ESA NAVISP EL1-021

Integrity Monitoring and Prediction Concept for Autonomous Car Resilience and Safety (IMPACARS)

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Overview of Presentation

- An Introduction to the IMPACARS Project
- Sensors to be used within IMPACARS
- Functional Approach
- Challenges in Vehicular Channel and Mitigation Plan
- Conclusions

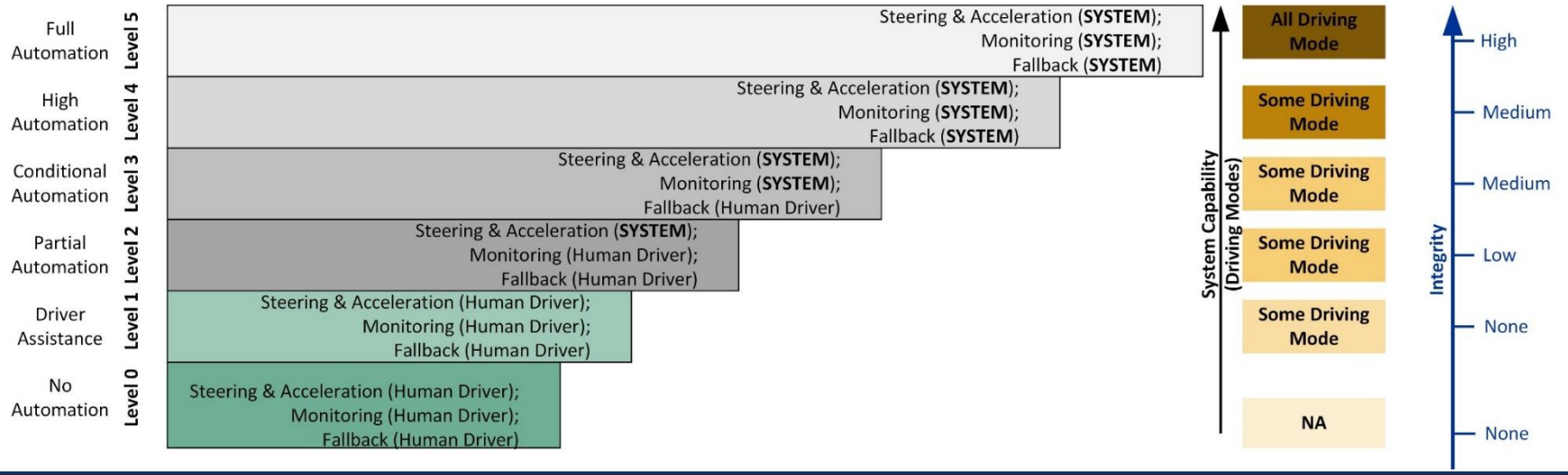
An Introduction to the IMPACARS Project [1/3]

Objectives

- Funded by ESA through the NAVISP Element 1 Programme;

- To develop and prove the practical feasibility of an **innovative Integrity Risk monitoring and prediction concept** for autonomous vehicles, to be used in the emerging field of **Automatic Passenger Vehicles (APVs).**

Concept of Autonomous Vehicles



An Introduction to the IMPACARS Project [2/3]

