



**Grant Agreement Number: 731993**

**Project acronym: AUTOPILOT**

**Project full title: AUTOMated driving Progressed by Internet Of Things**

## **D.3.2**

### **Final Pilot Tests Specifications**

**Due delivery date: 30 June 2018**

**Actual delivery date: 28 June 2018**

**Organization name of lead participant for this deliverable: CERTH**

Dissemination level		
PU	Public	X (with restricted Annex)
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Project funded by the European Union's Horizon 2020 Research and Innovation Programme (2014 – 2020)

## Document Control Sheet

<b>Deliverable number:</b>	D3.2
<b>Deliverable responsible:</b>	CERTH
<b>Work package:</b>	3
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Document Revision History			
Version	Date	Modifications Introduced	
		Modification Reason	Modified by
V0.1	30/1/2018	First draft with ToC, Purpose and Audience sections	Evangelia Gaitanidou
V0.2	18/5/2018	Draft for internal review	Evangelia Gaitanidou, Floriane Schreiner, All pilot site/UC leaders
V0.3	1/6/2018	Updated draft	Evangelia Gaitanidou, Floriane Schreiner, All pilot site/UC leaders
V1.0	11/6/2018	Version for peer review	Evangelia Gaitanidou, Floriane Schreiner, All pilot site/UC leaders
V1.1	28/06/18	Final check before submission	Rita Bhandari, ERTICO
V2.0	28/06/18	Submitted version	Rita Bhandari, ERTICO

Abstract
This document presents the final specifications and pilot plans of the AUTOPILOT test sites.

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## Abbreviations and Acronyms

Acronym	Definition
5G	5th-Generation Wireless Systems
6LoWPAN	6Low-Power Wireless Personal Area Networks
AD	Automated Driving
ADAS	Advanced Driver Assistance Systems
ADASIN	ADAS Instructions
ADF	Automatic Direction Finder
ANOs	Anomaly Detection
API	Application Programming Interface
App	Application
AVP	Automated Valet Parking
BLE	Bluetooth Low Energy
C-ACC	Cooperative Adaptive Cruise Control
CAM	Cooperative Awareness Message
CCTV	Closed-Circuit Television
CeH	Connected E-Horizon
CEMA	Consumer Electronics Manufacturers Association
C-ITS	Cooperative Intelligent Transport Systems
DATEX II	Data Exchange
DDS	Data Design System
DENM	Decentralized Environmental Notification Message
DSRC	Dedicated Short-Range Communications
EC	European Commission
FI-PI-LI	Firenze-Pisa-Livorno
FMS	Fleet Management System
GA	Grant Agreement
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
HD	High Definition
HDD	Hard Disc Drive
HMI	Human-Machine Interface
HW Puddle	Highway Puddle
I2V	Infrastructure to Vehicle
IBM	International Business Machines Corporation
ICT	Information and Communications Technology
IMU	Inertial Measurement Unit
IoT	Internet of Things
ISI	Intersection Safety Information
ITS	Intelligent Transport System
Kph	Kilometers Per Hour
LED	Light Emitting Diode
LIDAR	Light Detection And Ranging
LTE	Long-Term Evolution
LTE-V	Long-Term Evolution- Vehicle
M2M	Machine-To-Machine
MAP	Mobile Application Part
MAV	Micro Aerial Vehicle

Acronym	Definition
MoniCA	Monitoring and Control Application
N.B.	Nota Bene
NB-IoT	Narrowband Internet of Things
NTRIP	Networked Transport of RTCM Via Internet Protocol
OBU	On Board Unit
OCB	Organizational Citizenship Behaviour
OEMs	Original Equipment Manufacturer
Opt	Optional
P&R	Park and Ride
PO	Project Officer
PoI	Point of Interest
PP	Project Place
PS	Pilot Site
QoL	Quality of Life
RH	Road Hazard
RSU	Road Side Unit
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
RW	Road Works
RWS	Roulette Wheel Selection"
RWW	Road Works Warning
SME	Small Medium Enterprises
SPaT	Signal Phase and Time
TASS	Traffic Advanced Simulation Software
TBC	To Be Confirmed
TCC	Traffic Control Centre
TL	Traffic Light
TLA	Traffic Light Assist
UI	User Interface
UWB	Ultra-Wide Band
V2V	Vehicle to Vehicle
V2X	Vehicle-To-Everything
VFLEX	Flexible-Fuel Vehicles
VGO	City Of Vigo
VGP	Versailles Grand Parc
VIP	Very Important Person
VMS	Vehicle Management System
VRU	Vulnerable Road Users
W.R.T.	Wireless Receiver/Transmitter
WP	Work Package
WS	Workshop
WSN	Wireless Sensor Network

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## Executive Summary

Deliverable 3.2, named “Final Pilot site specifications” aims at presenting the final considerations for all AUTOPILOT pilot sites, including pilot site specifications and detailed pilot plans, prior to the initiation of the AUTOPILOT piloting activities. To do this, a series of actions have been undertaken since the beginning of the project and are reported in D3.1 and further updated, enriched and finalised in the present document.

Upon defining the broad specifications of the pilots (as reported in D3.1) the next step has been to specify exact storyboards for each use case elaboration. The storyboards have been defined for each pilot site at use case level, in order to consider the variability of conditions and characteristics of both different sites and use cases. Detailed presentation of the storyboards is included in Chapter 3.

Moreover, a table for collecting the pilot sites specifications has been defined at the beginning of the WP3 lifetime. The aim has been to map all relevant specifications to the different pilot sites and their use cases. Separate tables have been filled in for each pilot site and their contents have been further updated to reflect the current status at M18. These tables are included as an annex in this Deliverable (Annex 2).

Being a step before pilot activities kick-off, detailed pilot plans have been elaborated by each pilot site at Use Case level of detail. A standard template has been used for the collection of information from each site. The collected information includes, not only technical, organisational and operational aspects related to the realisation of the pilots, but also issues related to the needs of the assessment of the pilots findings, foreseen within WP4. The detailed pilot plans per site and use case can be found in Chapter 5 and the relevant templates are annexed (Annex 1).

Overall, D3.2 provides an overview of all piloting activities to be performed within AUTOPILOT, along with a detailed timeplan aligned also to the planned pilot events of the project. As several local conditions of any nature may vary during the pilot implementation period, any necessary major changes will be reported in subsequent AUTOPILOT Deliverables.

## **1 Introduction**

### **1.1 Purpose of the document**

The purpose of the present Deliverable 3.2 is to present the final test sites' specifications and plans of all the AUTOPILOT pilot sites. This includes on one hand the pilot specifications (as preliminary defined in D3.1) and their progress as reported in the pilot specifications table, and on the other, the detailed plans for the realization of the pilots. For the latter, specific scenarios (storyboards) are defined in each pilot site and for each of the addressed Use Cases, while a detailed planning, with dates and commitments is also specified, following a common agreed template throughout all pilot sites.

This can provide an easy way to monitor the realization of the pilots during the piloting period for each site, keeping in time and according to schedule and preventing deviations from the plans that could cause subsequent delays in the project work.

Moreover, detailed scenarios and plans for the pilots are effective tools also for WP4 assessment activities, in order to optimally plan and perform the foreseen evaluations.

### **1.2 Intended audience**

This is a public document thus the audience that may have access to it is quite broad. For the needs of the project it would be of interest mainly for WP3 and WP4 partners, associated with the pilots and their evaluation respectively, but also for WP2 ones, dealing with the development of the different system components.

## **2 Methodology**

### **2.1 Storyboards building**

In order to have a very clear view on the course of the demonstrations deployed on each pilot site, the pilot site leaders have defined storyboards. The objective of the storyboards is to detail the user experience of the participants of the demonstrations.

The storyboards describe in simple words the whole experience of the user who is going to test the services provided (the type of user participating differs between the test sites, as explained in Chapter 5). It starts when the user arrives at the location of the demonstration, describes the whole process he/she is following and ends with the last action completing the iteration. Pictures/cartoons have been added to illustrate the story. Most of the pilot sites have several storyboards, usually one for each use case. Indeed, the experience for an automated valet parking service is different from the experience of a platooning service.

The exercise of detailing the user experience step by step was very useful in the pilot site preparation phase. It was helpful in the sense that it allowed highlighting all actions needed for a smooth execution of the demonstration. The storyboards also aim at integrating the rather technical demonstrations into a comprehensive, user and business-oriented context.

### **2.2 Pilot plans definition**

The AUTOPILOT pilot plans have been defined in WP3 for all pilot sites per use case. The process has been initiated by setting up a common template for the specification of all related aspects. This template has been agreed by all pilot site leaders and a first version of the pilot plans has been presented in a dedicated workshop in Berlin (March 2018). Moreover, WP4 assessment areas leaders have contributed to finalize the template, with specific items needed for WP4 activities. This

iterative process has resulted in the final pilot plans template.

All pilot sites were then asked to fill in the final templates by use case. As for the storyboards described above, there is at least one pilot plan per pilot site. The outcome of the completed pilot plans (i.e. the AUTOPILOT final pilot plans) are reported in chapter 5 of the present deliverable. All pilot plans (excel files) of each PS, as such, are annexed to the present document (Annex 1).

### **2.3 Monitoring of progress and finalization of pilot sites technical specifications**

As reported also in D3.1, a pilot specifications table has been defined early in the project, in order to map the specifications of each pilot site, also per use case. These tables have originally been filled in by all PS in M7 (July 2017) of the project, in order to be used as a basis for the construction of the AUTOPILOT checklist.

The pilot specifications table has been updated by all pilot sites at M17 (May 2018) of the project, in order to highlight the current situation, just before starting the piloting activities. The results of the specifications' collection are discussed in chapter 4 of the present document and the relevant tables are annexed (Annex 2).

N.B. Checklist: It should be noted that the checklist has been used throughout the preparation of the pilots and the PS leaders have filled it in at several stages of the project. The checklist is tool reflecting the progress of each PS and the results of it are going to be reported in D3.3 (Pilot sites adaptation validation; task 3.2).

## **3 Pilot scenarios/ detailed storyboards**

In this chapter the storyboards are detailed per test site and use case, according to the plans of each pilot. The tests are taking place locally at each pilot site, however multiple partners also from other countries are involved in each site with different roles. As the nature and procedures, as well as the involved stakeholders vary significantly between the different pilot sites, there was no standard template for the storyboard description; the test sites were rather free to present the procedures in the way that they deemed more appropriate according to the specificities of their test site.

### **3.1 Finnish pilot**

#### **3.1.1 Automated Valet Parking (AVP)**

The AVP pilot will take place in the VTT facilities at Niittyhaankatu, Tampere, Finland under the supervision and responsibility of VTT.

##### **3.1.1.1 Storyboard definition**

##### ***Test environment and infrastructure***

The tests will take place at the parking place of VTT. In case the current facilities at Tekniikankatu are still available in autumn 2018, the tests will be held either at (1) the parking place near the corner of Pollisikoulunkatu and Hervannan Valtaväylä or (2) the smaller parking lot near the vehicle laboratory.

As infrastructure, the service needs a traffic camera, which is installed at the mobile Road Side unit of VTT. The information is processed locally at the road side unit, using 5G or LTE broadband connection. The video stream is, depending on assessments made in the 5G-SAFE project, transmitted as video or as camera images to the monitoring centre for remote control.

The remote-control system is located in VTT's facilities. The operator has the possibility to stop the vehicle remotely in case of emergency. In addition, due to safety reasons, there will always be one supervisor sitting behind the steering wheel ready to react in case of any unexpected incidence.

The automated vehicle to be used for the tests is one of the prototype vehicles of VTT, Marilyn (Citroen C4) or Martti (Volkswagen Touareg), dependent on the availability and the implementation of the needed components.<sup>1</sup>

The tests will be performed under "summer" operating conditions (i.e. no black ice, ice or snow covering the parking place).

### Test users

Test users will be recruited by VTT. The amount of test users and their profile requirements (gender, age, background) will be discussed with the evaluation team, with a preliminary target of 50 to 100 persons. Test users will be passengers in the vehicle (see more details in Chapter 5).

### Test route

The test route depends on the location of the parking place.

The route starts at an entrance of the VTT building, where the test user enters the vehicle. The vehicle drives in automated mode to the drop-off point, where the user leaves the vehicle. After the user has left the vehicle, the vehicle parks itself at the parking place. The test user watches (as part of the user experience) how the vehicle parks itself. The test ends after the vehicle has parked.

Potentially during the pilots, objects may be placed in the path of the vehicle to force it to reroute.

Only a limited segment of the route is on public roads and may be covered by manual instead of automated driving, as the prototype vehicle only supports limited traffic scenarios.

Table 1: Storyboard of the AVP use case in Tampere

Phase	Description	Actors
Test user registration	The test user appears at the test site and parks his/her car at the reserved parking site (e.g. current VTT building front yard). The test user fills in the registration form.	test user
Test user briefing	The test user is given more information on the test. The test user fills in the first questionnaire, and consent letter.	test user
Start of the tests	The test user enters the vehicle Location: pre-identified starting point, e.g. near VTT entrance.	test user <sup>2</sup>
Pairing of phone and vehicle	(if Bluetooth used for detection of driver leaving vehicle) The test user pairs his phone to the vehicle by Bluetooth <i>other possibilities:</i> <ul style="list-style-type: none"> <li>- use of an app on the mobile phone to close the vehicle (and potentially to collect the vehicle)</li> <li>- dedicated device, also detecting presence of user.</li> </ul>	test user
Destination selection	The user opens the vehicle user interface, and selects the destination (VTT), and possibility to park near the destination	test user
Parking place reservation & route calculation to drop-off point.	The system reserves the parking place (Mattersoft app - tbc) and calculates the route.	-

<sup>1</sup> For more information on the vehicles, see: <http://www.vtt.fi/sites/urbanautotest/test-vehicles>

<sup>2</sup> in addition to the "test user" other test persons can be in the vehicle.



