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Quest for Autonomous Vehicles Safety Standardisation:

Automotive Radar Standards and Verification

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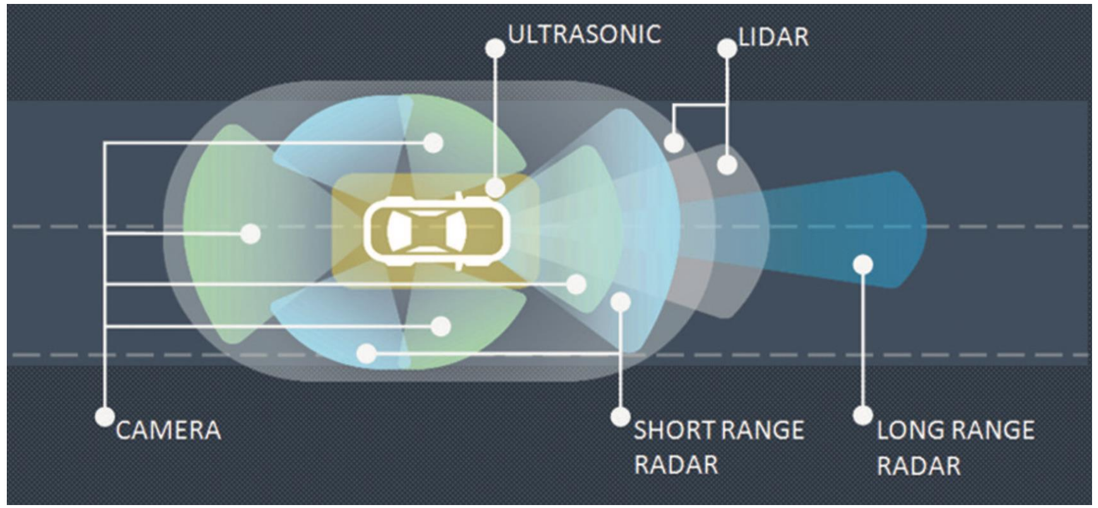
INTRODUCTION TO AUTONOMOUS DRIVING AND ADAS PROMISES

- Autonomous driving is revolutionising future mobility and car ownership
- Autonomous vehicles should create much higher safety than human drivers
- ADAS is growing beyond level 2 to level2+ and 3, demanding less responsibility from drivers
- The definition of ADAS features is not unified between car manufacturers
- **There is no standard for autonomy yet!**

