Transponder Based
Angle of Arrival Estimation

**Motivation**

Estimating Angle of Arrival (AoA) with active transponders:

- Timely detection of vulnerable road users (VRU) for high received signal power
- Target classification through active response
- Detection of AoA in non-line-of-sight situations
- Fusion with cooperative ranging and INS allows estimation and prediction of position of a VRU

**System Performance**

Measurements in anechoic chamber with axis-symmetric antenna

- Parallel phase responses
- Blind spots in orthogonal polarisation

**Angle of Arrival estimation**

- Communication signal or AoA tail can be used for AoA measurement
- Antenna array for measurement of phase differences
- AoA estimation using subspace analysis methods (MUSIC, ESPRIT, etc.)
- Forward/backward methods for spatial smoothing

**SafeTAG 2.0 Prototype**

- Prototype fully integrated in the bumper
- Frequency band 5.8 GHz (car2car)
- Using antenna array with 6 elements for AoA estimation
- Used bandwidth 2-4 MHz
- High performance DSP platform allows high update rates and accurate AoA estimation

Source: BMW

Outdoor measurements

- Update rate 50 Hz
- Accuracy
  - Line of sight: ~ 1°
  - Non-line-of-sight ~ 5°