Phase	Description	Actors
Driving to the drop-off point	The vehicle drives to the drop-off point (preferably automatically, if not manually).	(driver)
Drop-off	The test user leaves the vehicle	test user
Connection to monitoring centre	After arriving at the drop-off point, The vehicle connects to the monitoring centre.	(monitoring centre)
	The monitoring centre verifies that the reserved space is available, calculates the path to the reserved parking space. The monitoring centre identifies any potential objects on the parking space.	(monitoring centre)
Detection of driver leaving, automatic start	After arriving at the drop-off point, the vehicle identifies if it is still paired to the driver's Bluetooth. If the connection breaks (and the vehicle is connected to the monitoring centre), the vehicle starts moving.	(test user) <sup>3</sup>
	The vehicle starts moving unmanned along the path, transmitted by the monitoring centre. The test user observes the movement of the vehicle as part of the user experience	(test user as observer)
(opt) person/object on the route	The traffic camera identifies a person (e.g. appearing between vehicles) on the path. The path is recalculated. This can be part of the user experience	(test user as observer)
(opt) position correction	The traffic camera (or UWB technology) is used to improve the positioning of the vehicle in the parking area.	-
	The vehicle manoeuvres into the parking space.	(test user as observer)
	The vehicle is parked. The vehicle sends information that the task is completed to the monitoring centre.	(monitoring centre)
	The monitoring centre acknowledges, and the vehicle goes to sleep mode	monitoring centre
Test user debriefing	test user fills in the final questionnaire (and receives incentive)	

### 3.1.2 Urban Driving use case

The tests will take place in Hervanta on the intersection of Hervannan Valtaväylä and Korkeakoulunkatu.

#### 3.1.2.1 Storyboard definition

##### **Test environment and infrastructure**

As infrastructure, the service needs a traffic camera, which is installed at the mobile Road Side unit of VTT. The information is processed locally at the road side unit, using 5G or LTE connection.

The automated vehicle to be used for the test is either Marilyn or Martti, depending on the availability and the implementation of the needed components.

Due to safety reasons, there will always be one supervisor sitting behind the steering wheel ready to react in case of any unexpected incidence.

Tests will be performed under "summer" operating conditions (i.e. no black ice, ice or snow covering the parking place).

<sup>3</sup> potentially has to switch Bluetooth off

### Test users

Test users will be recruited by VTT. The amount of test users and their profile requirements (gender, age, background) will be discussed with the evaluation team. Test users will be passengers in the vehicle. The cyclist (or pedestrian) will be a trained person (see more details in Chapter 5).

### Test route

The test route may change depending on the tram network roadworks.

The route starts at VTT Sinitaipale or at Tekniikankatu. The vehicle drives in automated (or in manual mode) onto Hervannan Valtaväylä. The vehicle turns right into Korkeakoulukatu (or alternatively Teekkarinkatu), and the trip ends a little further in a parking place.

A cyclist (or pedestrian) approaches the traffic light, and drives in parallel to the car, and hence will have a conflict during green. As the car turns, the cyclist waits until the car gives a signal (e.g. using a string of LEDs installed at the front of the vehicle) that it has detected the cyclist and it is clear to proceed.

The test should preferably be performed in a way that the vehicle arrives at the traffic light during red (in order to assure that the cyclist scenario can be performed).

A step-by-step analysis of the testing procedure is presented in Table 2.

As the test will take place on a public road with dense traffic during working hours, tests will be performed during periods with little traffic. Special measures may have to be taken for ensuring safety.

**Table 2: Storyboard of the urban driving use case in Tampere**

Phase	Description	Actors
Start of the tests	The test user enters the vehicle Location: pre-identified starting point, e.g. near VTT vehicle hall.	test user <sup>4</sup>
Driving towards traffic light	The vehicle drives in automatic mode. UI: position of the vehicle on a map.	(test user)
Interaction with traffic light	The vehicle receives real-time status information of the traffic light phase. The vehicle modifies speed dependent on the status of the traffic light. UI: vehicle position + traffic light status + speed	(test user)
Turning	the vehicle turns towards the pedestrian crossing VRU moves towards pedestrian crossing	(test user), VRU
VRU detection	The camera detects the VRU and sends car message on VRU presence. UI: vehicle position + VRU position+ (blinking) amber light	(test user), VRU
VRU acknowledgement	The car stops prior to the pedestrian crossing. The car indicates with LED string that the VRU has been detected. UI: vehicle position + VRU position+ (blinking) amber light	(test user), VRU
	The VRU crosses the street	
VRU passed	The vehicle starts moving when the VRU has passed the vehicle (detected by either camera or by in-vehicle sensors) UI: vehicle position + traffic light status + VRU position	(test user), VRU
	End of trip: the vehicle continues the trip either automatically	

<sup>4</sup> in addition to the "test user" other test persons can be in the vehicle.

Phase	Description	Actors
	or manually.	

## 3.2 French pilot



### 3.2.1 Car sharing and Urban driving

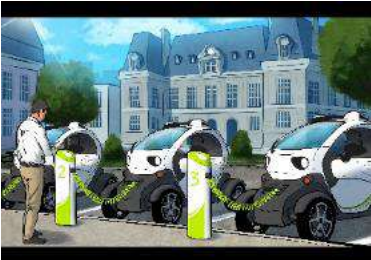



#### 3.2.1.1 Storyboard definition




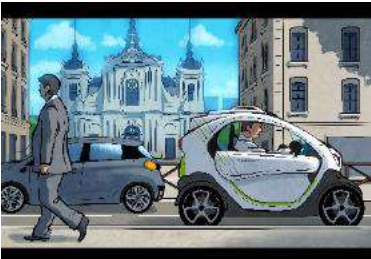

This use case can be divided in sub use cases: car sharing, point of interest notification and VRU detection.

The storyboard for the car sharing and urban driving Use Cases is presented and illustrated in the following table.







Table 3: Storyboard of the car sharing and urban driving use cases in Versailles




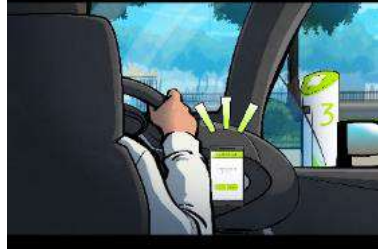
Action	Description	Illustration
<b>Downloading of the AUTOPILOT application</b>	<p>An untrained user downloads the AUTOPILOT application on his/her smartphone from the Apple Store or Google Play Store. The application has to check if the smartphone has Bluetooth low energy (BLE) communication which is compatible with the needs of the cars' virtual key function.</p> <p>The application has to ask the user to accept:</p> <ul style="list-style-type: none"> <li>- The activation of the Bluetooth (to communicate with the vehicle)</li> <li>- The general terms and conditions of use of the AUTOPILOT service (AD forms to be filled in and signed on a paper)</li> </ul> <p><i>Location: in the street in front of the tourism office of Versailles, at the entrance of Versailles Rive Gauche train station, next to the car, on the parking area etc.</i></p>	
<b>Booking of a VFLEX vehicle</b>	<p>The user, with his/her configured smartphone (cf. previous step), creates an account on the application and reserves a vehicle:</p> <ul style="list-style-type: none"> <li>- The application displays a map with the AUTOPILOT car sharing stations and the available cars in each station.</li> <li>- The user has to choose one station to reserve a vehicle.</li> <li>- Optional: the user can choose a station where he/she wants to give back the car. A parking spot is reserved at the arrival station for a determined duration.</li> </ul> <p>The application then sends to the user:</p>	


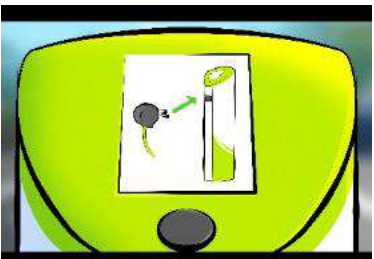
Action	Description	Illustration
	<ul style="list-style-type: none"> <li>- The virtual key of the VFLEX (from an external server) [Hidden from the user; only on the smartphone]</li> <li>- The license plate of the vehicle and the parking lot</li> <li>- A proposition to guide the user to the station where the vehicle that has just been reserved is parked</li> </ul> <p><i>Location: in the street in front of the tourism office of Versailles, at the entrance of the train station, etc.</i></p>	
Identification of the reserved vehicle	<p>The user arrives at the start station of AUTOPILOT and would like to identify the vehicle that he/she just reserved.</p> <p>The smartphone application indicates the number of the parking lot and the license plate to the user.</p> <p><i>Location: AUTOPILOT station</i></p>	
Identification of the user	<p>The user sends a message to the charging point to which the VFLEX is connected to stop the charge (server interface via API through the AUTOPILOT application).</p> <p>The application sends a wake-up-call to the car sharing box in BLE.</p> <p>Before starting, the user has to unplug the charger cable and store it in the front boot of the VFLEX. <i>[There will be a short tutorial on the application to explain how to store the cable correctly.]</i></p> <p>The user gets into the VFLEX.</p> <p><i>Location: AUTOPILOT station</i></p>	  
Starting procedure of	<p>The user fastens the seat belt, then turns on the vehicle.</p>	

Action	Description	Illustration
the vehicle	<p>The embedded vehicle screens welcome the user in the car (the end users are not allowed to use the smartphone while driving).</p> <p><i>[Make sure that the vehicle can only be turned on when the seat belt is fastened. In contrast, when the fleet operator (for the automated rebalancing) wants to start the vehicle, it should be possible to start it without fastening the seat belt.]</i></p> <ul style="list-style-type: none"> <li>- When the car wakes up, the vehicle screen has to display the welcome screen automatically and in less than 10 seconds.</li> <li>- The user will be identified thanks to a communication with his/her smartphone. A message like “Hello Mr / Ms Xxx” will be displayed instantly.</li> </ul> <p>The vehicle screen asks the user to verify [or confirm] that the cable has been unplugged.</p> <p>The user sits in the vehicle and is ready to go.</p> <p>The vehicle starts in manual mode.</p> <p><i>Location: AUTOPILOT station</i></p>	  
Manual driving in an urban environment	<p>Within Versailles, the user is going to follow the preprogrammed touristic itinerary.</p> <p>The vehicle drives on the preprogrammed itinerary and arrives at the first Point of Interest (Pol).</p> <p><i>[Pol detection via BLE beacon]</i></p> <p>A notification shows up on the vehicle screen and a speech synthesis comes out of the speakers. E.g. “we are now in front of the Saint-Louis cathedral”.</p> <p><i>[The sound comes out of the VFLEX’s speakers]</i></p> <p><i>Location : city centre of Versailles</i></p>	 



Action	Description	Illustration
Entering of the autonomous driving zone	<p>The user enters the autonomous driving zone (information given by the vehicle).</p> <p>A notification shows up on the screen and a speech synthesis comes out of the speakers. If the user decides to activate the AD mode, he/she must follow the tutorial displayed on the vehicle screen.</p> <p>The user can also push the NO button and stay in the manual mode.</p> <p><i>Location : Garden of the Versailles Castle : Allée des Peupliers – Pièce d'Eau des Suisses. Lane only open for pedestrians, cyclists (and the VEDECOM AUTOPILOT AD cars).</i></p>	 
Autonomous driving	<p>The vehicle drives autonomously (or manually) on the preprogramed itinerary around the Pièce d'Eau des Suisses and arrives near a Pol.</p> <p>A notification shows up on the screen and a speech synthesis comes out of the speakers: "We are in front of the Pièce d'Eau des Suisses."</p> <p><i>[The sound comes out of the VFLEX's speakers]</i></p> <p>Audio message (if manual driving) or streaming of a short video on the smartphone's screen (if autonomous driving).</p> <p>Length of the video: 1-minute max per Pol.</p> <p>In autonomous driving mode, the vehicle is able to detect pedestrians and cyclists thanks to their connected devices (smart watch, smartphone...), provided to the participants for their testing procedures.</p> <p><i>Location : Garden of the Versailles Castle : Allée des Peupliers – Pièce d'Eau des Suisses. Lane only open for pedestrians, cyclists (and the VEDECOM AUTOPILOT AD cars).</i></p>	   

Action	Description	Illustration
Exit of the autonomous driving zone	<p>As soon as the vehicle approaches the end of the autonomous driving zone, a countdown starts on the vehicle screen: It includes an audio signal as well as a coloured warning (green-orange-red) on the HMI to indicate to the user that he/she has to take back the control of the car.</p>  <p>The user takes back the control of the vehicle either by touching the steering wheel, or by pressing the drive/brake pedal.</p> <p><i>Location : Garden of the Versailles Castle : Allée des Mortemets – Pièce d'Eau des Suisses. Lane only open for pedestrians, cyclists (and the VEDECOM AUTOPILOT AD cars).</i></p>	
Pausing of the car rental	<p>The user decides to park the vehicle for a reason X but does not want to interrupt the car rental.</p> <p>The vehicle is stopped and turned off. The smartphone application informs the user that the rental is still ongoing and displays a function “continue driving”.</p> <p>The user activates the function “continue driving” when he/she wishes to get going.</p>	
Restitution of the VFLEX	<p>The user drives around in manual mode in the streets of Versailles and wants to give back its VFLEX in one of the AUTOPILOT stations. The user has already reserved a parking spot in one of the two AUTOPILOT stations</p> <p>The application guides the user to the station and tells him/her which parking spot to use.</p> <p>Once the vehicle is parked, the AUTOPILOT application:</p> <ul style="list-style-type: none"> <li>- Asks the user if he/she wants to give back the VFLEX</li> <li>- Displays a message to “apply the hand brake and turn the engine off” (this message shows up only if the user has not already done these two actions)</li> <li>- Shows a tutorial on how to connect the charger cable (as soon as the cable is connected, the car rental is over)</li> </ul> <p><i>[The restitution of the vehicle is not finalized]</i></p>	 

Action	Description	Illustration
	<p><i>until the charger cable is not correctly connected.]</i></p> <p>The smartphone application sends a message to the charging point to start the charge and a confirmation to the user's smartphone application that the vehicle has been returned.</p> <p>The smartphone application verifies that the charging starts correctly. If not it informs the user (on the smartphone) that the charger cable has probably not been plugged in correctly or that the vehicle is not parked on the right spot.</p>	 


### 3.2.2 Platooning

#### 3.2.2.1 Storyboard definition





This use case is aiming at platoon driving of car fleets (e.g. fleets of a car-sharing or rental car company) and can be divided in three sub use cases: intelligent fleet management, traffic lights assist and platooning.





