SAFE-UP DEMOS

Demo 1

Demo 1 (SAFE-UP's passive safety system) consists of an occupant monitoring system plus an adaptive restraint system. The restraint system components (i.e. seat belts, airbags) are able to provide actuation concepts, deployment strategies and reduce the occupant's injuries severity in new extended and rotated seating positions. The occupant monitoring system detects the position, posture and characteristics of the occupants of a vehicle considering new seating positions by means of sensors and cameras.

Demo 2

Demo 2 focuses on optimizing VRU detection of active safety systems by considering bad weather conditions and taking into consideration real-world scenarios. The demonstrator includes a vehicle with advanced sensor configuration and VRU detection algorithms with the main focus on VRU detection in heavy rain and fog conditions.

Demo 3

Demo 3 develops advanced vehicle dynamics intervention functions to avoid or mitigate critical events. The demonstrator will include a vehicle with combined trajectory planning and control for combined automatic emergency braking and steering manoeuvres including system for VRU detection, motion planning and trajectory control to enhance real world performance

Demo 4

Demo 4 develops a VRU safety system based on V2X technology that provides enhanced communication between vehicles, road infrastructure (RSU installed on traffic light) and VRUs (pedestrians and cyclists). The actual target is to provide additional environmental perception to vehicles regarding the presence of VRUs in critical situations, especially in cases where the vehicle sensors reach their limits (i.e. obstructed areas).

DEMO 1

DEMO 1 consist of a mock-up vehicle equipped with occupant monitoring system and of a series of sled tests demonstrating physical tests of the ATD (anthropomorphic test device) in new reclined position.

DEMO 1 shows the necessity of implementing the occupant monitoring system in the autonomous vehicles as well as it demonstrates the necessity of implementation of the new concepts of restraint systems to protect occupants in new positions resulting from different level of autonomous vehicles.

The DEMO 1 consists of a vehicle equipped with occupant monitoring system which consist of several cameras mounted to view the front and rear occupants, computer which evaluate and executes the algorithm of monitoring and much more.

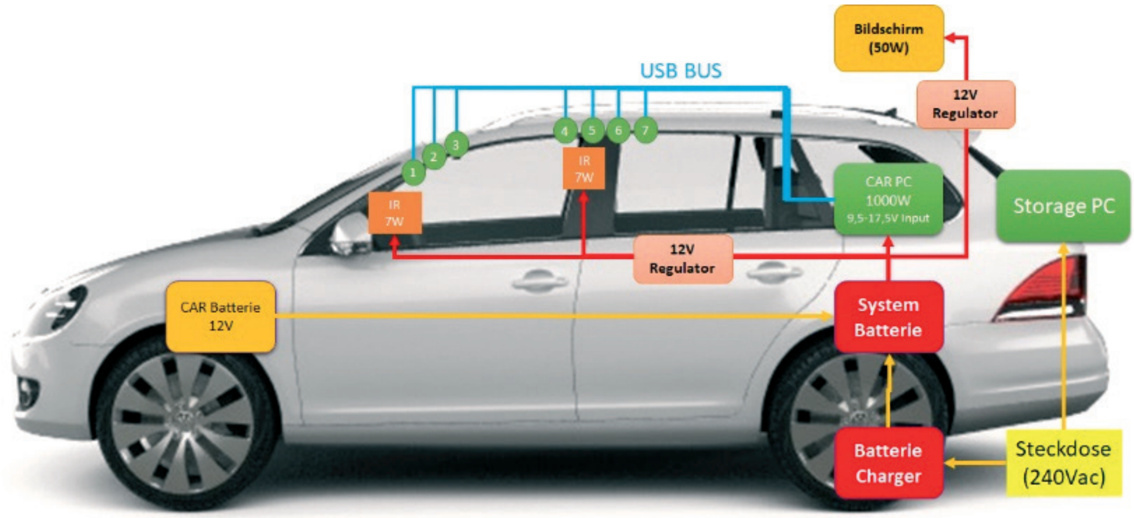


Figure 1: Mock-up vehicle with Occupant monitoring system

Figure 2: Occupant monitoring system interface

Another part of the DEMO 1, sled test, consists of:

- Generic environment
- Semi-rigid seat
- Optimized restraint systems
- THOR-Reclined dummy

The generic environment is equipped with several accelerometers to ensure the repeatability of the tests and approximately 5 high speed cameras will record the impact event for further analysis. Dummy's response will be measured by means of several sensors measuring forces, accelerations, displacements, etc.