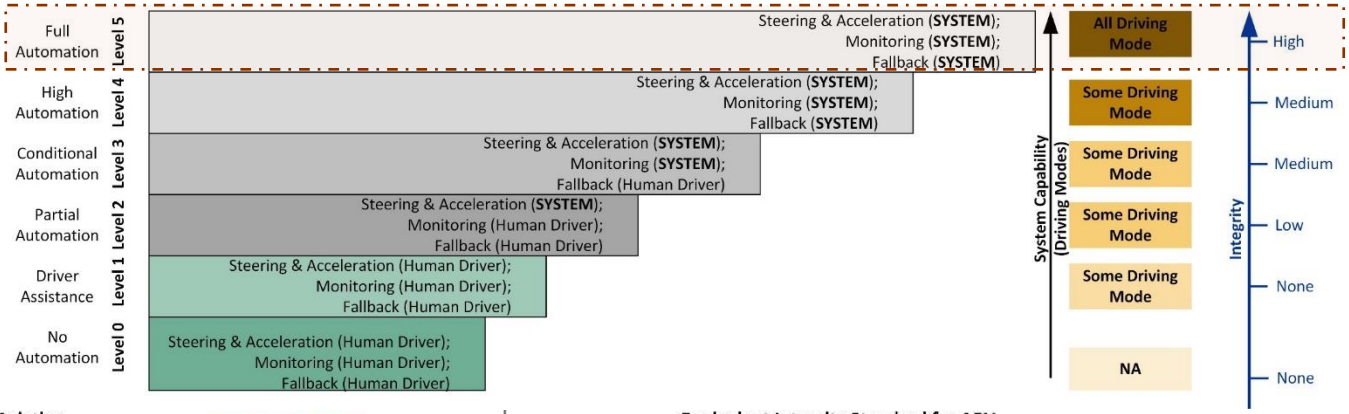
Objectives

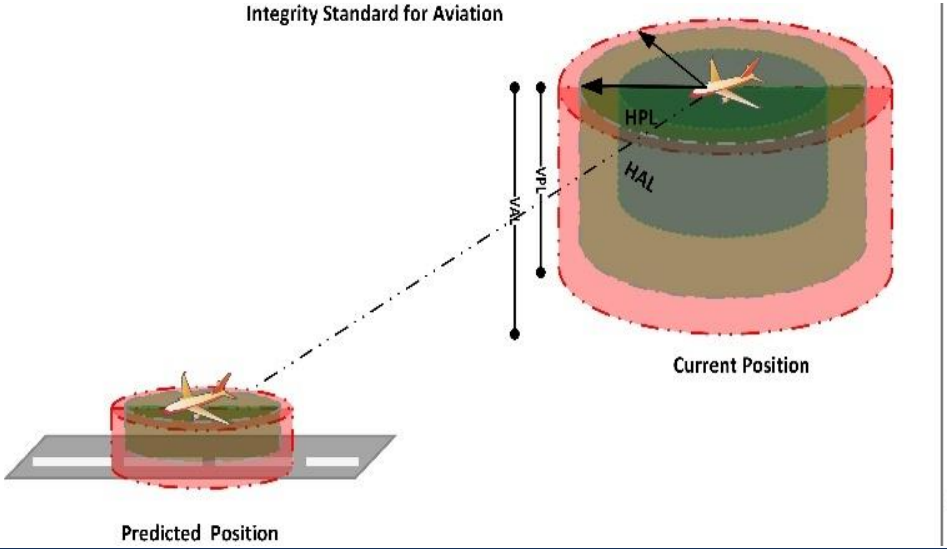
- The project is 12 Months in length and is expected to conclude in January 2020.
  - To develop and prove the practical feasibility of an innovative integrity monitoring and prediction concept for autonomous vehicles, to be used in the emerging field of Automatic Passenger Vehicles (APVs).
  - The concept will be able to achieve a level of Integrity risk suitable for this domain (characterized by a very dynamic environment) and will be based on a derivation of the concept of integrity used in aviation.
  - Simulating testing of integrity for level 5 type of autonomous
  - Experiment/data campaign using multiple sensor on Van to test PNT and communication type algorithm in various road traffic environment.

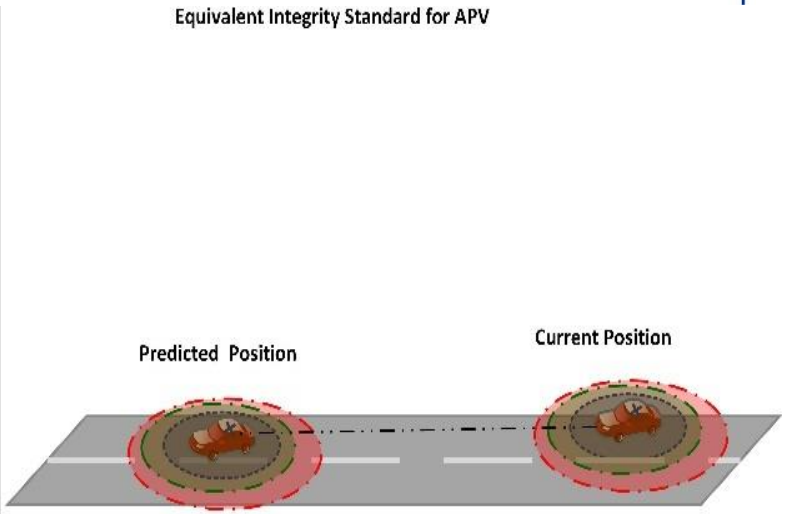
An Introduction to the IMPACARS Project [3/3]