The storyboard for the platooning Use Case is presented and illustrated in the following table.




Table 4: Storyboard of the Platooning use case in Versailles

Action	Description	Illustration
<b>Login to AUTOPILOT operator application and reception/acceptance of the mission</b>	<p>A trained operator arrives at the car sharing station, switches on his/her smartphone, starts the AUTOPILOT operator application and identifies him/herself. The operator mobile application indicates:</p> <ol style="list-style-type: none"> <li>1. The reference of the lead vehicle he/she will use as well as the reference of the start/end stations where he/she is going to pick up and give back the vehicle(s).</li> <li>2. The reference of the station where he/she has to go pick up the other vehicles (and the information on how to get there).</li> </ol>	



Action	Description	Illustration
<b>Pick up of the lead vehicle</b>	The operator picks up the lead vehicle by using the normal car sharing process (but using the operator app).	
<b>Arrival at the AUTOPILOT station</b>	<p>At the station, he/she receives the license plates of the vehicles that have to be moved, their destination (on his app) and their order in the platoon (on the screen of the lead vehicle).</p> <p>N.B. As soon as the vehicles that have to be moved have been identified, they have to disappear from the FMS.</p> <p>The smartphone application downloads the virtual keys from the VEDECOM platform.</p> <p>The AUTOPILOT operator application sends a message to the charging points in order to stop the charging and another message to the car sharing boxes in Bluetooth low energy technology (so called wake-up calls).</p> <p>Location: AUTOPILOT station</p>	
<b>Preparation of the platoon</b>	<p>The operator unplugs the charger cables of the vehicles which have to be moved and stores them in the front boots.</p> <p>The operator goes back to the lead vehicle and moves it to the area set aside for the purpose (road markings).</p> <p>Location: AUTOPILOT station</p>	 
<b>Platoon set up</b>	<p>Each vehicle already knows its own position in the platoon (directly sent from FMS through connectivity platform).</p> <p>The operator sends an order to each VFLEX to come behind the lead vehicle (use of the vehicle screen).</p> <p>One by one, the VFLEX come in position behind the VFLEX of the operator.</p> <p>Location: AUTOPILOT station</p>	

Action	Description	Illustration
		
<b>Start of the platoon</b>	<p>The operator checks (visual control + feedback from HMI) that the VFLEX are all well aligned and validates the start of the platoon on the vehicle screen.</p> <p>The operator starts to drive along the itinerary (manual mode), the other vehicles following autonomously.</p> <p>The embedded screen is dedicated to platoon HMI.</p> <p>Location: AUTOPILOT station</p>	 
<b>Platoon in motion</b>	<p>The platoon drives in the streets of Versailles to the destination station. The operator supervises the state of functioning of the vehicles in the platoon with the vehicle screen.</p> <p>The vehicles communicate among each other and with the front vehicle. The operator's vehicle also communicates with the traffic lights.</p> <p>Two cases:</p> <ul style="list-style-type: none"> <li>- Simple crossroads: The traffic lights don't need to be ordered by the vehicle: the application has to inform the operator if he has to stop or to continue.</li> <li>- Complex crossroads: The traffic lights have to be ordered by the platoon: The application allows the operator to send a request of priority passage (the traffic light controller gives the priority to the convoy by adjusting its phase. Once the platoon has crossed the intersection, the traffic light phase gets back to its classic functioning mode.</li> </ul>	
<b>Arrival at the destination</b>	<p>The operator stops at the planned area (road markings) and stops the platooning with the vehicle screen.</p> <p>The operator sends (through the vehicle screen) an order to each VFLEX to go park itself on its destination parking spot. One by one, the VFLEX</p>	

Action	Description	Illustration
	<p>park themselves on their spot. Each vehicle already knows its own parking spot (sent by the FMS through connectivity platform at the waking up of the vehicle). The operator checks that all VFLEX are shut off and that the handbrakes are pulled. (The vehicles turn off their engine and active the handbrakes automatically).</p> <p>The operator plugs in the charger cables of the vehicles to the corresponding charging points.</p> <p>The operator returns his/her vehicle using the normal car sharing process (could be at the same station or in another station).</p> <p>The operator leaves the station.</p>	 
		

### 3.3 Italian pilot

#### 3.3.1 Highway Pilot

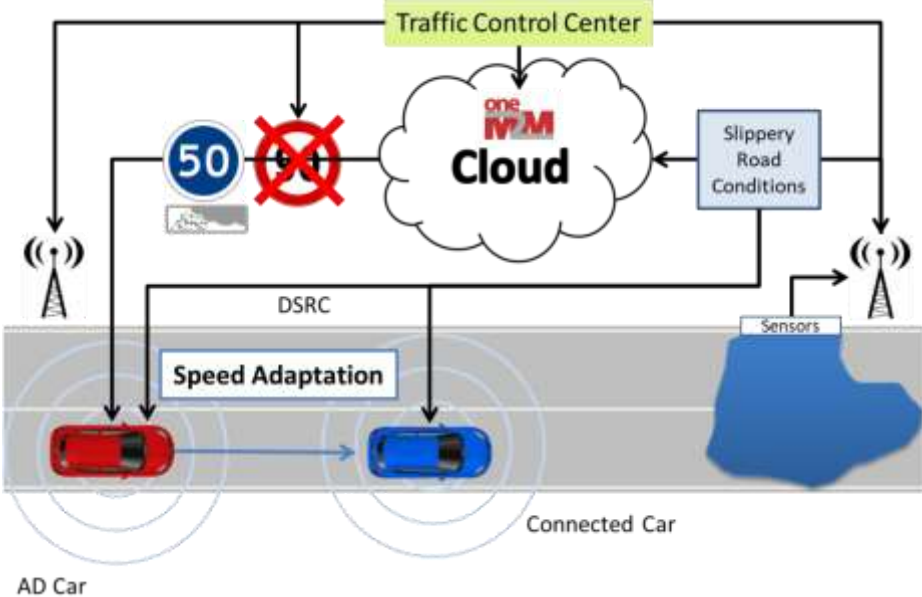
##### 3.3.1.1 Storyboard definition

A driver travels with an AD car from Florence to the Livorno harbour to embark on a ferry. The road travelled during the journey is a “smart highway”, notably the Fi-Pi-Li (Firenze-Piza-Livorno) with IoT sensors and road side equipment capable to trigger hazard warnings to the Traffic Control Center and to the connected vehicles. The driver enables two AD functions: speed adaptation with lane keeping and lane change. The Driver Assistant on the car is supported by the Internet of Things (IoT).

Before entering the critical zones, the AD car receives detailed hazard warnings from the services enabled by the IoT. Thus, the electronic controls of the AD Car can perform the manoeuvre appropriate to the situation.

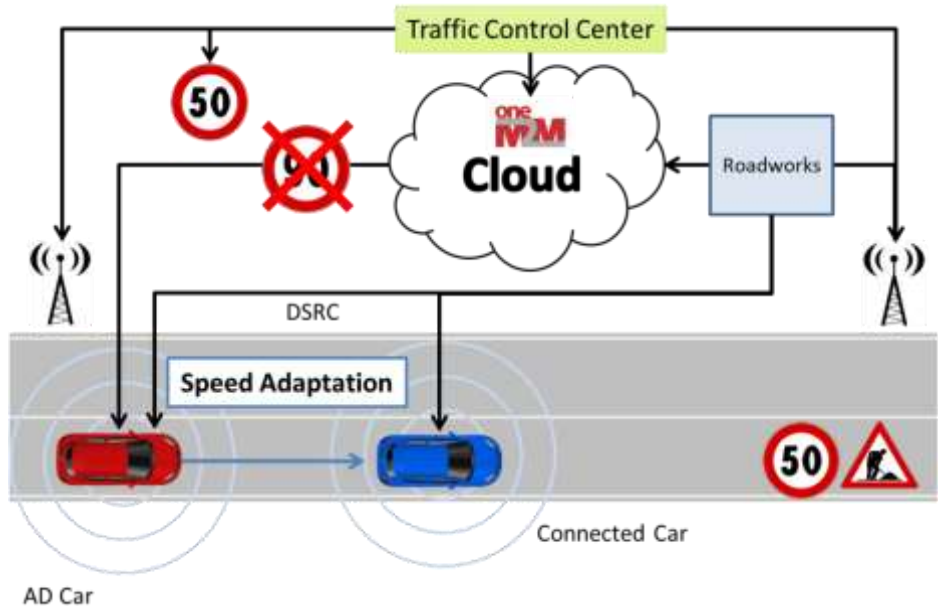
This use case can be divided in sub use cases:

**Table 5 Storyboard of the highway pilot use case in Livorno (road hazard warning, puddle)**

Use case description	
<b>Situation</b>	<p>Sensors, placed along the highway, detect a relevant presence of water on road surface. This event triggers a warning condition that can be notified in advance to the vehicle. The AD system reduces its speed and the vehicle reaches the interested area moving at an appropriate speed.</p> 
<b>Scenario description</b>	<p>IoT sensors placed along the highway monitor continuously the presence of puddles and if a warning condition has been detected, send an alert to the Road Side Unit (RSU) that broadcasts this information to vehicles (DENM) and to the Traffic Control Centre (TCC). It validates the alert, forwards the DENM message to farther away RSUs and feeds the IoT OneM2M cloud platform with alert related data. The information of the presence of puddles generates a temporary update of the speed limit in the interested area, transmitted from the CONTI/FCA Cloud to the Connected e-Horizon (CeH) installed inside the FCA prototypes.</p>

Use case description	
	The in-vehicle application feeds the appropriate autonomous functions that performs a smooth speed adaptation (IoT-enabled speed adaptation for AD car) in combination with information obtained from DENM.
<b>IoT Input to AD</b>	<ul style="list-style-type: none"> <li>• From I2V (DENM): Slippery road/bad weather conditions.</li> <li>• From V2V (CAM): presence information of other vehicles.</li> <li>• From IoT OneM2M cloud: temporary speed limit due to roadworks presence slippery road/bad weather conditions</li> </ul>
<b>Manoeuvre and control</b>	Speed adaptation considering slippery road – bad weather conditions and traffic conditions.
<b>Display / alert principle</b>	<ul style="list-style-type: none"> <li>• “Slippery road – bad weather alert”, including anticipated speed limit/adaptation information</li> <li>• “Slippery road – bad weather inside”, including current speed</li> <li>• “Restored speed to legal limit” information, including current speed value</li> </ul>
<b>Demonstration storyboard</b>	<ul style="list-style-type: none"> <li>• The AD vehicle enters the highway, adapting its speed to the legal speed limits and to the presence of other vehicles moving in front.</li> <li>• At a given point in the stretch, the AD vehicle is notified of slippery road/bad weather conditions.</li> <li>• The AD vehicle sets a speed limitation according to the area interested by hazard conditions and it smoothly decelerates in order to enter in the area at the proper speed.</li> <li>• If the infrastructure provides the notification of end of dangerous area the vehicle will recover the legally allowed cruise speed.</li> <li>• Throughout the demonstration, the actual speed profile will depend on traffic conditions (vehicles in front, etc.).</li> </ul>

Table 6 Storyboard of the highway pilot use case in Livorno (road works warning)

Use case description	
Situation	<p>A roadworks event is planned by traffic/road operator and a temporary speed limit is associated with the event. The AD vehicle has to reduce its speed approaching the roadworks area, travel at the temporary speed limitation and increase again the speed at the end of the roadwork area.</p> 
Scenario description	<p>A (WSN) sensor node is attached to the roadworks trailer and announces the presence of roadway works to an RSU that triggers DENM messages, broadcasting information about available lanes, speed limits, geometry, alternative routes, etc. it can be a temporary RSU and use the LTE network for communicating with the TCC.</p> <p>TCC forwards the DENM message to farther away RSUs and feeds the IoT OneM2M platform with roadworks related data. The information of the presence of roadworks generates a dynamic reduction of the speed limit transmitted from the FCA Cloud to the Connected e-Horizon (CeH) installed inside the FCA prototypes. The in-vehicle application feeds the appropriate autonomous functions that perform the necessary adaptation of the driving style in a “smooth” way in combination with information obtained from DENM. AD car On Board Units (OBUs) can instantiate either smooth IoT-enabled speed adaptation and lane change.</p>
IoT Input to AD	<ul style="list-style-type: none"> <li>From I2V (DENM): Roadwork position and temporary speed limitation inside Road Works Warning (RWW).</li> <li>From V2V (CAM): presence information of other vehicles</li> <li>From IoT OneM2M cloud: temporary speed limit due to roadworks presence</li> </ul>
Manoeuvre and control	Speed adaptation considering roadworks presence and traffic conditions.
Display / alert principle	<ul style="list-style-type: none"> <li>“RWW alert”, including anticipated speed limit/adaptation information</li> <li>“RWW inside”, including current speed</li> <li>“Restored speed to legal limit” information, including current speed value</li> </ul>
Demonstration storyboard	<ul style="list-style-type: none"> <li>The AD vehicle enters the highway, adapting its speed to the legal speed limit and to the presence of other vehicles moving in front.</li> </ul>



Use case description	
	<ul style="list-style-type: none"> <li>At a given point in the stretch, the AD vehicle is notified of roadworks ahead; in this case, the expected behaviour is to decrease the vehicle cruise speed.</li> <li>The AD vehicle sets a speed limitation according to the RWW and it smoothly decelerates in order to enter in the roadworks zone at the proper speed. Inside this area, the AD vehicle maintains the speed under the temporary speed limit according with the RWW message content).</li> <li>After roadworks, the vehicle recovers the legally allowed cruise speed.</li> <li>Throughout the demonstration, the actual speed profile will depend on traffic conditions (vehicles in front, etc.).</li> </ul>

### 3.3.2 Urban Driving

#### 3.3.2.1 Storyboard definition

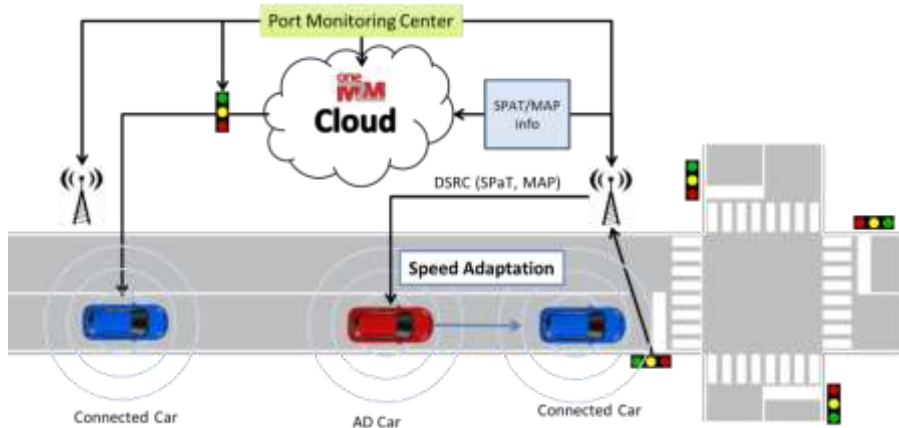
A driver with an AD car is travelling to embark on a ferry. In Livorno it exits from the highway and get into the public road inside the harbour landside. That area is a managed public road with "smart traffic light", road side equipment and a Port Monitoring System capable to provide information that are not detectable by on board sensors, notably the remaining time to traffic light phase change and also other useful information about VRUs behaviour and presence of crowd at cross road.