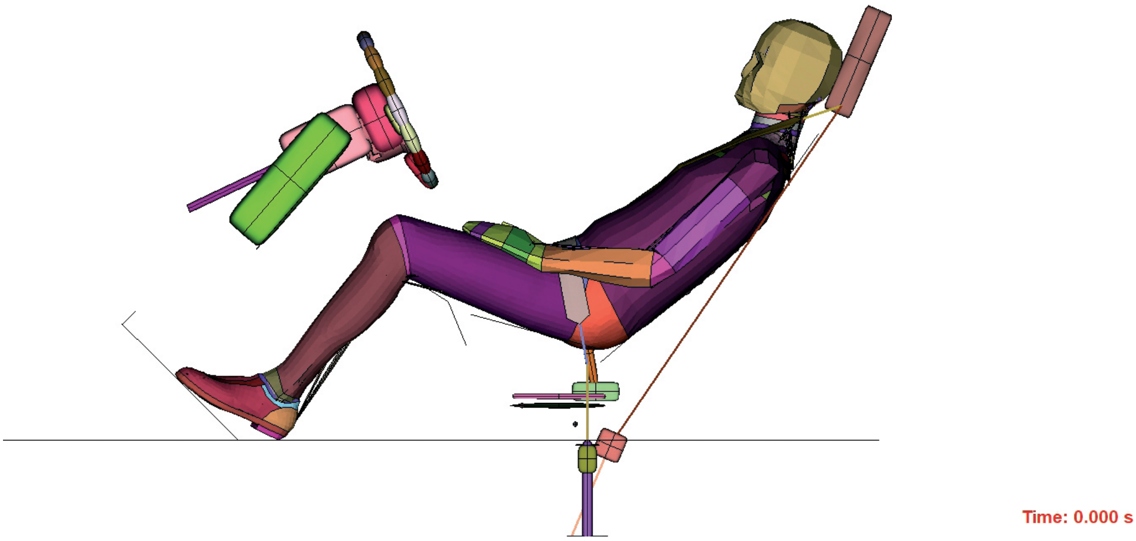


Figure 3: Virtual representation of the sled test using MADYMO HBM

Mock-up vehicle of DEMO1 is addressing new seating positions and different activities foreseen to be performed in autonomous vehicles like eating, drinking, reading newspapers, or working on the mobile phone or laptop.

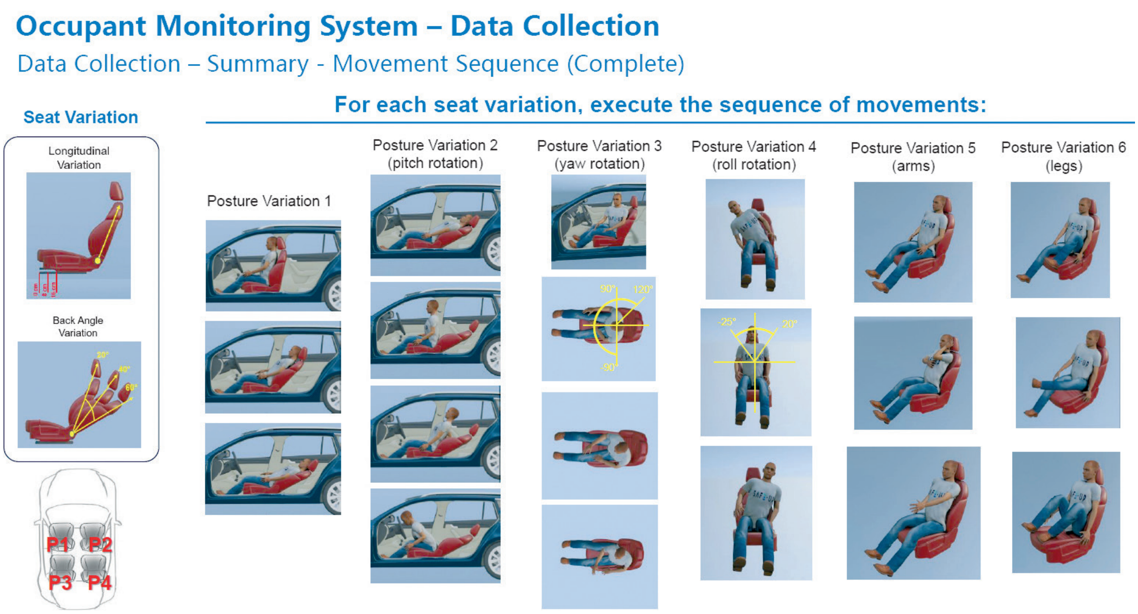


Figure 4: Variation of positions and activities

The sled tests will demonstrate the case of full-frontal load case at 40km/h with an occupant seated with 45º reclined seat further away from restraint systems and interior of the vehicle.