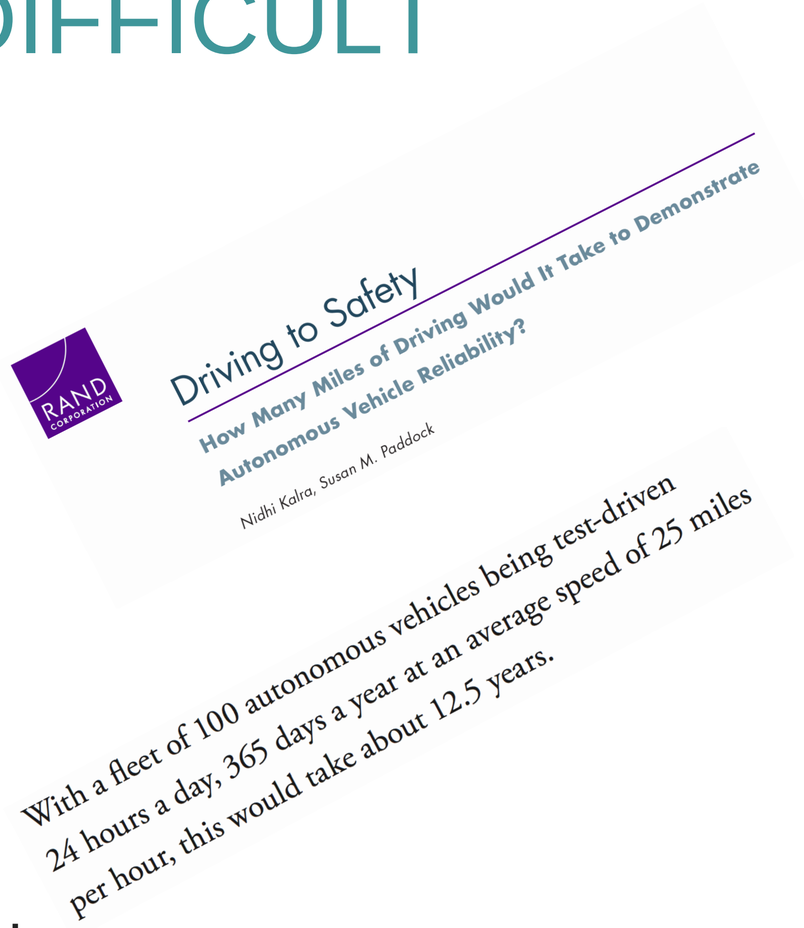
CHALLENGES FOR DEPLOYMENT AND UTILIZATION OF ADAS/AD

- Millions of kilometres of test-driving for demonstrating the safety of ADAS/AD
- Various sensors and complicated systems
- Need for “close to real-life” setups for extensive reliability tests
- Agile development is established in automotive industry, demanding even more testing



WHY TEST AND VERIFICATION IS DIFFICULT

- Different sensors need different tools to be tested
- Complex systems are hard to verify
- Long expeditions is needed to test in real-life
- Sensors and functions need to be tested under rare and dangerous traffic scenarios
- A lot of cases and scenarios exists for verification
- Ground truth (knowledge about actual scenario) is needed

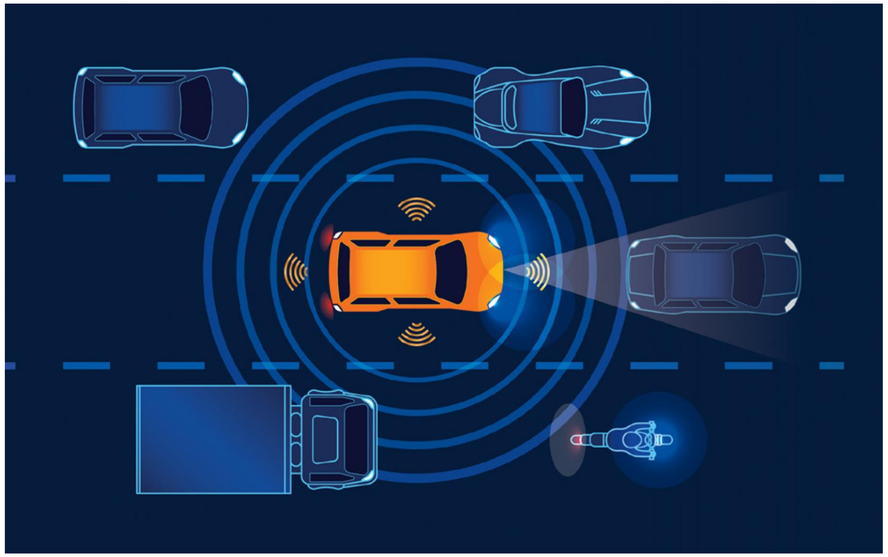


STANDARDIZATION EFFORTS FOR ADAS/AD

- SAE (Society of Automotive Engineers): Standards on levels of automation
- IEEE: P2020 Standard on automotive image quality
- ISO: Functional Safety Standard ISO 26262, ISO PAS 21448 SOTIF (2022)
- EuroNCAP: AES, AEB,
- ETSI and FCC