The speed adaptation AD function is enabled. The Driver Assistant on the car is supported by the Internet of Things (IoT). Before approaching to the traffic light, the AD car receives detailed information about the situation at the intersection: phase and remaining time before the phase change, traffic status, VRU presence and behaviour, jaywalking, etc.

Thus, the electronic controls of the AD Car can perform the manoeuvre appropriate to the situation.

This use case can be divided in sub use cases:

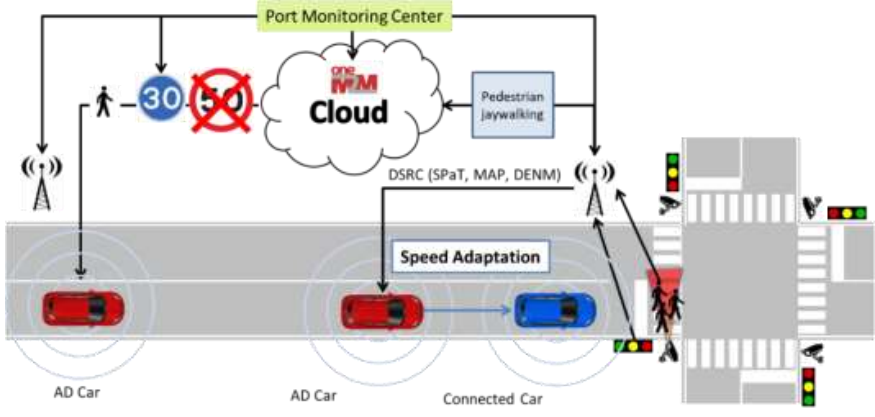
**Table 7 Storyboard of the urban driving use case in Livorno (speed adaptation approaching an intersection regulated by traffic lights)**

Use case description	
<b>Situation</b>	<p>An AD vehicle autonomously adapts its speed in order to cross the intersection without violating the traffic light phases and considering other vehicles moving in front.</p> 

Use case description	
<b>Scenario description</b>	<p>An AD vehicle is approaching an intersection regulated by traffic light. It receives, from infrastructure, SPaT and MAP messages describing the topology, actual status of the traffic light and an estimation of the traffic light behaviour. It means that the AD vehicle can extract information on the actual and next phases and the remaining time before the phase change. Thanks to this information it can adapt its speed in order to cross the intersection when traffic light is green or stop when it is red. AD vehicles also receive V2V messages that describe other vehicles positions and dynamics. Therefore, the AD vehicle can adapt its speed also to the traffic conditions.</p> <p>The information about the traffic light behaviour is also sent to the OneM2M platform and can be retrieved by the cars in advance respect to DSRC (e.g. in case of obstruction).</p>
<b>IoT Input to AD</b>	<ul style="list-style-type: none"> <li>• From I2V (SPaT, MAP): traffic lights phases and timing, road description and topology.</li> <li>• From V2V (CAM): presence information of other vehicles</li> <li>• From IoT OneM2M cloud: traffic lights phases and timing, road description and topology.</li> </ul>
<b>Maneuver and control</b>	The AD vehicle has to control its speed in order to safely cross the intersection.
<b>Display / alert principle</b>	<ul style="list-style-type: none"> <li>• Traffic light status, and time to remaining before the traffic light phase change.</li> </ul>
<b>Demonstration storyboard</b>	<ul style="list-style-type: none"> <li>• An AD vehicle is approaching an intersection regulated by traffic light.</li> <li>• Depending on the traffic light status (phase and remaining time before the phase change) and on the traffic status (presence of other vehicles moving in front) the AD vehicle has to automatically adapt its speed in order to cross the intersection when the traffic light is green.</li> <li>• If it is not possible, the AD vehicle will smoothly reduce its speed until it will stop at the stop line sign.</li> <li>• In presence of other vehicles moving in front it has to queue them and adapt its speed to the traffic condition approaching and crossing the intersection in safety conditions.</li> <li>• The traffic light information can be received in advance via cloud.</li> </ul>

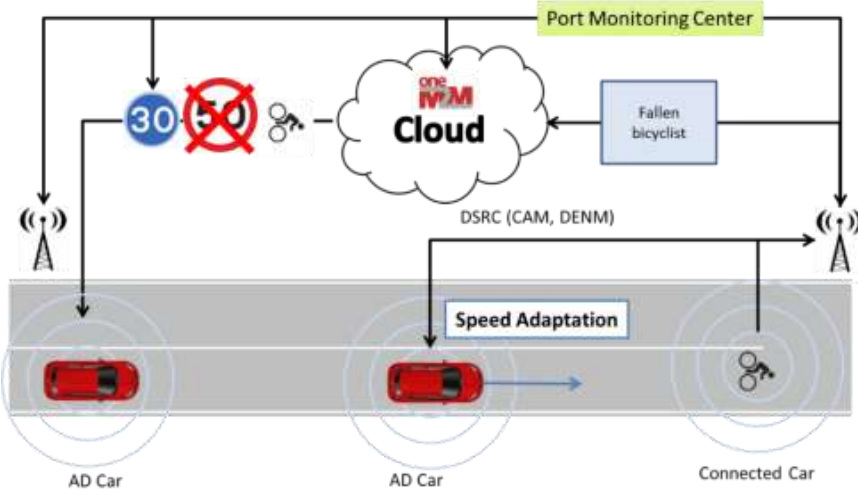


Table 8 Storyboard of the urban driving use case in Livorno (speed adaptation at jaywalking occurrence)

Use case description	
<b>Situation</b>	<p>An AD vehicle autonomously adapts its speed in order to stop even if the traffic light is green because a pedestrian is violating the traffic light rules.</p> 
<b>Scenario description</b>	<p>An AD vehicle is approaching an intersection regulated by traffic light. It receives from infrastructure MAP and SPaT messages that describe the topology of the intersection, the actual status of the traffic light and an estimation of the traffic light behaviour. Smart cameras detect a pedestrian traffic light violation and the infrastructure notifies this information to AD vehicles via DSRC using a DENM. The AD vehicle elaborates this data and stops at traffic light avoiding a pedestrian accident.</p> <p>The information is also sent to the OneM2M platform and can be retrieved by other vehicles in the same area via cloud. The OneM2M notifies also the MONICA cloud that can change the advisory speed limit in the relevant area to avoid possible problems.</p>
<b>IoT Input to AD</b>	<ul style="list-style-type: none"> <li>From I2V (SPaT, MAP, DENM): traffic lights phases and timing, road description and topology; jaywalking occurrence.</li> <li>From V2V (CAM): presence information of other vehicles</li> <li>From IoT OneM2M cloud: temporary speed limit due to crowd at cross road or jaywalking occurrence.</li> </ul>
<b>Manoeuvre and control</b>	<p>The AD vehicle has to control its speed in order to stop at the intersection stop sign line.</p>
<b>Display / alert principle</b>	<ul style="list-style-type: none"> <li>Traffic light status, and time to remaining before the traffic light phase change.</li> <li>Pedestrian traffic light violation warning.</li> <li>"Restored speed to legal limit" information, including current speed value</li> </ul>
<b>Demonstration storyboard</b>	<ul style="list-style-type: none"> <li>An AD vehicle is approaching an intersection regulated by traffic light adapting its speed in order to cross the intersection when the traffic light is green, as described in the previous sub-use case.</li> <li>At a certain point, a pedestrian violates the traffic light rules and</li> </ul>

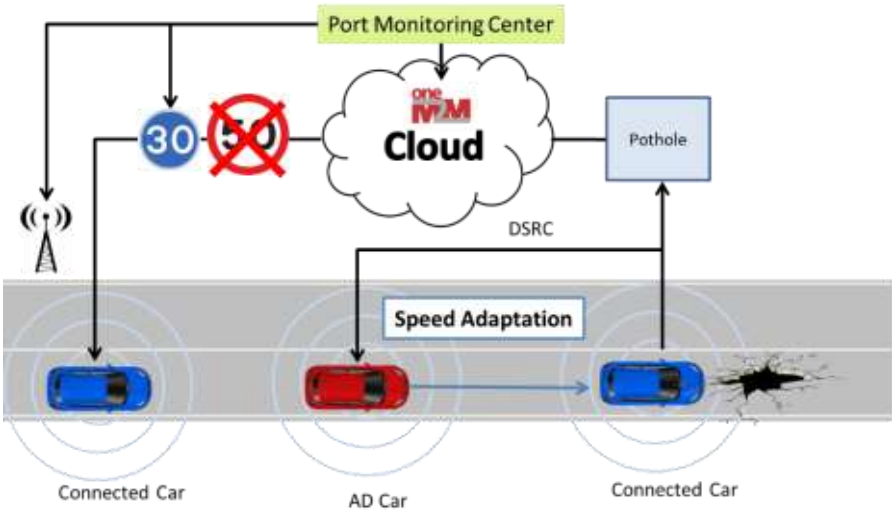
Use case description	
	<p>the AD vehicle decreases its speed and stops avoiding pedestrian accident.</p> <ul style="list-style-type: none"> <li>Vehicles receive information about pedestrian and temporary speed limit via cloud.</li> </ul>

Table 9 Storyboard of the urban driving use case in Livorno (speed adaptation with a fallen cyclist)

Use case description	
<b>Situation</b>	<p>A bicyclist falls down in a "smart" urban environment. The hazard warning is broadcasted to the vehicles by IoT based services. AD cars, approaching the accident area have to reduce their speed and to stop.</p> 
<b>Scenario description</b>	<p>Connected bicycles, equipped with connection modules and sensors, are able to detect when a bicyclist falls down. If any event is detected, the connected bicycles send CAMs to other vehicles and to infrastructure. In case of fallen bicyclist, the connected bicycle sends DENMs to other entities on the neighbourhood, to warn of them of the danger. AD vehicle receives this notification and adapts its speed in order to stop before the fallen bicyclist.</p>
<b>IoT Input to AD</b>	<ul style="list-style-type: none"> <li>From V2V (CAM, DENM): presence information of other vehicles and bicycles. Warning that notifies the fallen bicycle.</li> </ul>
<b>Manoeuvre and control</b>	<p>The AD vehicle has to manage its speed in order to stop before crash with the fallen bicyclist.</p>
<b>Display / alert principle</b>	<ul style="list-style-type: none"> <li>Information of bicyclists presence</li> <li>Fallen bicyclist warning</li> </ul>
<b>Demonstration storyboard</b>	<ul style="list-style-type: none"> <li>An AD vehicle is moving in urban scenario and other road users, including connected bicycles, notify their presence to the AD vehicle.</li> <li>At a certain point, a bicyclist falls while the AD is moving towards</li> </ul>

	<p>the accident zone.</p> <ul style="list-style-type: none"> <li>The AD vehicle, informed by IoT of the dangerous situation, smoothly decreases its speed and stops before reaching the accident area.</li> </ul>
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**Table 10 Storyboard of the urban driving use case in Livorno (speed adaptation when potholes are detected)**

Use case description	
<b>Situation</b>	<p>The cars can detect a pothole using the combination of one or more of the following sensors: smartphone, 6LoWPAN vibration sensor, IMU.</p> <p>The information is sent to the cloud and can be sent back to other connected vehicles for warning.</p> <p>The information is also transmitted via V2V to AD cars that can automatically adapt the speed.</p> 
<b>Scenario description</b>	A vehicle detects a pothole thanks to its sensors and send the information via V2V to the upcoming vehicles. The warning is also sent to the cloud and can be distributed to the vehicle coming in the relevant area.
<b>IoT Input to AD</b>	<ul style="list-style-type: none"> <li>From V2V (DENM): warning about a pothole.</li> <li>From IoT OneM2M cloud: warning about a pothole.</li> </ul>
<b>Manoeuvre and control</b>	Decreasing speed
<b>Display / alert principle</b>	<ul style="list-style-type: none"> <li>"Pothole alert"</li> </ul>
<b>Demonstration storyboard</b>	<ul style="list-style-type: none"> <li>A vehicle detects a pothole and send the information via V2V and toward the cloud</li> <li>An upcoming AD vehicle can arrange its speed accordingly</li> </ul>

### 3.4 Dutch pilot

#### 3.4.1 Platooning

##### 3.4.1.1 Storyboard definition

In the platooning use case, 2 users (Bert and Wendy) want to use car sharing services and platooning services to get to their destination, while doing other activities at the same time and while taking advantage of the priority lane.