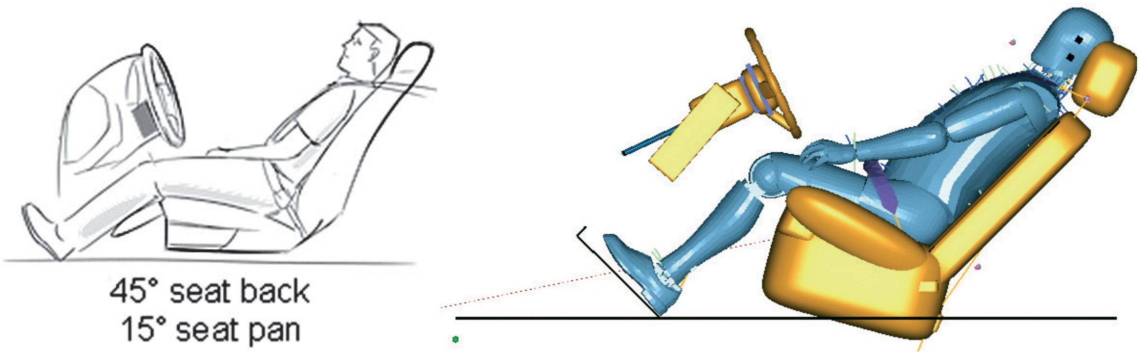
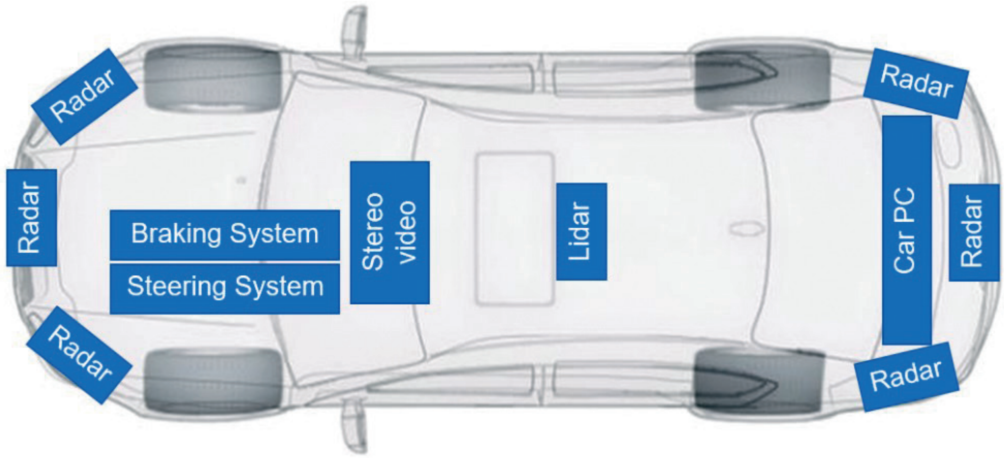