Objectives

- Integrity Standards and Requirements

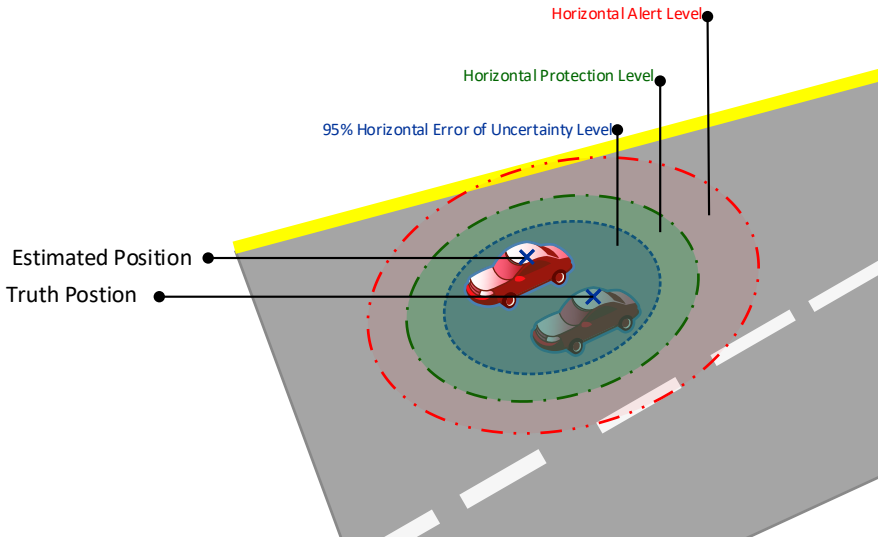


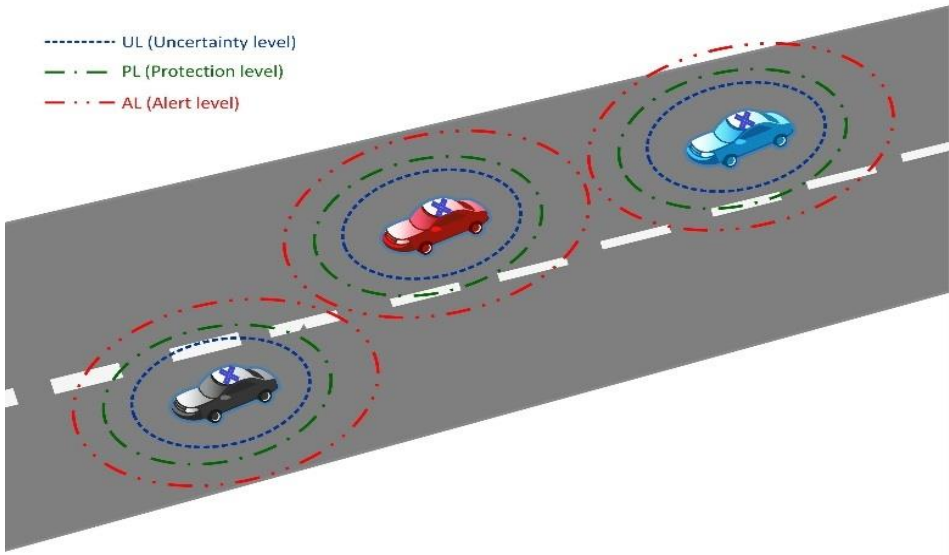




Functional Approach [1/3]