More specifically, Bert wants to drive to Eindhoven. He is thinking of booking a platooning service and a car sharing service, to pick up someone on his way and use the priority lane. Wendy, is at the TNO office and has an appointment at the university at 15.00. She wants to book a car sharing vehicle for 14.30 and also request a platooning so that she can do some work along the way. Both requests have been confirmed by the platooning system. While driving in Helmond, Bert finds someone to pick up at TNO and use the priority lane, while Wendy receives a notification that her shared vehicle has arrived.

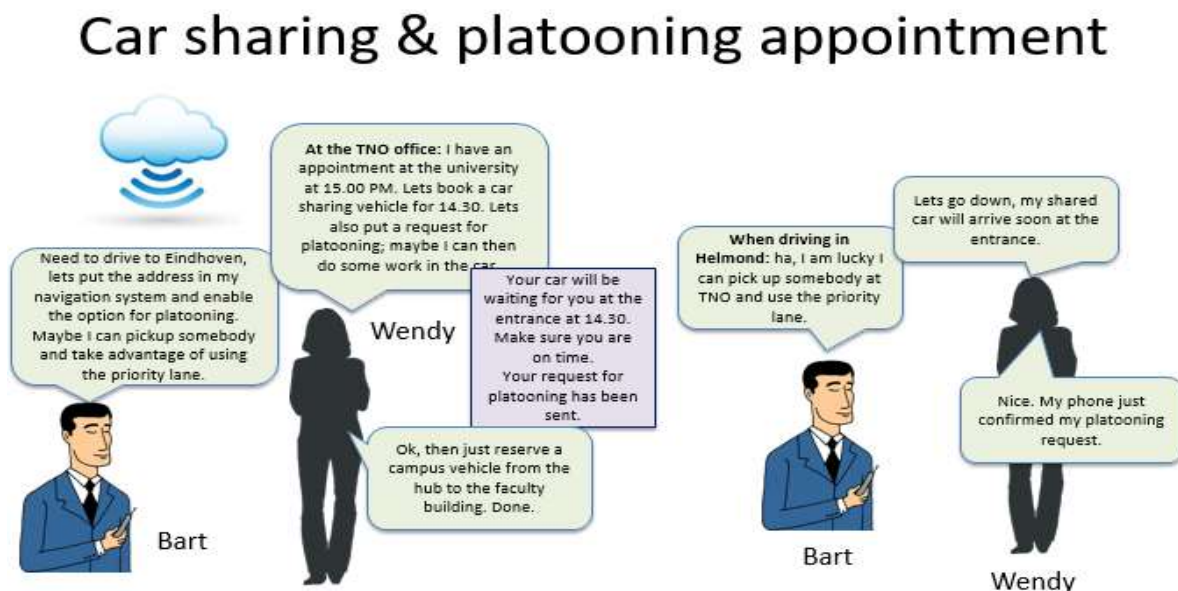




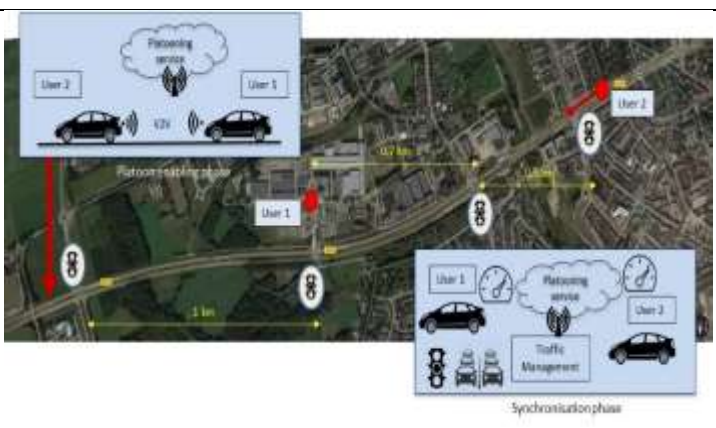

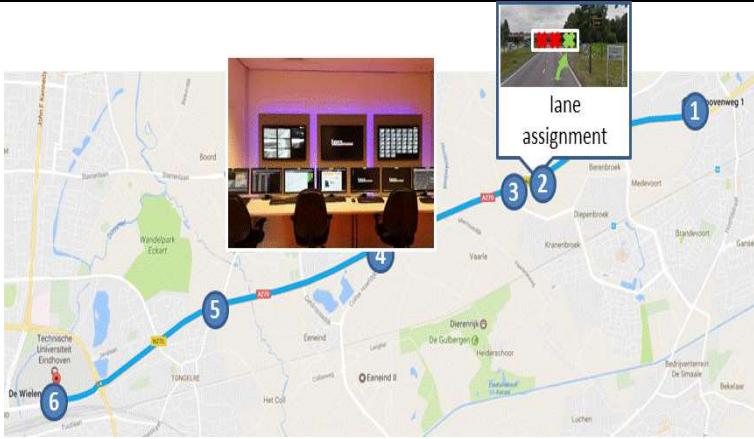
Figure 1 Illustration of the Dutch platooning storyboard


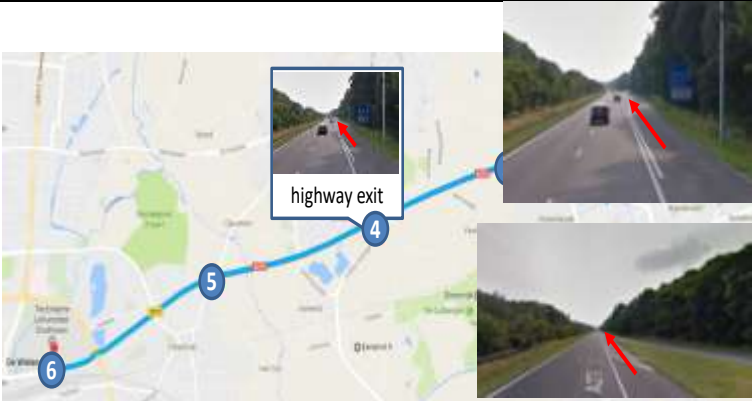
The following actions take place through the storyboard:

**Table 11: Storyboard of the platooning use case in Brainport**

Action	Description/illustration
<p>The car sharing vehicle for Wendy parks at the valet parking drop off zone.</p> <p>Wendy enters the car and follows the instructions of the AUTOPILOT app.</p> <p>Active entities &amp; information exchange</p> <ul style="list-style-type: none"> <li>User prompts car sharing service with request for car sharing vehicle</li> <li>Platoon service confirms lane availability with traffic management centre</li> <li>Platoon service facilitates lead car</li> <li>AVP service retrieves car sharing vehicle</li> </ul>	 <p>Automated driving functions</p> <p>Lead car: speed advice</p> <p>Follow car: unmanned driving (AVP function)</p>
<p>Wendy starts manual driving when requested.</p> <p>The platooning service gives speed advice to Wendy and Bart so that their cars arrive at approximately the same time at the start of the Highway; the lead vehicle has arrived at the meeting point earlier.</p> <p>Active entities &amp; information exchange</p> <ul style="list-style-type: none"> <li>User prompts car sharing service with request for car sharing vehicle</li> <li>Platoon service confirms lane availability with traffic management centre</li> <li>Platoon service facilitates lead and follow car</li> <li>AVP service retrieves car sharing vehicle</li> </ul>	 <p>Automated driving functions</p> <p>Lead car: speed advice</p> <p>Follow car: speed advice</p>



Action	Description/illustration
As soon as the two vehicles meet, the platooning phase begins.	
Use case overview Platooning phase	
<b>Lane assignment &amp; platoon engagement</b> At the beginning of the highway, the lane that will be used for platooning is communicated to the vehicles. The lane is assigned based on traffic monitoring. Vehicles are manually steered on the emergency lane and platooning is engaged. <b>Active entities &amp; information exchange</b> <ul style="list-style-type: none"> <li>Cars send request to initiate platooning on electronic lane</li> <li>Traffic management centre confirms use of electronic lane</li> <li>Legacy traffic is monitored by road-side cameras and using smartphone traces</li> </ul>	
	<b>Automated driving functions</b> Lead car: Speed advice from traffic management centre, e.g. max. speed Follow car: Automated steering and headway control

Action	Description/illustration
<p><b>Traffic light</b></p> <p>When the platoon is approaching the traffic light, a request to set the light to green is issued. Platoon speed is optimized to traffic light status.</p> <p>At all cases, platoon break up is avoided.</p> <p>Optionally, at the traffic light, a 3<sup>rd</sup> platoon car has entered the Highway. The 3<sup>rd</sup> car gets speed advice and joins the platoon.</p> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>• Time of platoon reaching traffic light is communicated by platooning service</li> <li>• Traffic light controller: traffic light status &amp; request handling</li> </ul>	 <p><b>Automated driving functions</b></p> <p>Lead car: Speed advice</p> <p>Follow car 1+2: Automated steering and headway control</p>
<p><b>Highway exit &amp; entrance</b></p> <p>When the platoon approaches the highway exit, it has to deal with exiting traffic. When approaching the entrance, it has to deal with merging traffic.</p> <p>Follow car 2 leaves the platoon to take the Highway exit [Optionally]</p> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>• Legacy traffic is monitored by road-side cameras and using smartphone traces</li> <li>• Position, velocity, etc. of legacy traffic is communicated to platoon together with speed advice for smooth merging and exiting</li> </ul>	 <p><b>Automated driving functions</b></p> <p>Lead car: Speed advice</p> <p>Follow car 1: Automated steering and headway control</p> <p>Follow car 2: Transition of control</p>

Action	Description/illustration
<p><b>Bus lane usage</b></p> <p>When the platoon approaches the bus lane, appropriate speed advice is given to the lead vehicle so that the bus schedule is not disturbed.</p> <p>At the end of the bus lane, the platoon disengages and merges into mixed traffic.</p> <p>In case the driver of the follow car does not take over, the car stops at the end of bus lane (safe state)</p> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>• Bus is monitored by road-side cameras &amp; bus tracking system</li> <li>• Position, velocity, etc. of bus is communicated to platoon together with speed advice</li> <li>• Legacy traffic is monitored by road-side cameras and using smartphone traces</li> <li>• Speed advice &amp; merge moment are communicated to platoon</li> </ul>	 <p><b>Automated driving functions</b></p> <p>Lead car: speed advice from traffic management center</p> <p>Follow car:</p> <ul style="list-style-type: none"> <li>• Automated steering and headway control</li> <li>• Safe state handling</li> </ul> <p>Both: disengaging of platoon</p>
<p><b>Campus arrival</b></p> <p>Wendy arrives at TU/e Science Park, where Twizy is already waiting.</p> <p>Parking lot gate automatically opens and reserved parking lot space is communicated</p> <p>Wendy continues her trip on TU/e science park with Twizy</p> <p><b>Active entities &amp; information exchange</b></p> <p>Platoon arrival time is communicated to parking lot gate and campus car service</p>	 <p><b>Automated driving functions</b></p> <ul style="list-style-type: none"> <li>• For platooning: none</li> </ul>



### 3.4.2 Automated Valet Parking

#### 3.4.2.1 Storyboard definition

Bert has a meeting with Wendy in a few minutes but cannot find a parking spot for his vehicle. He then uses the AVP application to drive his vehicle towards a drop-off zone. Upon reaching the drop-off zone, he receives a notification in the HDD/app informing him that AVP is available. Bert exits the vehicle, activates the AVP function using the app and goes to his meeting with Wendy. In the meantime, the vehicle drives to a suitable parking spot and the AVP app informs Bert that the vehicle has reached a safe parking position. When Bert finishes his meeting with Wendy, he can use the app again to command the vehicle back to the drop-off point.

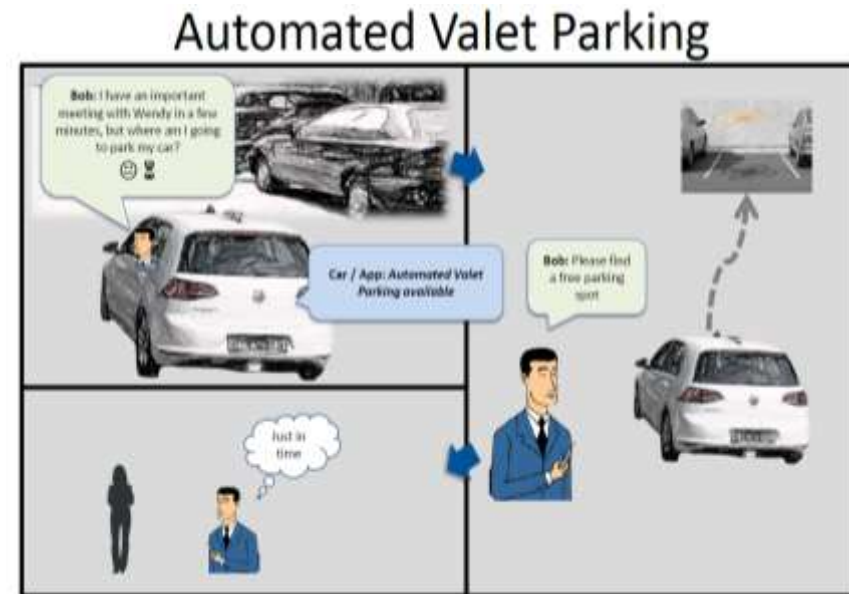



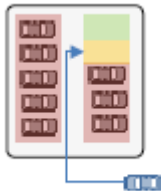


Figure 2 Illustration of the Dutch AVP storyboard

The breakdown of the story in steps is depicted below:

Table 12: Storyboard of the AVP use case in Brainport

Action	Description/Illustration
<b>Manual Driving</b> Bart drives car manually to drop-off zone <b>Active entities &amp; information exchange</b> Possible: Drone could get information about approaching vehicle and lift off to detect suitable parking spots	 <p>Manual driving</p> <p>1</p> <p><b>Automated driving functions</b> None</p>

<p><b>Drop-off vehicle</b></p> <ul style="list-style-type: none"> <li>Upon reaching the drop-off zone, Bart receives a notification in the HDD/app that AVP is available</li> <li>Bart exits the vehicles and activates the AVP function with the app.</li> </ul> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>Vehicle detects arrival at dropoff zone</li> <li>Backend determines if parking possible (e.g. vacancies detected by drone and camera)</li> </ul>	 <p><b>Automated driving functions</b> Automated Valet Parking</p>
<p><b>Automated Valet Parking</b></p> <ul style="list-style-type: none"> <li>While Bart goes to meet Wendy, his vehicle automatically drives to a suitable parking spot</li> <li>The app informs Bart that his vehicle has safely reached the parking position (and offers to command the vehicle back to a pickup spot).</li> </ul> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>Backend determines optimal parking spot and “guides” vehicle using input from available sensors (drone, camera, possible other vehicles on the parking)</li> <li>The degree of guidance can span from simply giving information about free parking spaces and routing to planning and possibly control level commands</li> </ul>	 <p><b>Automated driving functions</b> Automated Valet Parking</p>
<p><b>Use by non-automated vehicles</b></p> <p>Bob is attending the meeting with Wendy too. He has no automated vehicle but nonetheless he can use his smartphone to get information about free parking spots, reserve one and be guided to the reserved spot.</p> <p><b>Active entities &amp; information exchange</b></p> <p>Backend determines available parking spots and assigns / reserves a parking spot to the user and provides guidance for the user to drive his vehicle manually to the parking spot</p>	 <p><b>Automated driving functions</b> Vehicle is driven manually, but information on a navigation level is provided to the user</p>

### 3.4.3 Highway pilot

#### 3.4.3.1 Storyboard definition

The storyline for the highway pilot is focused on Bert and his ride along the A270 highway, on his autonomous vehicle.