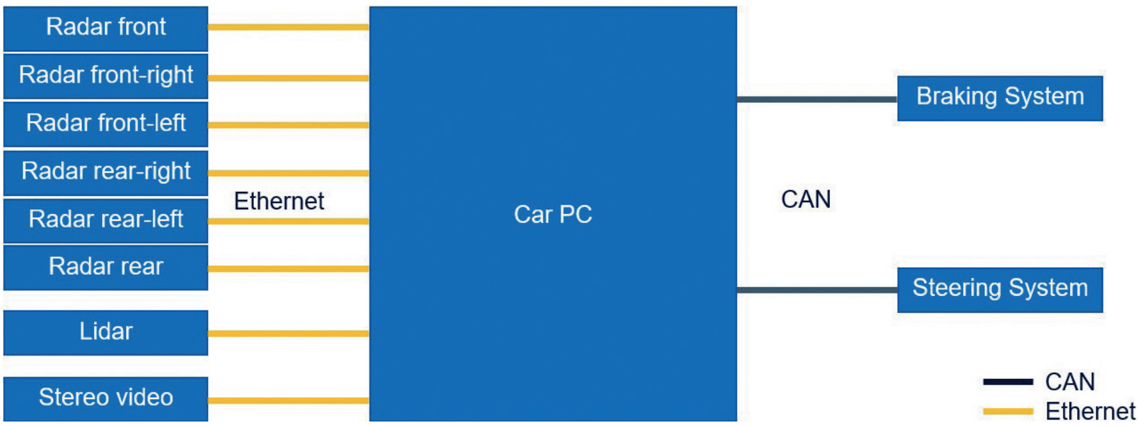
Figure 5: Definition of the sled test demonstrations (left), MADYMO representation of sled test set-up (right)

DEMO 2

Demo 2 focuses on optimizing VRU detection of active safety systems by considering bad weather conditions and taking into consideration real-world scenarios. The demonstrator includes a vehicle with advanced sensor configuration and VRU detection algorithms with the main focus on VRU detection in heavy rain and fog conditions.

Demo 2 vehicle consists of sensors, actuators and elaboration units.





One front, one rear, two front corner and two rear corner radar sensors with +/-60° field-of-view each, a front stereo video sensor, as well as a rooftop Lidar sensor with +/-360° field-of-view are used to detect moving and stationary objects within and next to the vehicle's path.

DEMO 3

A substantial proportion of accidents involving passenger cars and VRUs cannot be addressed by today's active safety systems (automatic emergency braking (AEB) or evasive steering support (ESS)) due to the facts that

1. **a potential collision becomes detectable** at such a late time that an emergency braking manoeuvre will not be able to avoid an accident and
2. **drivers being distracted or being shocked** by the safety critical situation prevents an ESS system to be triggered, as it requires user/driver input.

"Demo 3 will integrate advanced intervention functions to avoid or mitigate critical events" - Vehicle demonstrator for trajectory planning and control for combined automatic emergency braking and steering manoeuvres including system for VRU detection, motion planning and trajectory control to enhance real world performance.

Demo 3 vehicle consists of sensors, actuators and elaboration units.

One front radar sensor with +/-55° field-of-view and two corner radar sensors with +/-75° field-of-view are combined with a mono video sensor with +/- 20.5° field-of-view to detect moving and stationary objects within and next to the vehicle's path.

Scenarios

Context: AV drives on an urban road, driver is not paying attention or not present. In the distance a pedestrian is walking towards the road.
Explanation of potential problem: If the AV and pedestrian maintain their current trajectory and velocity they might be in each other path.
Problem: Pedestrian does not correctly looks at oncoming AV. AV does not foresee/ predict this crossing and is not able to prevent collision.

Solution created within Safe-up:

The AV can prevent a collision by evading the pedestrian (Steering) or braking in advance.

Context: AV drives on an urban road, driver is not paying attention or not present. In the distance a pedestrian is walking towards the road.
Explanation of potential problem: If the AV and pedestrian maintain their current trajectory and velocity they might be in each other path.
New solution: The AV uses the information that receives to determine a safe action in order to prevent a collision while maintaining driver comfort.