Confidence level for APVs



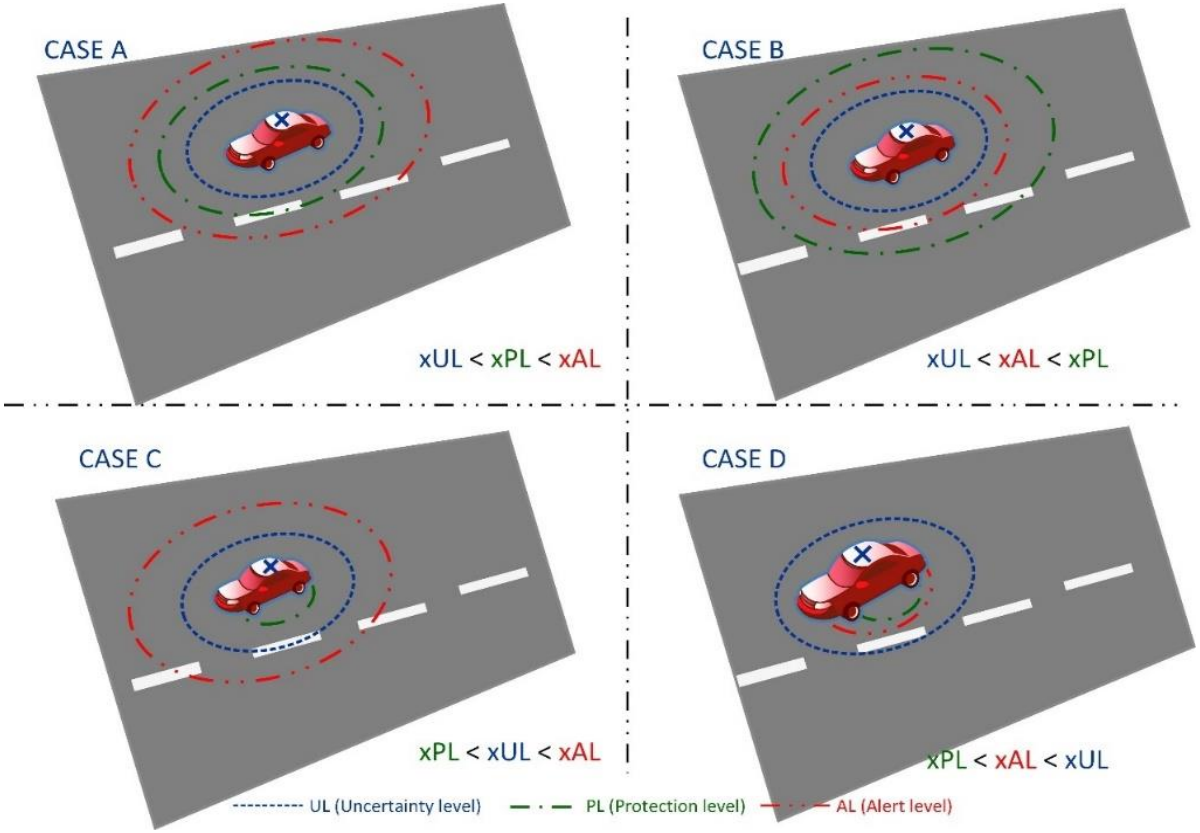


According to GSA's recent report, the require confidence limit recommended as 99.9% (*GSA, 2018*).

Report on Road User Needs and Requirements, Outcome of the European GNSS's User Consultation Platform, GSA's Report, *GSA-MKD-RD-UREQ-233537, (1.0), 18th October 2018*.

Functional Approach [2/3]

Confidence level for APVs



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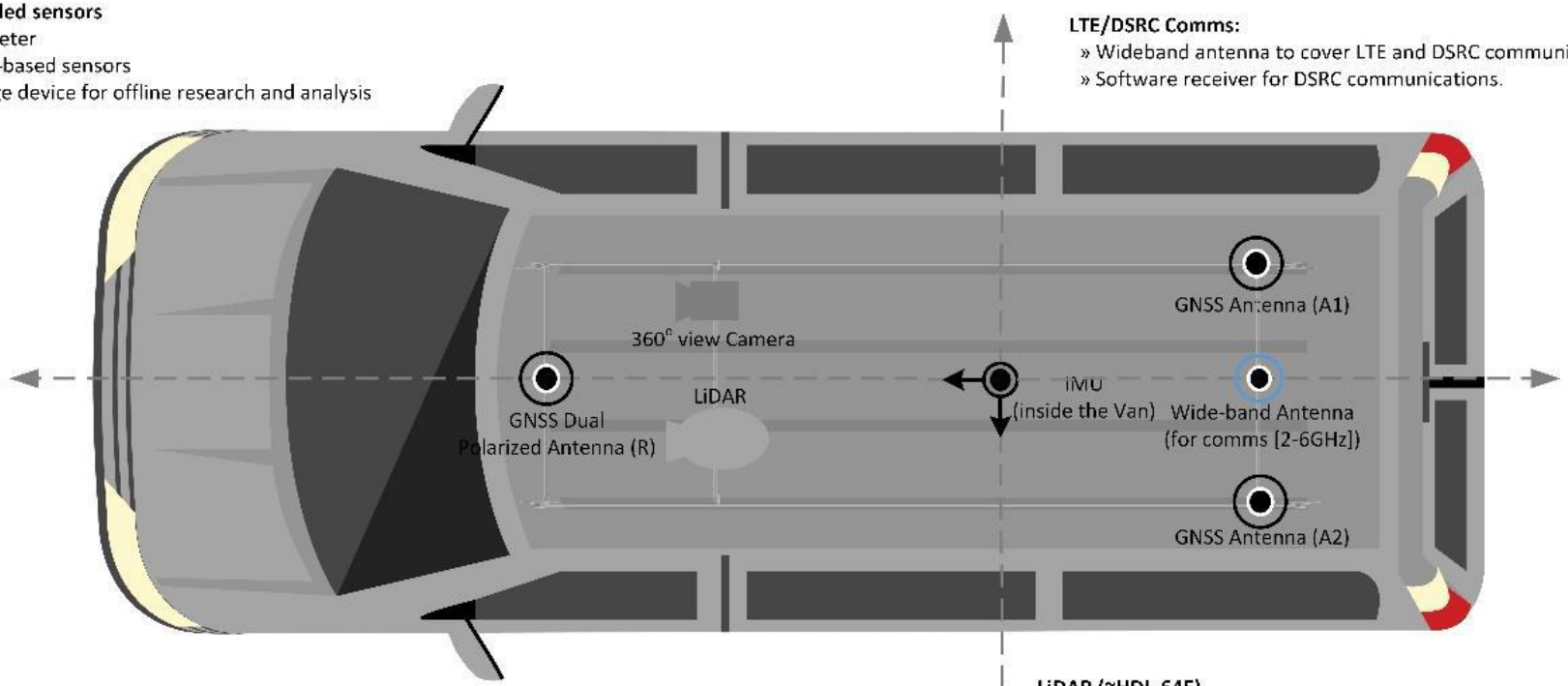
Functional Approach [3/3]