The A270 highway is a busy road, one that many vehicles use, causing the road to deteriorate (potholes and bumps have formed, puddles are appearing when raining, etc.). All vehicles that use the A270 highway share a common trait: their respective sets of sensors are silently monitoring the road condition and reporting it to an online service.

Bart is taking the A270 on his autonomous vehicle to reach a destination. Although he is generally happy with his AD vehicle, he finds that the ride on the A270 is often bumpy and rough, with the vehicle hitting the same misplaced potholes on that right lane or getting hard on the brakes and steering wheel to avoid the bump, at the last second, every time. Fortunately, Bart's vehicle recently received a software update, bringing a 6<sup>th</sup> sense feature that is said to provide the vehicle with anticipation skills. Bart found out it actually works; his vehicle is displaying warnings about road hazards ahead well in advance and the vehicle informs him of its intention to manoeuvre over or around the hazard point.

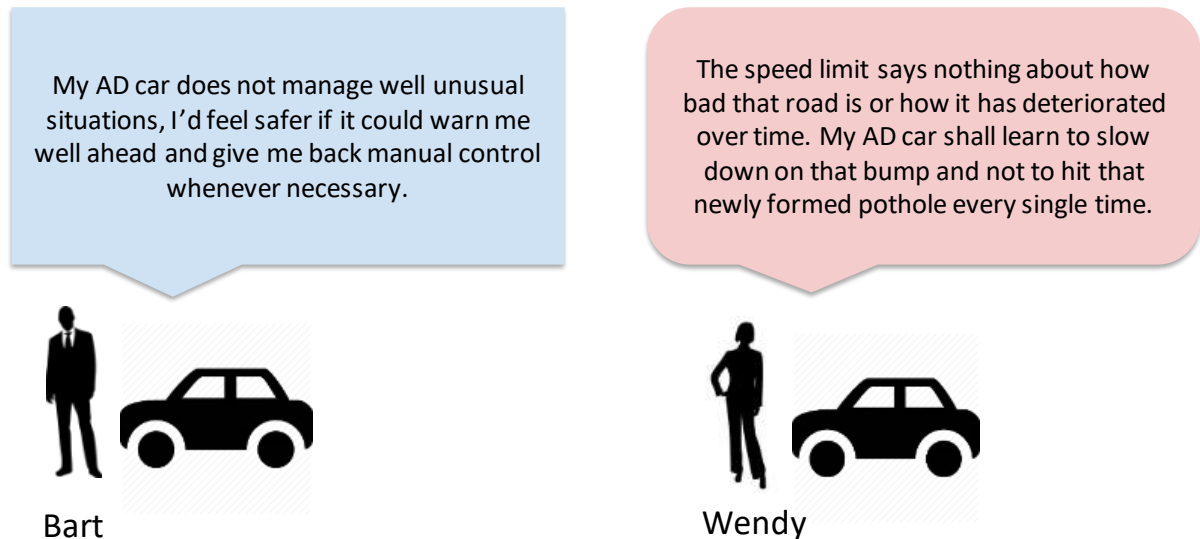

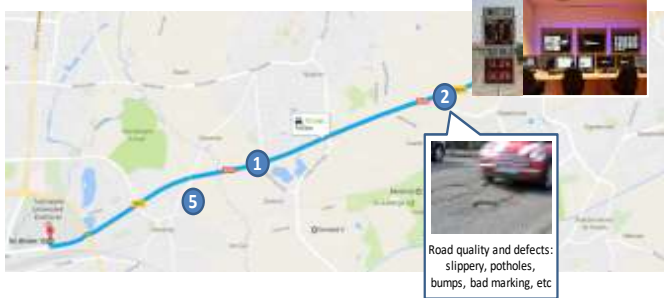


Figure 3 Illustration of the Dutch highway pilot storyboard

As the vehicle approaches the road hazards, it executes what is intended and then resumes its normal speed, immediately after by passing the hazards.

Table 13: Storyboard of the highway pilot use case in Brainport

Scenario/Action	Illustration/Description
<b>Abnormal events</b> <ul style="list-style-type: none"> <li>A probable obstacle is detected by roadside cameras or vehicles sensors and driving (trajectory / speed) changes.</li> <li>Bart's car is informed of the obstacle ahead (out of own detection range).</li> <li>Bart's car slows down / adapts trajectory and/or suggests switching to</li> </ul>	

Scenario/Action	Illustration/Description
<p>manual mode (and may come to full stop if unmanageable situation)</p> <ul style="list-style-type: none"> <li>Road signals are used to warn other drivers too</li> </ul> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>Roadside Units / Accidented Car / Observant Car -&gt; Control Centre</li> <li>Control Centre -&gt; Incoming cars (direct or via smartphones) / Road signals / Map Provider / Road Maintenance</li> </ul>	<p><b>Automated driving functions</b></p> <ul style="list-style-type: none"> <li>Automatic reporting from car if detection of obstacle, or if own failure</li> <li>In-car HMI display of incoming information</li> <li>Adaption/Override of AD speed</li> <li>Remote disengagement of AD</li> </ul>
<p><b>Road quality and defects</b></p> <ul style="list-style-type: none"> <li>Bart's car senses peculiar road defects and reports them online anonymously.</li> <li>A Cloud Service detects consistent pattern at that specific location confirmed by many vehicle reports.</li> <li>The info is propagated to drivers and AD systems with instructions (new speed, trajectories recommendations)</li> </ul> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>Car -&gt; IoT Cloud -&gt; Control Centre / Map Providers</li> <li>Control Centre -&gt; Roadside Equipment / Road Maintenance Team / Incoming vehicles</li> <li>Map Providers -&gt; All Vehicles (through LDM)</li> </ul>	 <p><b>Automated driving functions</b></p> <ul style="list-style-type: none"> <li>Sensors monitoring + Local processing</li> <li>Fusion local dynamic map, road signals, alerts</li> <li>HMI display</li> <li>Remote AD command (speed limit, trajectory)</li> </ul>

### 3.4.4 Urban Driving

#### 3.4.4.1 Storyboard definition

The use case can be divided into two parts: rebalancing and urban driving (VRU detection). The business case for this relates to the use of Cloud infrastructure that will enable the rebalancing service. More specifically, the vehicles will transmit their location across the TU/e campus to the cloud and they will be instructed to relocate accordingly, based on user demand and based on the location of the VRUs. Using both real-time and historical information, the predicted demand for the vehicle can be computed and taking into account the crowdedness on campus, the vehicle will drive in less crowded areas and at times where there are less people walking or cycling on campus, to prevent possible dangerous situations between the fully driverless vehicle and VRUs. In case the vehicle is still to encounter VRUs, the vehicle will warn the VRUs on their smartphone and the vehicle is aware of these VRUs using the location sent by their smartphone.



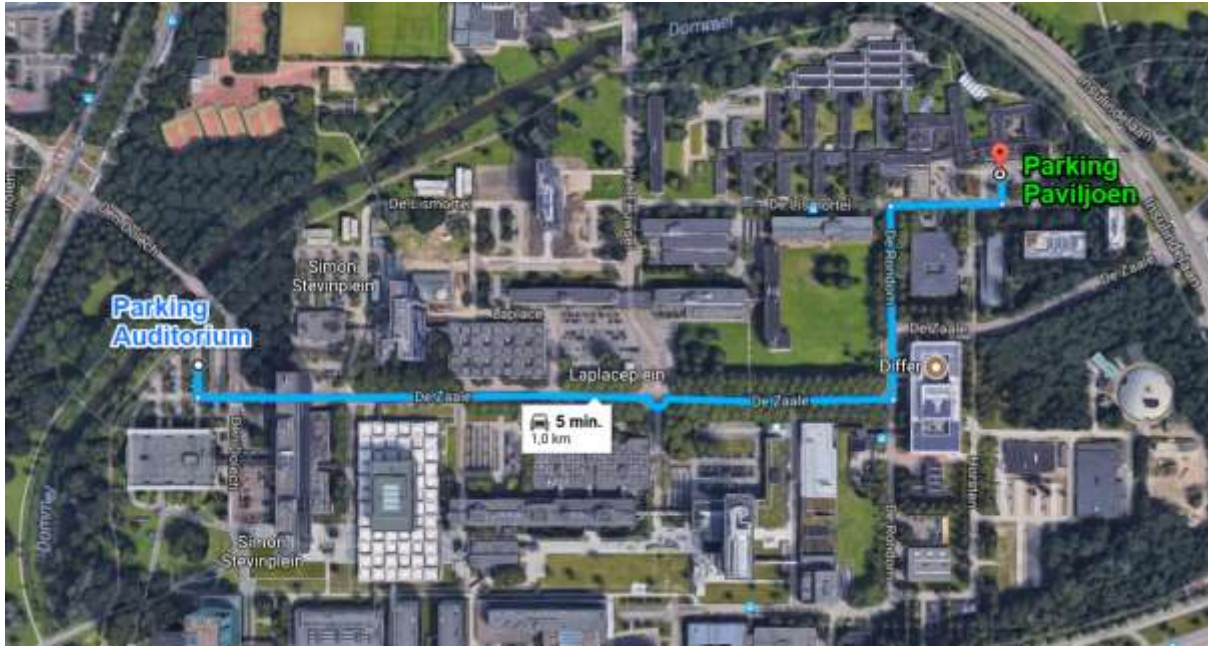
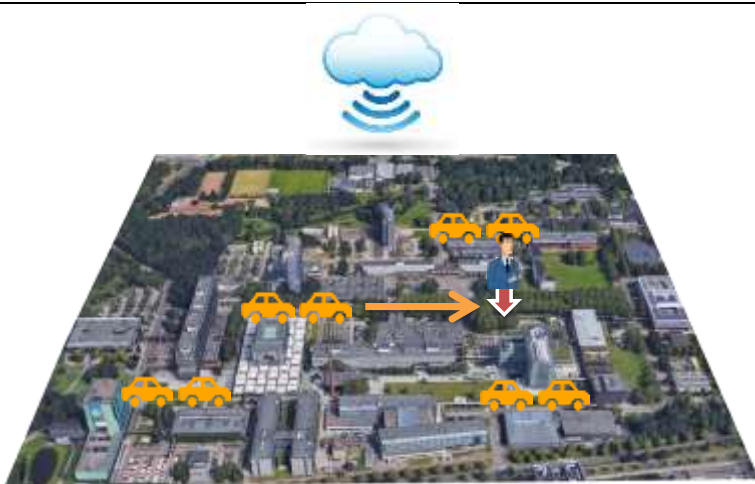
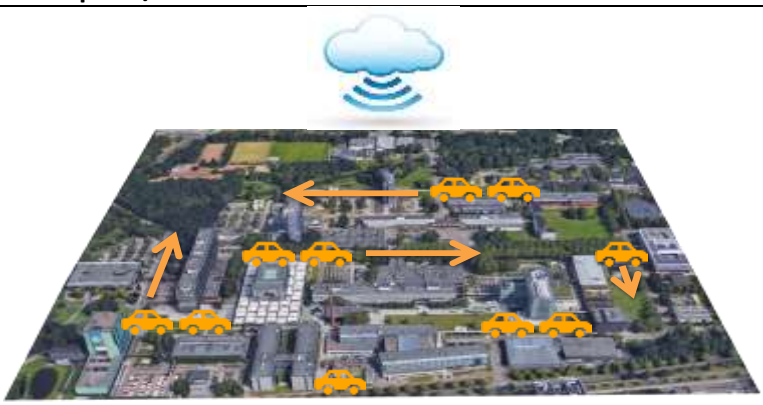



Figure 4 Illustration of the Dutch urban driving storyboard

During the Pilot Tests, the main route to be tested is between Auditorium and Paviljoen on TU/e campus (see figure above). In the Pilot Tests, the vehicle will be able to change the route accordingly (still to be implemented).