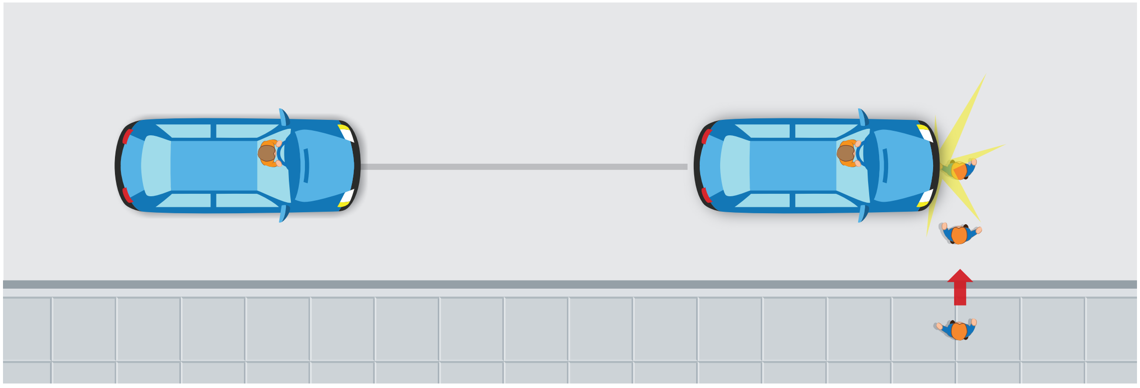


Figure 6: Crash

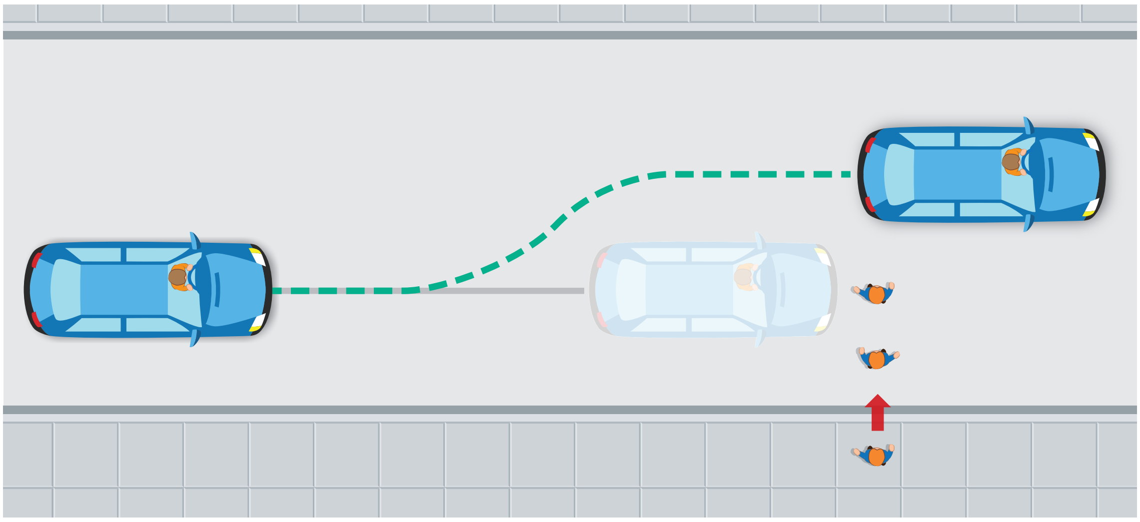
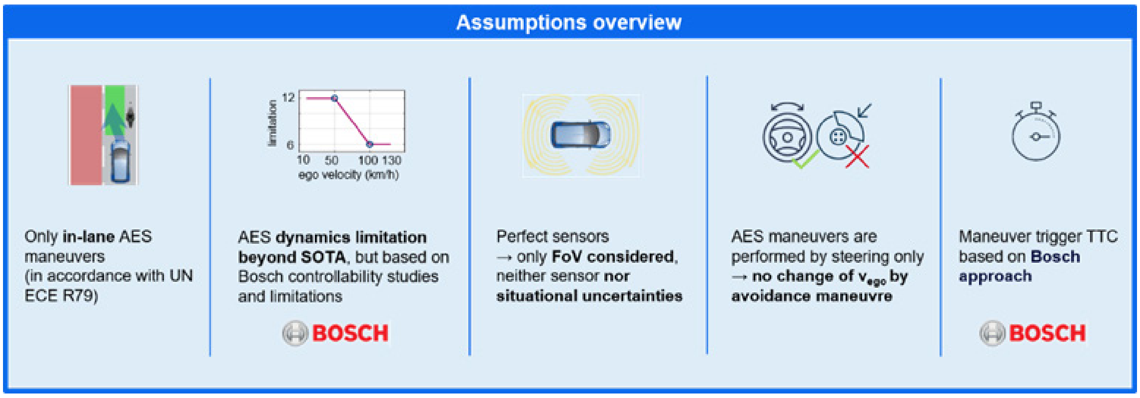


Figure 7: Full collision avoidance used as avoidance criterion

Simulation assumptions for the assessment of the accident avoidance potential of an AES maneuver.



DEMO 4

Demo 4 develops a VRU safety system based on V2X technology that provides enhanced communication between vehicles, road infrastructure (RSU installed on traffic light) and VRUs (pedestrians and cyclists). The actual target is to provide additional environmental perception to vehicles regarding the presence of VRUs in critical situations, especially in cases where the vehicle sensors reach their limits (i.e. obstructed areas). Connected VRUs are able to directly exchange V2X messages with both the equipped V2X vehicles and the infrastructure RSU, whereas the non-connected VRUs are monitored by the RSU that exchanges direct messages with the equipped V2X vehicles.