Sensors to be used within the IMPACARS

Other aided sensors
- » Odometer
- » Radar-based sensors
- » Storage device for offline research and analysis

LTE/DSRC Comms:
- » Wideband antenna to cover LTE and DSRC communication.
- » Software receiver for DSRC communications.



GNSS
- GNSS:
  - » One Dual polarized antenna [LHCP, RHCP] for GNSS signa at BB-band (or IF). One High-specification COTS receiver connected to RHCP for positioning.
  - » Interference detector (for post-processing)
  - » Two GNSS antenna (A1&A2) for heading
- IMU:
  - » Six degree of freedoms: accelerometer, Gyros
  - » Three degree freedom for magnetometer

LiDAR (~HDL-64E)
- » 360° horizontal and 26.8° vertical field of view (FOV)
- » 120 meters of range (0.2 cm incremental size)
- » Spinning rate: 5-15 Hz (user-defined)
- » Data packets: 106 Bytes
- » Waveform: 10 ns pulse, 905 nm wavelength

360° View Camera:
- » 360° view camera for offline research and analysis in the Lab

Functional Approach [3/3]

- The integrity concept shall be based on the Feature Extraction (FE) and Data Association (DA) techniques.
  - *This shall be based on the use of LiDAR sensors.*

- The integrity concept is expected to be based on a derivation of the concept of integrity used in aviation.

- The project will provide an assessment of achievable integrity performances under the identified scenarios.
  - *This will be achieved using real data and considering simulation approaches.*

- The project will provide an assessment of suitability of the developed integrity monitoring and prediction concept(s)

Challenges in Vehicular Channel and Mitigation Plan [1/5]

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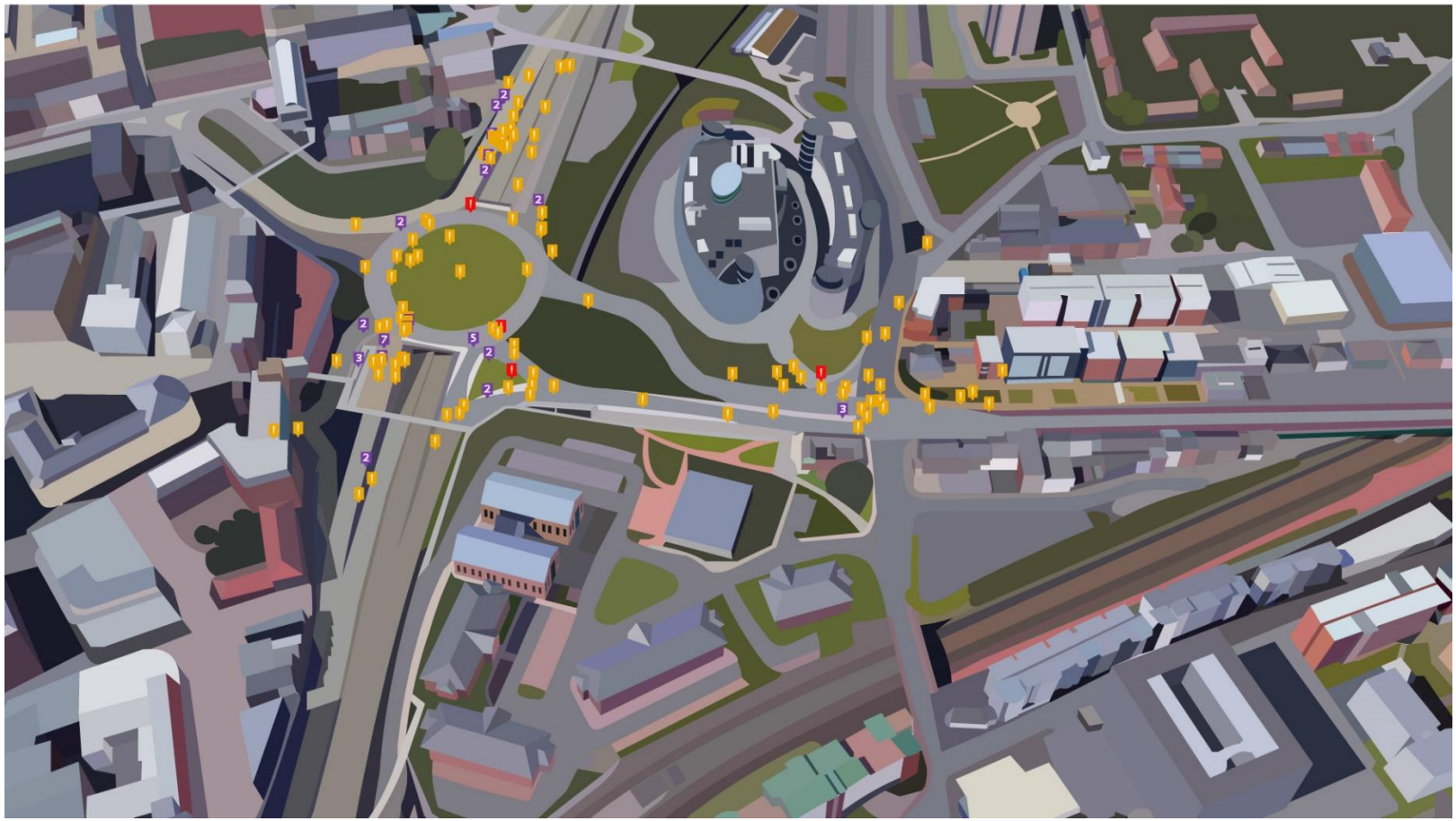
Challenges in Vehicular Channel and Mitigation Plan [2/5]