Table 14: Storyboard of the urban driving use case in Brainport

Action	Description/Illustration
<p>While Bart is walking to the nearest or preferred pick-up point, the IoT platform dispatches a car to that location.</p> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>IoT platform receives reservation request and, if needed, sends car to nearest pick-up location.</li> <li>IoT platform handles identification, payment, etc. (not part of TU/e demonstrator).</li> </ul>	 <p><b>Automated driving functions</b> Slow speed (10 Km/h max) fully-automated driving on pre-defined and 3D mapped tracks on TU/e campus only.</p>

Action	Description/Illustration
<p>In the background, the IoT platform is pro-actively rebalancing cars to meet expected demand</p> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>IoT platform tracks user positions using the App. This is hard limited to 1 Km radius around TU/e campus for privacy.</li> <li>Historic and live tracks and requests are used to rebalance the cars</li> </ul>	 <p><b>Automated driving functions</b> Slow speed (10 Km/h max) fully-automated driving on pre-defined and 3D mapped tracks on TU/e campus only.</p>
<p><b>Research question:</b> Is the tracking and communications of VRUs fast enough so that their locations can be send to automated cars and be used for <b>IoT enhanced HAD</b>.</p> <p><b>Active entities &amp; information exchange</b></p> <ul style="list-style-type: none"> <li>VRUs using apps send their live tracks to vehicles.</li> <li>Preferably, using direct/single-hop IP links that do not require IoT back-office involvement, to reduce latency</li> </ul>	 <p><b>Automated driving functions</b></p> <ul style="list-style-type: none"> <li>Tracks are used to predict VRU positions and to enhance the vehicle's automated driving functionality.</li> <li>Specifically, to <b>prevent VRU accidents</b>.</li> </ul>

### 3.4.5 Car sharing / ride sharing

#### 3.4.5.1 Storyboard definition




In this section, the storyboard for the ridesharing use case is reported. The best-case scenario is to be implemented exactly these steps, possibly with the use of multiple vehicles. The worst-case scenario would be to implement the functionalities as described here, but in a more confined area (e.g., TU Eindhoven campus).


User 1 wants to go from Helmond to TU/e campus and sends a request to be picked up by an AD vehicle the soonest possible. User also states that is open to ridesharing. In the meantime, a second user (user 2) sends a request to be picked up the soonest possible from Nuenen and be delivered to TU/e campus, stating also open to ridesharing. The car sharing service receives the requests, dispatches a car to Helmond and retrieves a car with AVP, while informing both passengers. A car arrives to collect user 1, after authentication. The car begins its journey towards TU/e and connects to real time route information. En route to the pickup point of the second passenger, the vehicle receives a notification about a massive traffic event on the central highway, thus rescheduling its route. The vehicle picks up passenger 2 at a designated parking spot, reschedules its route and informs both passengers about it. Finally, both passengers are dropped off at their destination and the car remains on stand-by mode.

In the following table, the full storyboard is reported.



Table 15: Storyboard of the car sharing use case in Brainport

Action	Description/Illustration
Passenger 1 sends request Passenger 2 sends request	
Car sharing service processes request	
A car arrives Passenger 1 authenticates and enters	

Action	Description/Illustration
A traffic jam alert is published on the IoT platform New route is chosen and passengers are informed	
Pick up of passenger 2 Inform passengers of new route	
Drop-off passengers Stand by	

## Functionality overview (use case)

- Customers will requests pick up and delivery at specified locations for specified time-windows



- The service will need to do know:

### Basics:

- Location
- Origin/destination/time
- Ride alone or share-a-ride
- Rider or driver

### Optional:

- Time-windows specifications
- Vehicle features selection/ capacity (luggage)
- Accessibility



Figure 5 Functionality overview of the car sharing use case in Brainport







### 3.5 Spanish pilot



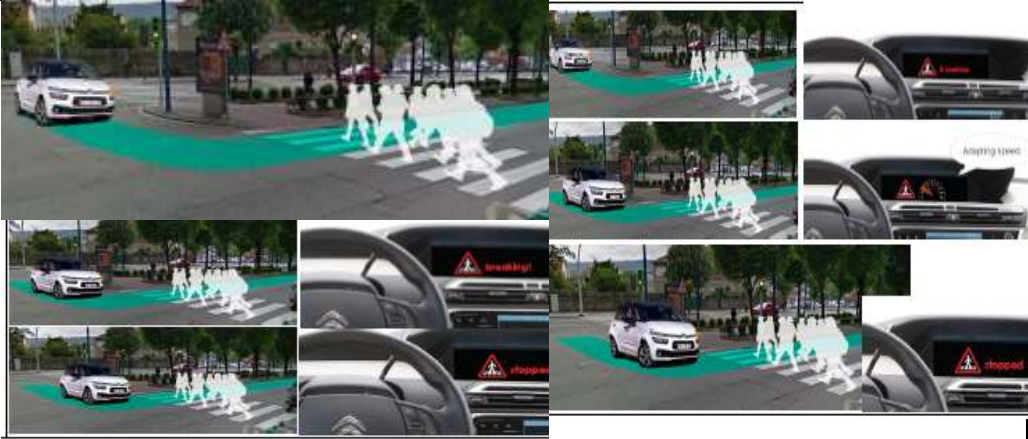
#### 3.5.1 Urban driving




##### 3.5.1.1 Storyboard definition

The framework on which this use case is placed and set up is a scenario where level 3-4 capabilities can be found on market vehicles, and cities are aware of the need of certain infrastructure adaptation, allowing autonomous driving in some of city roads under certain requirements. Different typical situations of urban driving environment are considered and how would be the experience with and without IoT. In this sense, the IoT capabilities would allow passing from level 3 to level 4 in the case of driving through traffic lights and, in the case of approaching to hazards and pedestrians, would improve safety, smoothness of reactions and vehicle behaviour.

**Table 16: Storyboard of the urban driving use case in Vigo**

Action	Description	Illustration
<b>Introduction</b>	John has the chance of driving a PSA autonomous vehicle. During his trip has to drive through the City of Vigo which is one of the first Cities who allow vehicles circulate in autonomous mode under certain conditions in some of its roads, in particular Gran Via.	
<b>Urban Autopilot Activation</b>	John is accessing the section of Gran Via Avenue in Vigo where autonomous driving is allowed. Once within the area he activates AUTOPILOT urban driving function. The vehicle starts driving by itself based on its own sensors.	
	<b>Without IoT</b>	<b>With IoT</b>
<b>Approaching to a traffic light**</b>	<p>Once within Gran Via and with Autopilot activated the vehicle is approaching a traffic light intersection.</p> <p>In order to crossing safely or stop according TL status, the vehicle warns the driver that has to take back the control of the vehicle.</p> <p>John takes the steering wheel and the autopilot is deactivated. If Traffic light shows red light so John stops, otherwise he will continue.</p> <p>John drives manually through the intersection and activates Autopilot after crossing.</p>	<p>Once within Gran Via and with Autopilot activated the vehicle is approaching a traffic light intersection.</p> <p>Status and time to change are known for the vehicle and shown in HMI to the driver. Depending on the remaining time, it is capable of adapt the speed for passing in green (keeping speed value within a gap compatible with safety) or smoothly stop in case of red light.</p> <p>In the second case the vehicle will run again as soon as the traffic light shows green and the current traffic allows it.</p>
		
<b>Approaching to a Hazard (Traffic Jam/acciden</b>	<p>John is circulating through Gran Via within PSA autonomous at maximum allowed speed.</p> <p>The vehicle approaches now a traffic jam/accident where the traffic is stopped. The</p>	<p>John is circulating through Gran Via within PSA autonomous at maximum allowed speed. The vehicle receives a warning of traffic jam/accident ahead and adapt the speed according the remaining distance in</p>

Action	Description	Illustration
t example with traffic stopped)	vehicle brakes and stops as soon as the last vehicle of the queue (or the one having the accident) is detected	order to perform a smooth approach. Finally detects the last vehicle of the queue (or the one in the accident) and stops behind.
		
Driving through intersection s with crossing pedestrians	<p>The vehicle is approaching to a U turn manoeuvre.</p> <p>The intersection has a zebra crossing. The vehicle is performing the turn while pedestrians are crossing.</p> <p>The pedestrians are detected by the vehicle sensors and the vehicle stops until no pedestrian is detected.</p>	<p>The vehicle is approaching to a U turn manoeuvre. The intersection has a zebra crossing. The vehicle is aware of the presence of the pedestrian in the zebra crossing (detected by the camera and available to the vehicle by IoT). The vehicle adapts the speed in advance which allows a smoother approach and stopping until the pedestrians has crossed.</p>
		
Surrounding pedestrian detection	<p>John follows now another vehicle. Although the safety distance is kept the vehicle sensors are in some way limited by the presence of the former vehicle.</p> <p>The former vehicle is approaching to an area with pedestrians in the side walk.</p> <p>One of the pedestrians crosses after the former vehicle and John's vehicle has to hard brake in order to avoid the collision.</p>	<p>John follows now another vehicle. Although the safety distance is kept the vehicle sensors are in some way limited by the presence of the former vehicle. Such vehicle, which is equipped with V2X technology and connected to City IoT platform, detects the surrounding pedestrians and generates a warning. John's vehicle is also connected by IoT and has access to the warning from the former vehicle. John's vehicle reduces the speed. A pedestrian crosses after the former vehicle and John's vehicle brakes avoiding the collision.</p>



Action	Description	Illustration
		
<b>Blind pedestrian detection*</b>	<p>John approaches now an intersection with blind pedestrian in the surrounding. The vehicle receives a warning of blind pedestrian and adapts the speed in order to minimize the risk crossing such traffic light intersection.</p> 	



### 3.5.2 Automated valet parking

#### 3.5.2.1 Storyboard definition


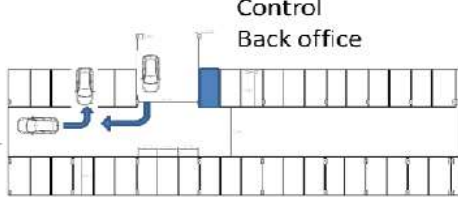
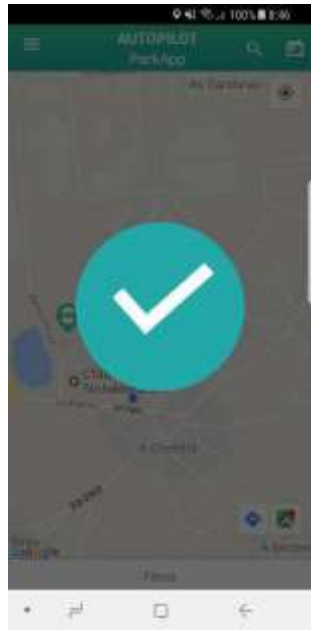



Within this scenario AVP is available at some of the parking areas in the city and a user could take their autonomous vehicle there and benefit from a considerable time saving in the operation of delivering and picking up the vehicle. Also, search for a parking with such facility, check availability of parking spaces, book it and get identified when arriving the parking lot.

Table 17: Storyboard of the AVP use case in Vigo

Action	Description	Illustration
<b>Introduction</b>	John has the chance of driving a PSA autonomous vehicle. During his trip has to drive through the City of Vigo which is one of the first Cities which has available an Automated Valet Parking services deployed in his City Council Parking facilities.	
<b>Localization parking which support AVP and availability of parking spaces</b>	The city of Vigo and private parking companies are using IoT platform to publish in a common format the status of the parking spaces available in the city and information about the characteristics of the parking spaces as location, size, AVP place.	

Action	Description	Illustration
Navigate to drop-off/pick-up area	<p>The city of Vigo and private parking companies are using IoT platform to publish the parking space dedicated to pick-up/drop-off and the location of the closest parking entrance to the space.</p> <p>John can use this information to navigate to the pick-up/drop-off space inside the parking facility.</p> <p>John accesses the public parking of the City of Vigo and leaves the car in the pick-up/drop-off space. John uses his mobile app to connect to the parking infrastructure and complete the vehicle drop off, by activating the Drop-off function.</p> <p>John receives information whether the parking manoeuvre can be started, for example, sending an alert if the door is open.</p> <p>John receives a confirmation when the vehicle starts the parking manoeuvre.</p>	
Automated Valet Parking Drop off	<p>John uses his mobile app to connect to the parking infrastructure and complete the drop-off of the vehicle activating the Drop-off function.</p> <p>John receives information whether the parking manoeuvre can be started, for example, sending an alert if the door is open.</p> <p>John receives a confirmation when the vehicle starts the parking manoeuvre.</p>	
Connection to Parking IoT platform and providing positioning info and parking space available	<p>The vehicle connects to the parking infrastructure to get the map and positioning info together with an assigned parking space.</p>	



Action	Description	Illustration
<b>Autonomous driving until assigned parking space and parking manoeuvre</b>	<p>The vehicle drives until the assigned parking space based on in-vehicle sensors and the information received by IoT: the parking map, parking space position, presence of obstacle, pedestrians or other vehicles detected by parking cameras.</p> <p>The vehicle arrives at the assigned parking space and starts the parking manoeuvre. Once parked the vehicle goes on stand-by mode John receives the information that the vehicle is parked.</p>  	
<b>Vehicle request for pick up</b>	<p>John wants to leave the parking and starts the pick-up request.</p> <p>The mobile app shows that the vehicle starts the pick-up manoeuvres.</p> <p>The user triggers the process through the mobile app.</p>	
<b>Vehicle driving until pick up area.</b>	<p>The vehicle abandons stand-by mode and leaves the parking space based on the info received by IoT: Map and position of pick up area, presence of obstacles or other vehicles detected by parking cameras. The vehicle drives until the assigned pick-up spot based on its in-vehicle sensors and the information received by IoT:</p> <p>The parking map, parking route, parking space position and size, presence of obstacle, pedestrians or other vehicles detected by parking cameras.</p>	
<b>Arriving pick up area and access to the vehicle</b>	<p>The vehicle arrives at the assigned pick-up spot.</p> <p>John receives the information that the vehicle is parked and is safe to enter.</p>	

## 3.6 Korean pilot

### 3.6.1 Urban Driving

#### 3.6.1.1 Storyboard definition

The urban driving use case addresses the provision of an Intersection Safety Information Service that will warn vehicles about pedestrians in order to avoid accidents. The road will be equipped with a radar that will detect pedestrians and transmit information to the vehicle's OBU. The OBU, having received the information from the road radar, generates information, raises awareness and gives a time warning to the driver.