Demo 4 consists of three main components:

- Vehicle equipped with V2X technology
- Road-side unit: Infrastructure component equipped with sensors that detect traffic participants (vehicles and VRUs), in addition to V2X technology.
- VRU system equipped with V2X technology

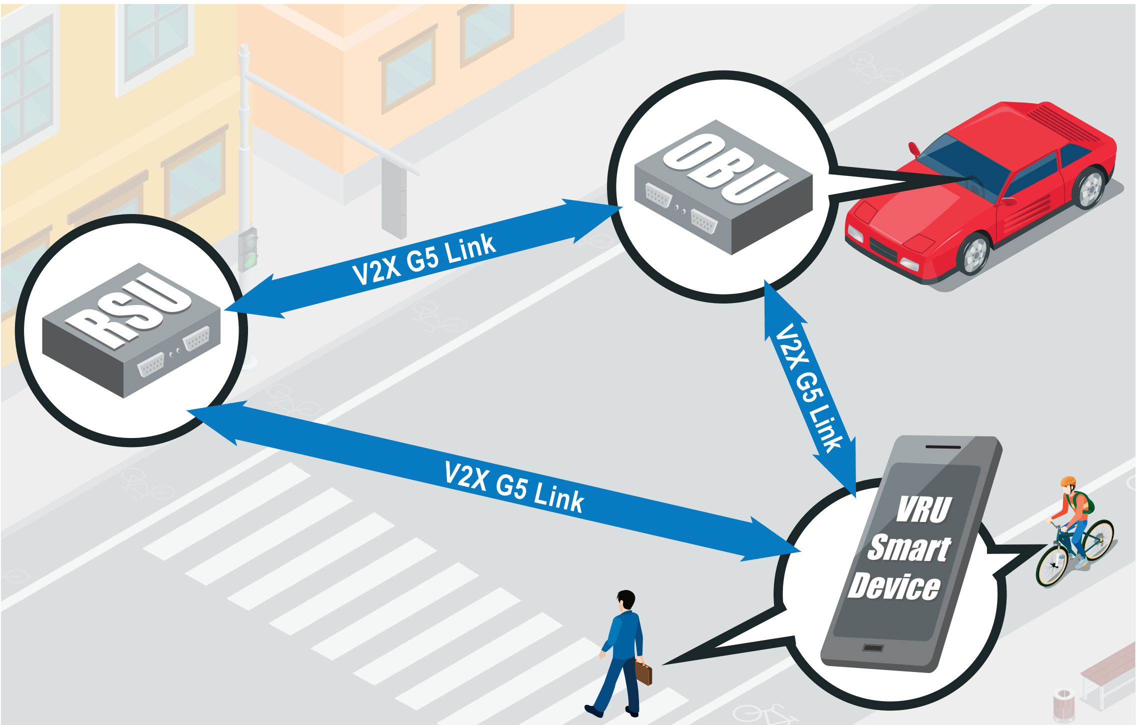
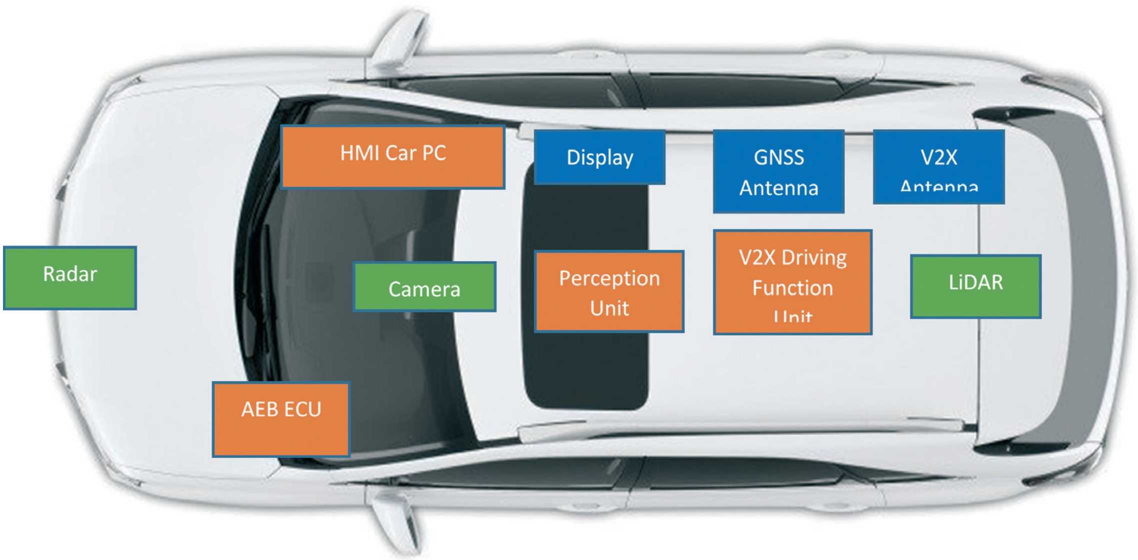
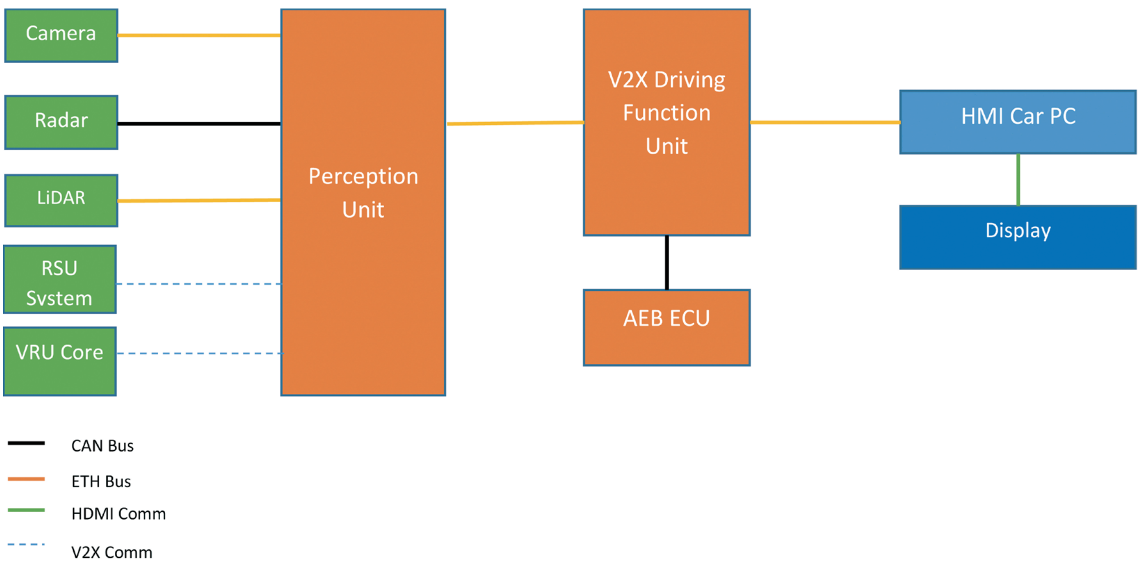


Figure 8: Demo 4’s main components

The vehicle is composed by the following components:

- Radar: Sensor able to detect static and dynamic objects. They usually have between ±15 and ± 60 degrees width and long-range detection.
- LiDAR: Sensor able to give information in 3D (distance, position and height). Range is limited in bad weather conditions like fog, since the measurements are light-based.
- Camera: It has a limited vision and it is very sensible to the conditions (light, fog, etc.)
- Perception Unit: Device able to decode the sensors and V2X data (from the V2X Antenna) and perform a data fusion to extract the detected objects list.
- V2X Driving Function Unit: This component takes the output of the Perception Unit to analyse the situation between the ego vehicle position (from GNSS Antenna) and dynamics (from CAN bus) and the detected objects.
- AEB ECU: Admits control orders to make the device react as desired to avoid or minimize a dangerous situation.
- HMI Car PC: Computer able to build HMI messages to be shown to the drivers via the Display
- Display: Screen where alerts and information are shown to the driver.
- GNSS Antenna: Antenna used to position the vehicle.
- V2X Antenna: Antenna used to receive and send V2X data.





SAFE-UP

PROACTIVELY PROTECTING PEOPLE
INSIDE AND OUTSIDE OF THE VEHICLE

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