Simulation for Autonomous Vehicle Integrity

Real road traffic simulation for next generation V2V Communication (location: Newcastle upon Tyne, UK)

Challenges in Vehicular Channel and Mitigation Plan [2/5]

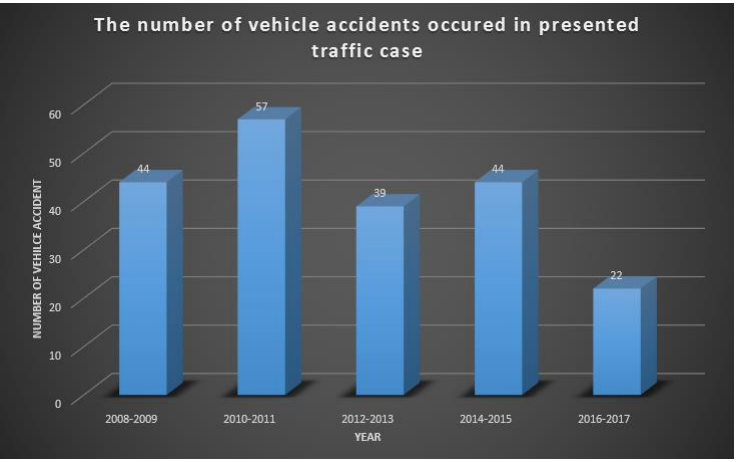
Simulation for Autonomous Vehicle Integrity

