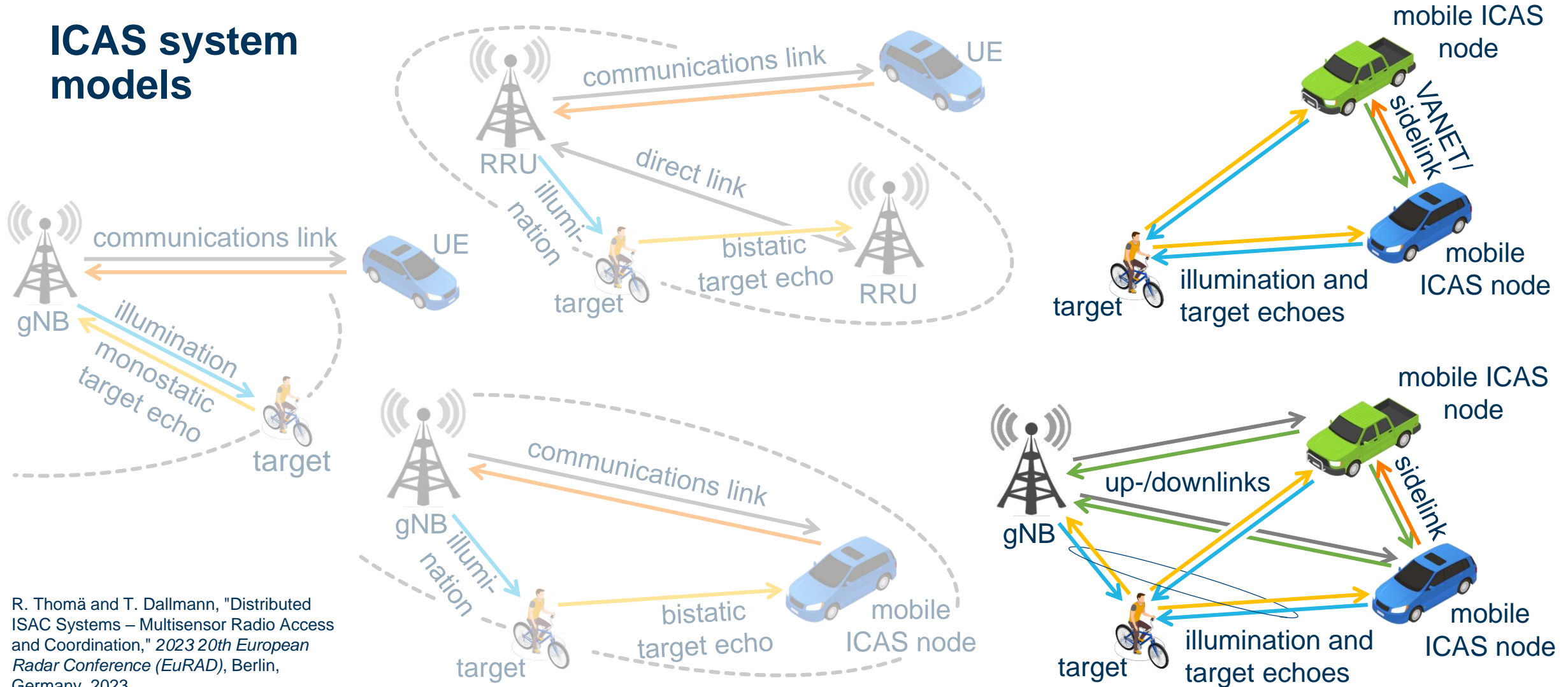
Understanding and controlling the “long tail”