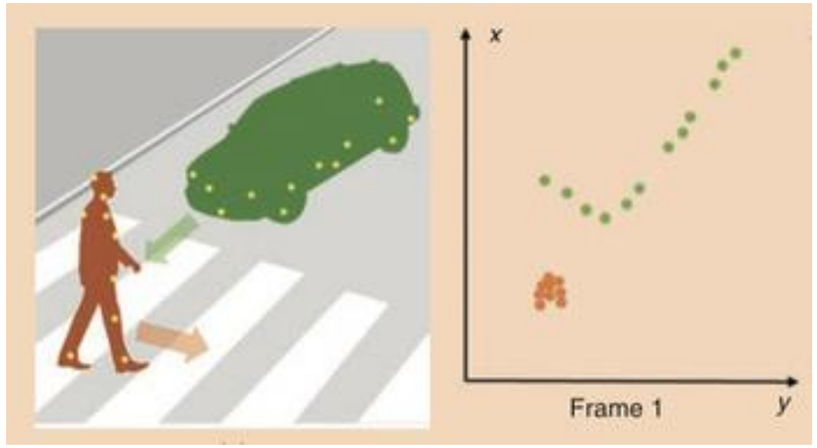
EXPECTATIONS OF RADAR STANDARDS FOR ADAS/AD

- Frequency band, radiated power and out of band emissions
- Design features, such as antenna FOV, minimum and maximum detection range, resolutions, etc.
- Radar performance in terms of
  - False alarm and mis-detection probabilities
  - Number of detectable targets
  - Detection of Vulnerable Road Users (VRUs)
  - Reliability in severe weather conditions, ice, snow, etc.
  - Interference detection and mitigation



RADAR VERIFICATION EXPECTATIONS

- Automotive radars need to detect, classify and track slowly moving pedestrians or animals as well as fast moving vehicles
- Radar test systems must be able to create targets with:
  - Minimum distances < 30cm and max distance>300m
  - More than 50 reflection points
  - Dynamic range > 80dB
  - FoV > 80 degrees
  - Agile angular perception for all targets
  - Micro-Doppler signatures



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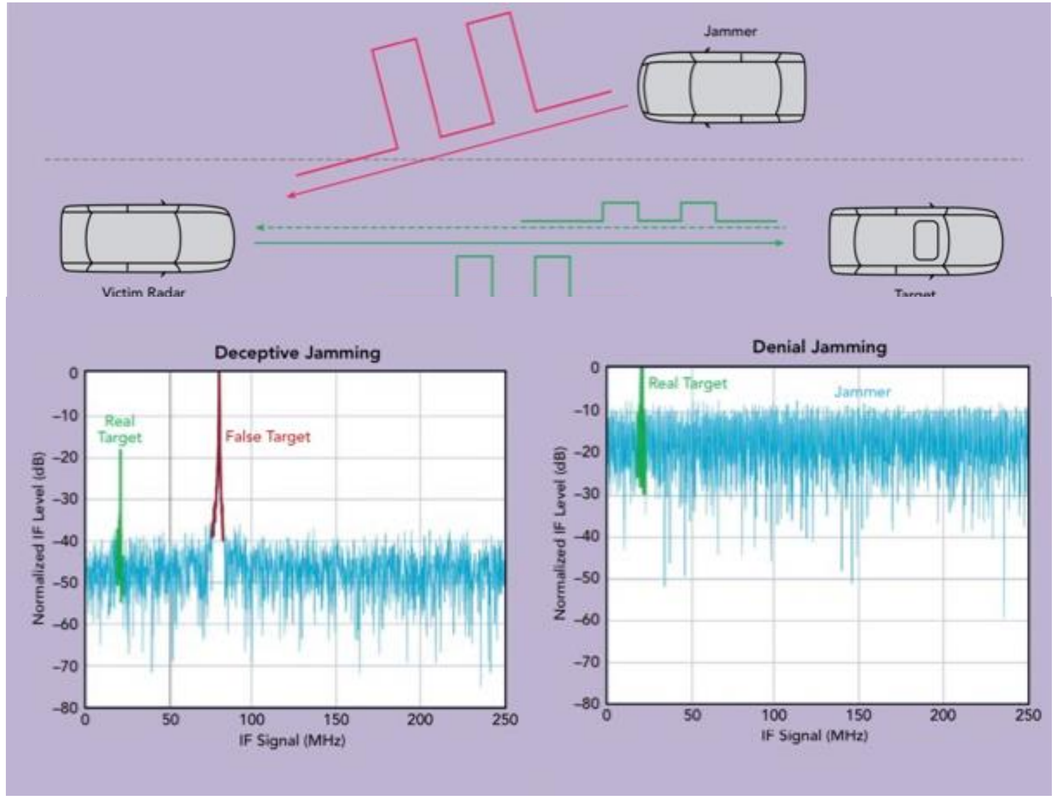
INTERFERENCE EFFECT ON RADAR DETECTIONS