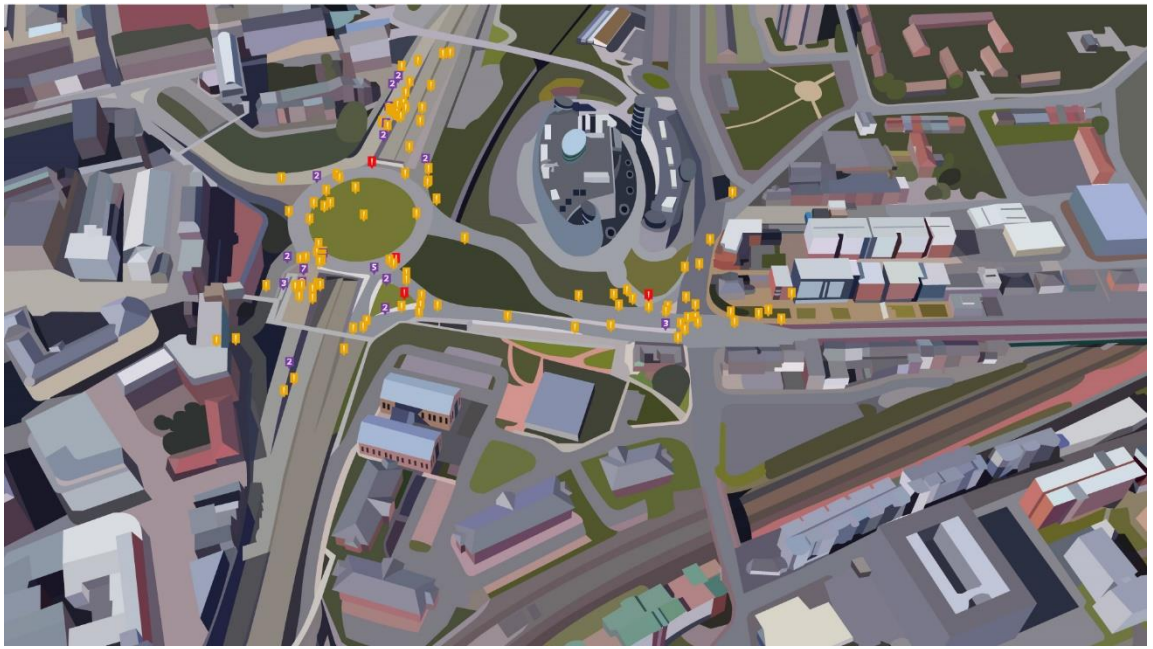


Real road traffic simulation for next generation V2V Communication (location: Newcastle upon Tyne, UK) , Source for number of Accidents (DoT, UK)

Challenges in Vehicular Channel and Mitigation Plan [3/5]

Simulation for Autonomous Vehicle Integrity



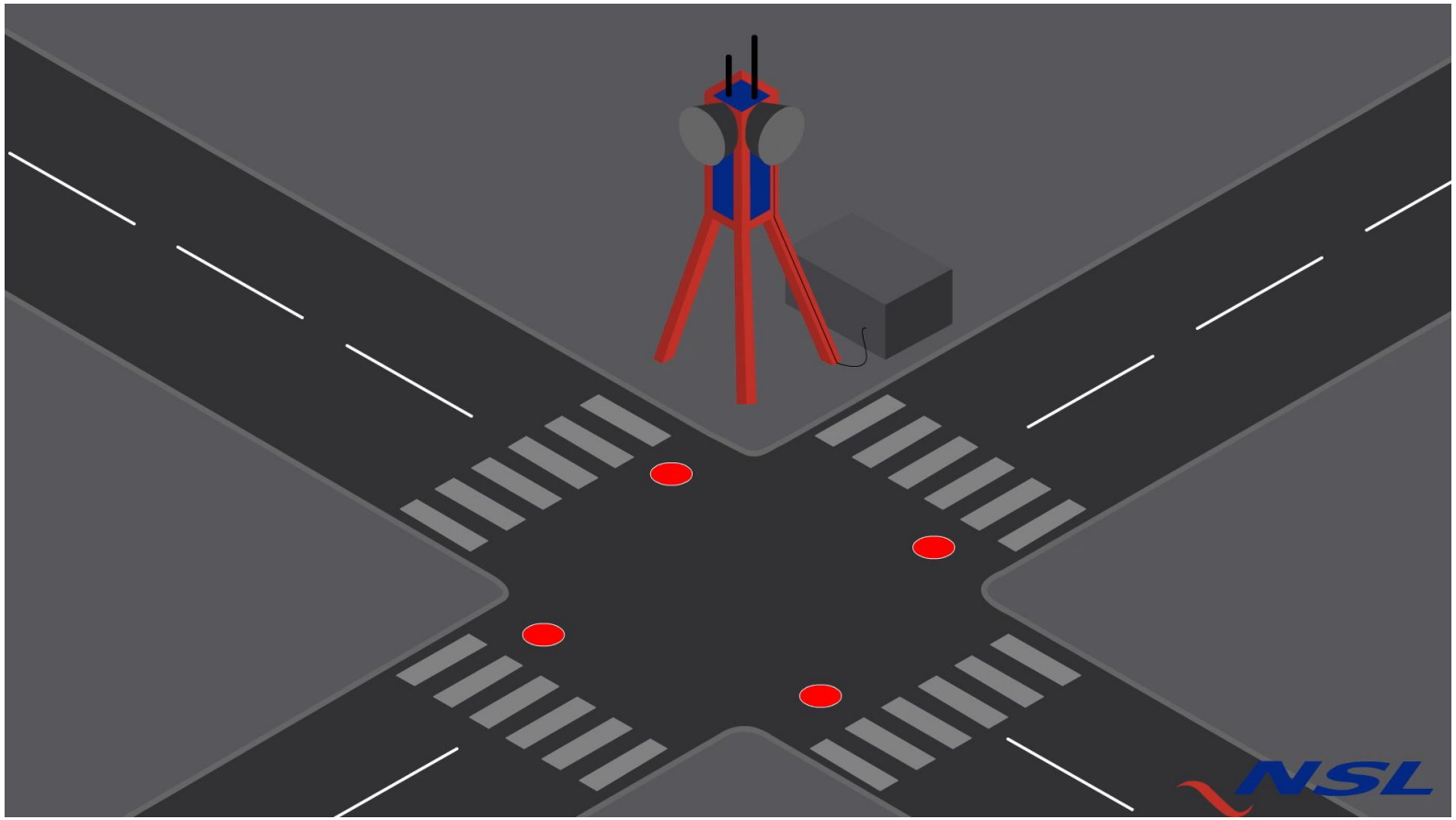


Source for number of Accidents (DoT, UK)

Li Haicang and R. Tiwari (2018), Safe and reliable spatio-temporal model for roundabouts and road intersection using vehicular communication system, *IEEE, 16th International Conference on Intelligent Transport System Telecommunications* (*ITST 2018*).