OTA/ViL emulation



Implementing and validating new sensor functions

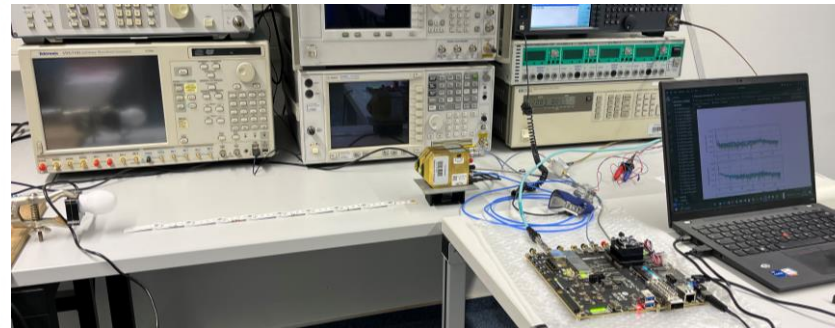
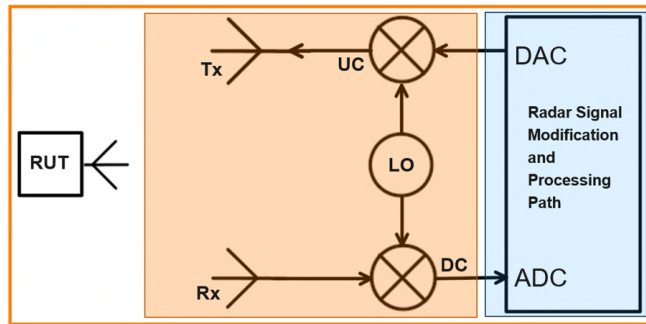
ICAS system models



R. Thomä and T. Dallmann, "Distributed ISAC Systems – Multisensor Radio Access and Coordination," 2023 20th European Radar Conference (EuRAD), Berlin, Germany, 2023.

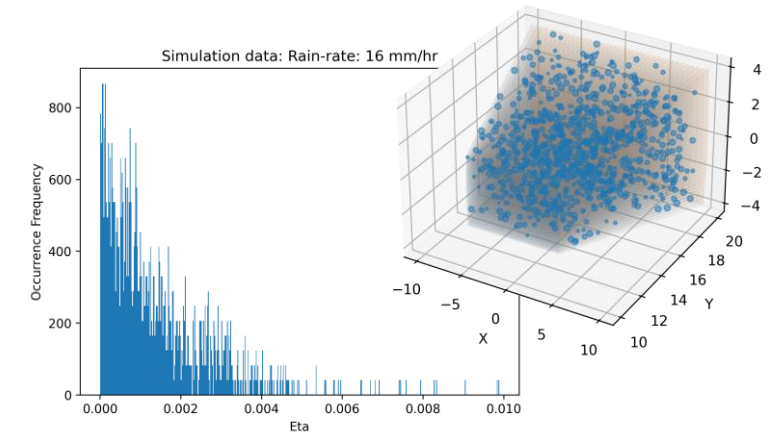
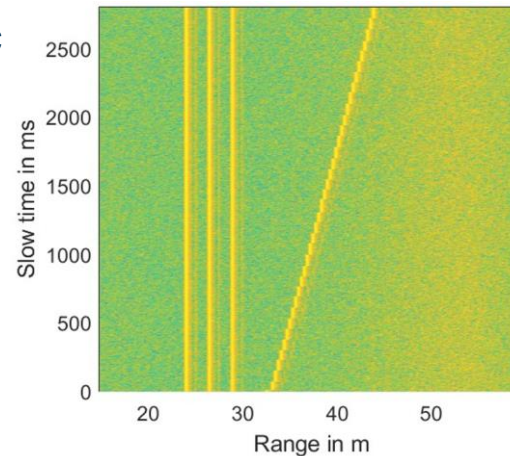
FAVF Research Group

Research activities



Radar target emulator for generation of virtual static and dynamic targets as well as precipitation

- Virtual validation of automotive radars
- Development of radar target emulators
- Analysis, modeling, and emulation of precipitation



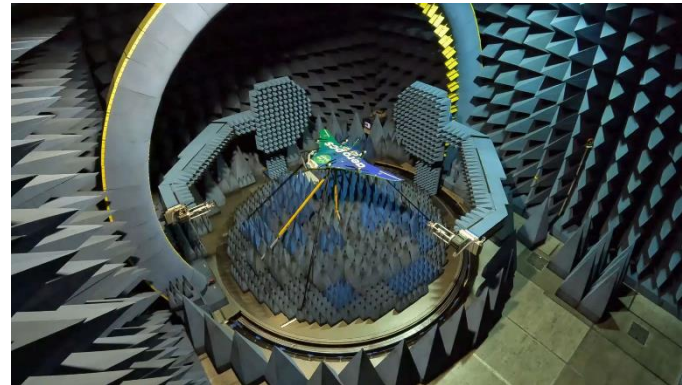
Measurement and simulation of precipitation for the validation of automotive radars

EMS Research Group

Research activities



Characterization of the reflectivity of vehicles and drones



- Channel measurement, characterization, and emulation for V2X applications
- Reflectivity analysis of dynamic traffic participants in the FR1-FR3 frequency bands



Channel Sounder for V2X radio channel characterization