- Widespread use of automotive radars
- Radars facing unintentional interference/ jamming
- Radar losing track of real target
- Compromised safety



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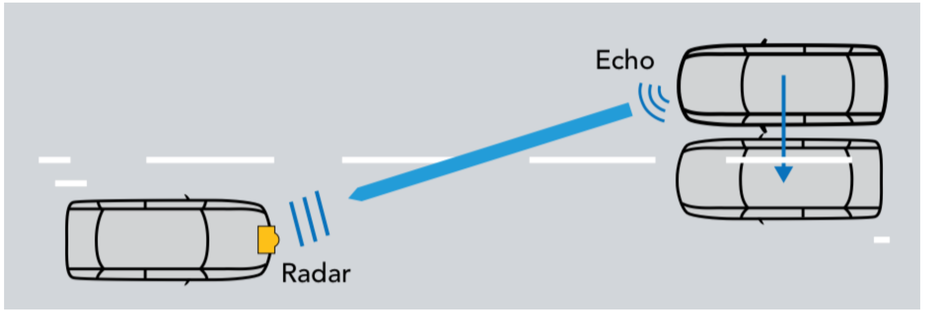
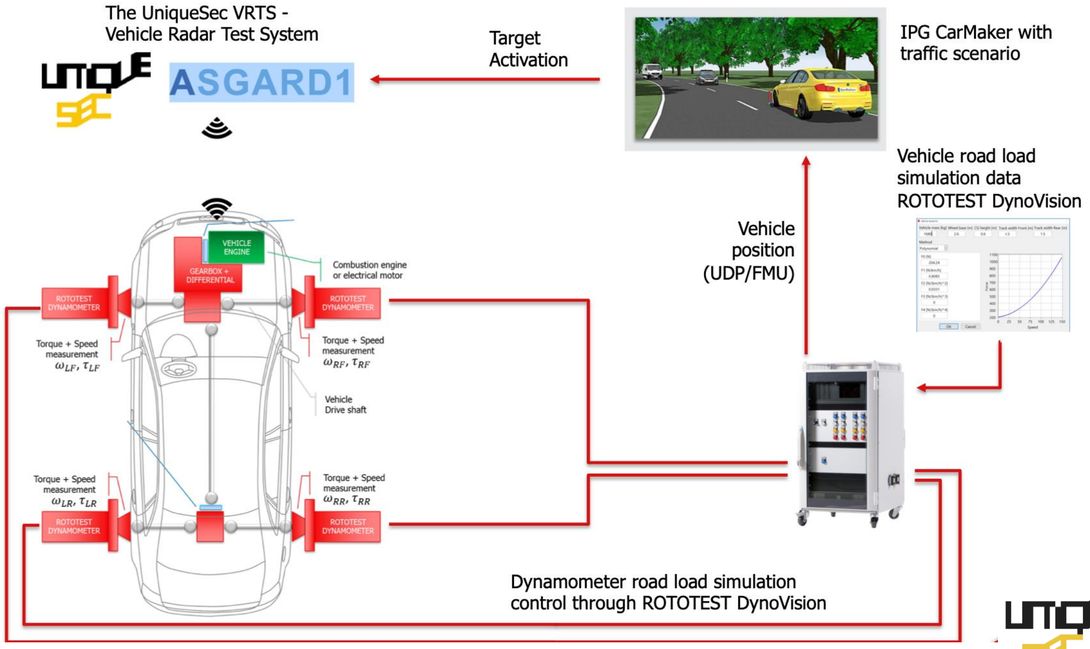
TESTING MECHANISMS FOR RADAR VALIDATION

- Radar target simulators (RTS) use
  - Delay method
  - Frequency spectrum method
- Calibration and alignment
- HIL / VIL testing
  - Sensor fusion
  - Crowded urban scenarios
  - Effect of fascia , emblem and paint





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DIFFERENT STAKEHOLDERS FOR RADAR STANDARDISATION

- OEMs

- Tier-1s

- Testing agencies

- HIL manufacturers
- Environment Simulators
- EoL station manufacturers
- Workshops
- Car inspections
- etc.