Challenges in Vehicular Channel and Mitigation Plan [4/4]

Simulation for Autonomous Vehicle Integrity



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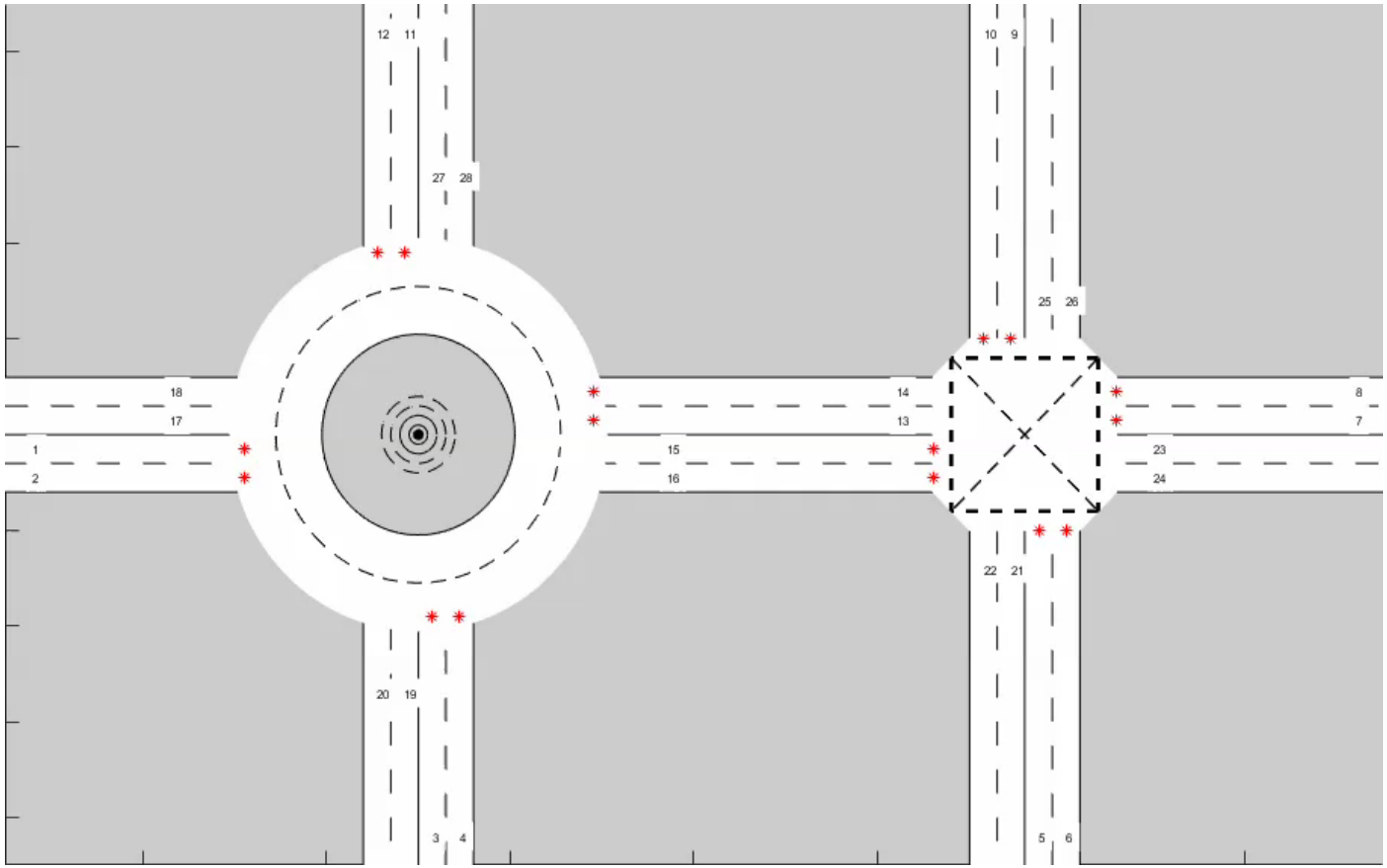
Challenges in Vehicular Channel and Mitigation Plan [5/5]

Simulation for Autonomous Vehicle Integrity



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Conclusions

- The project is currently in the preliminary assessment phase. From April further details of the integrity concept will be defined.

- From May 2019, we will start to develop the system and then from September, testing will take place at the HORIBA MIRA test track.

Thank you for your attention!

Questions are welcome