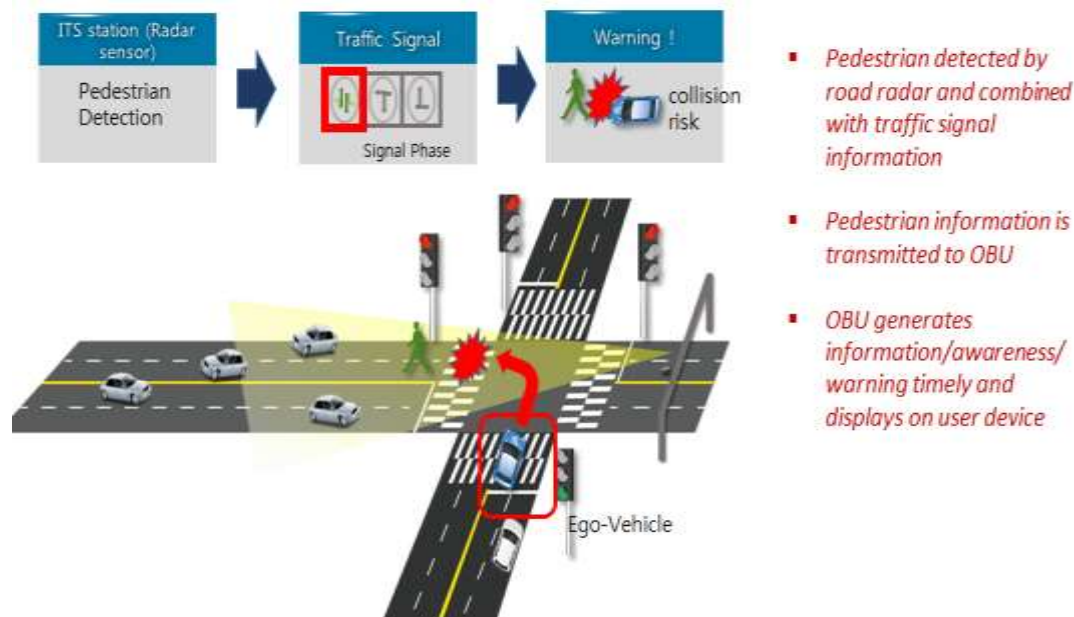


Figure 6 Illustration of the Korean urban driving storyboard

## **4 Final specifications of pilot sites**

### **4.1 Specifications table results**

The table for collecting the pilot sites specifications has been defined at the beginning of the WP3 lifetime. The aim has been to map all relevant specifications to the different pilot sites and their use cases. All pilot sites filled in the table with the information available at that time (summer 2017).

This input has been used as the basis also for the creation of the AUTOPILOT Checklist, which has been created within T3.1 and served as a monitoring tool for the progress of the specifications of the pilot sites as several intervals throughout the pilot preparation period (M9 to M18). More details on the Checklist can be found in D3.1. The data collected through the checklist has been made available to T3.2 and the results of the relevant analysis are reported in D3.3.

In order to have an illustration of the status of specifications of the pilot sites just before the pilot activities are kicked off, all pilot sites have filled in the specifications table again in M17 (May 2018), reporting the current situation. As several of this information is of confidential nature, it has been decided that the contents of the tables will be kept in a confidential annex of D3.2 (see Annex 3).

### **4.2 Problems encountered and mitigation actions**

No major problems were reported in the AUTOPILOT Pilot Sites during the preparation period. Some minor ones, like e.g. the change of location of the test realisation in Tampere, were effectively solved without the need of specific mitigation actions.

Issues that are still pending, like recruitment of participants, ethical approval, specification of data collection items, are not considered as major problems and the Pilot Site leaders are confident that they will be resolved in time not to cause any drawbacks to the overall pilot planning.



## 5 Final pilot plans

### 5.1 Finnish pilot

#### 5.1.1 Automated Valet Parking (AVP)

The AVP pilot will take place in the VTT facilities at Niittyhaankatu, Tampere, Finland under the supervision and responsibility of VTT.

##### 5.1.1.1 Scope

The scope of this use cases addresses Automated Valet Parking with the support of Traffic Cameras. The vision of this use case is for the automated vehicle to automatically book a parking place near the drop-off point, as soon as it receives information about the destination. Moreover, the parking management system determines the path of the vehicle from the drop-off point to the parking spot, based on the current configuration (e.g. objects in the alternative paths). Objects are identified by cameras installed in the parking facility. During unmanned driving, the operator at the parking management system is responsible for the vehicle and continuously monitors it, allowing it to move or stop as appropriate.

##### 5.1.1.2 Storyboard definition

The storyboard is described in section 3.1.1.1.

##### 5.1.1.3 Baseline

The AVP service is enabled through the use of IoT technology. Without external communications, the vehicle drives automatically (in manned mode) to a parking space. The driver selects the parking space and the vehicle calculates and then selects the route to the parking space. After parking is completed, the driver leaves the vehicle. The location accuracy is, when the vehicle only relies on GNSS, not sufficient for parking within the parking space boundaries. The execution of the baseline requires additional work, for which no resources have been allocated.

##### 5.1.1.4 Pilot planning

AVP pilot has two iterations:

- Iteration 1 will be conducted in midsummer and will follow the complete use case, with the participation of one vehicle. A VIP event and a stakeholders' workshop is held. The worst-case scenario of iteration 1 refers to a partial mock-up of the complete use case.
- Iteration 2 will be conducted in autumn and will address user tests that will take place in Niittyhaankatu, with the participation of one vehicle. No VIP events or stakeholder workshops will be held.

##### 5.1.1.5 Technical Evaluation

The technical evaluation addresses Automated Valet Parking.

The precondition requires the driver to have entered his/her destination and the system to have reserved a parking place. A vehicle will be driven to the drop-off point.

The actions/events that take place are the following:

- The traffic camera identifies an object and informs the parking management centre and the vehicle.
- The parking management system selects an object-free route.
- Transmission of object-free route to the vehicle.
- The system drives in unmanned mode to the parking space.

- The vehicle parks in the parking space.

The hypotheses that will be tested in this use case are stated below:

- The ability to detect the environment, through the use of IoT technology, enhances and enables Automated Driving functionalities adding new features.
- The position, localisation and navigation data that is provided by IoT enhances (and in some cases, enables) Automated Driving functionalities, improving overall performance.
- The IoT data increases accuracy by providing complementary data to GNSS positioning and improves navigation by providing more data about the environment, traffic and obstacles.
- IoT improves the performance of the communication in terms of bandwidth, throughput, latency, jitter and error rate compared to different advanced communication

Upon completion of the technical evaluation, it is expected to have achieved improved environmental detection, improved accuracy (through UWB) and to allow remote control of the vehicle.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle log file (DDS)
2. Mobile road side unit log file
3. Parking management log file
4. IoT platform log

#### 5.1.1.6 User acceptance

The test user is passenger and is driven by the vehicle to the drop-off point automatically. The test user observes how the vehicle drives automatically to the designated parking place. The duration of a complete test run is about 10 minutes and the number of tests per day is set to 10 (up to 3 test users in the same vehicle). The characteristics of the user are determined in collaboration with WP4, as they depend on WP4 targets and the recruitment effort. For safety reasons, the test user can only be a passenger, and the driver must be a VTT team driver. The test should be conducted in summer road conditions, with no other traffic and during daytime. The use of IoT is also necessary.

General notes include the following:

- There should be a clear distinction between test runs carried out with and without IoT assistance.
- Test runs should be conducted in a random order with different variables
- The differences in these variables should not be explained to passengers in the pre-trial briefing.
- There should be a description of artificial obstacles and traffic density.
- The different variables of the driving environment should be logged in each test run. It should be possible to link these to individual users. This data should be made available to the interviewer, should there be interviews after the test run.

#### 5.1.1.7 Business impact

The business impact of Automated Valet Parking is discussed in a workshop on 26.4.2018 in Tallinn, organised by UITP and in a workshop on 19.6.2018 in Tampere. During the Tallinn workshop a first version of the value proposition canvas and the business model canvas is drawn and completed in the Tampere workshop.

*Main business opportunities:* valet parking near airports or shopping malls, as well as Park & Ride.

*Main stakeholders:* parking facilities operators, cities (P&R),

*Main costs:* infrastructure costs: traffic cameras, potential indoor location network, IoT platform & services

*Main risk:* access to vehicle for unmanned/remote driving - due to cybersecurity risks, liability during

## unmanned driving

### 5.1.1.8 Quality of life

Test passengers will be involved in both iterations, with 10 participants in iteration 1 and 30-50 participants in iteration 2. Iteration 1 will involve test users that are developers or company employees with AD project experience, while iteration 2 will involve users who are company employees with AD project experience, company employees without AD project experience, general public (specific groups) and general public sample. Recruitment will be achieved through the following means: public web site, through press release (at public event), company internal, social media.

**Table 18: Finnish AVP pilot participants' groups per iteration**

Participant group	Iteration 1	Iteration 2
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	YES	NO
Company employees (involved in AD projects)	YES	YES
Company employees (not involved in AD projects)		YES
General public (specific groups, e.g. family members of employees, students etc.)		YES
General public (generalised sample)		YES
Total	10	30-50

The tests will mostly be carried out in the parking space of VTT and for the largest extent with no other traffic allowed. The following tasks and characteristics have been determined:

**Table 19: Finnish AVP pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Driver is from VTTs Automated Vehicle team, and he is responsible for the vehicle during the test
Is the driver monitored by the system? (e.g. by cameras in car)	no
Are passengers monitored by the system? (e.g. by cameras in car)	no
Is there an HMI / display / app for non-professional passengers? What does it show?	no; there will be a user interface for parking management
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	when driver takes hands off wheel
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	similar
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	no video are planned for all tests since they may contain personal data; video for selected demonstrations may be provided, e.g. taken by drone

Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	"parking manager"
If people outside of vehicles are involved: Are they employees only or can they be general public?	personnel
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	no
<b>for AVP:</b>	
Is the parking operated from inside the vehicle only or also remotely? Is there always someone inside the car during the whole parking procedure?	the supervisor driver is always in the car, also during unmanned operation
What speed range does the AVP support?	0-20 kph (tbc)

### 5.1.2 Urban Driving use case

The test for this use case will take place in Hervanta - Korkeakoulunkatu crossing, under the supervision and responsibility of VTT.

#### 5.1.2.1 Scope

The scope of this use case comprises driving at signalised intersections with the support of traffic cameras. According to the scope's vision, the vehicle, when its own sensor has difficulties or conflicts detecting VRUs, will be warned about VRUs that have right of way from the infrastructure sensors. The vehicle will stop before the pedestrian crossing and wait until the VRU has crossed.

#### 5.1.2.2 Storyboard definition

The storyboard is described in section 3.1.2.1.

#### 5.1.2.3 Baseline

The baseline of this use case refers to the vehicle turning into the crossing with only its sensor support. If the vehicle must give right-of-way, the driver has to take over control and to press the brake pedal. Baseline and treatment can be arranged on the same test route, as there are traffic lights for which no signal state information is available.

#### 5.1.2.4 Pilot planning

The pilot planning has two iterations. Iteration 1 will take place in October 2018, will have no VIP events or stakeholder workshops and will examine the scenario where all components are ready. The tests will take place at VTT facility and one vehicle will take part. Iteration 2 will take place in March/April 2019, without VIP events or stakeholder workshops. The scenarios will be presented and discussed in the Automated Valet Parking event and stakeholder workshop. The scenario examined will be the user testing in Hervanta and 2 vehicles will participate.

#### 5.1.2.5 Technical Evaluation

The technical evaluation addresses Urban Driving. The precondition requires the vehicle to approach the intersection.

The actions/events that take place are the following:

- The vehicle receives a signal state and adapts its speed.
- The IoT device detects a VRU and sends this information to the IoT platform.
- The vehicle waits for the VRU to cross.
- The vehicle starts moving when VRU has crossed (detection with the vehicle's sensors or the traffic camera).

There is no baseline situation in this use case due to the fact that, without IoT, the scenario cannot be realized with the prototype vehicle.

The hypotheses that will be tested in this use case are stated below:

- The IoT will provide safer reactions in the presence of pedestrians and hazards.
- IoT will increase safety by integrating additional / redundant sensor information (environmental data, hazards, decreasing detection and reaction time...).
- IoT improves the performance of the communication in terms of bandwidth, throughput, latency, jitter and error rate compared to different advanced communication.
- IoT will provide a more reliable perception of traffic light status for speed adaptation and higher in vehicle comfort.

Upon completion of the technical evaluation, it is expected to have achieved improved safety for VRUs at intersections.

Throughout the process, a number of log files are generated. More specifically:

- 1 Vehicle log file (DDS)
- 2 Mobile road side unit log file
- 3 IoT platform log
- 4 Questionnaires

#### 5.1.2.6 User acceptance

The user in the use case is the driver/passenger that has no actual, active role, other than being driven through the intersection. At the pedestrian crossing, the vehicle is informed of an upcoming cyclist and the vehicle waits for the cyclist to cross the intersection. The duration of one complete test run is 15 minutes and the number of tests per day is set to 7-8. For safety reasons, the driver will be a VTT driver and the test person is a passenger. The characteristics of the user remain to be determined, as they depend on WP4 targets and recruitment effort. The test should be conducted in summer road conditions, with no other traffic and during daytime. The use of IoT is also necessary.

General notes include the following:

- There should be a clear distinction between test runs carried out with and without IoT assistance.
- Test runs should be conducted in a random order with different variables
- The differences in these variables should not be explained to passengers in the pre-trial briefing.
- There should be a description of artificial obstacles and traffic density.
- The different variables of the driving environment should be logged in each test run. It should be possible to link these to individual users. This data should be made available to the interviewer, should there be interviews after the test run.

#### 5.1.2.7 Business impact

The business impact of Urban Driving was discussed in a workshop on 26.4.2018 in Tallinn, organised by UITP and in a workshop on 19.6.2018 in Tampere. During the Tallinn workshop a first version of the value proposition canvas and the business model canvas is drawn and completed in the Tampere

workshop.

*Major stakeholders:* cities, traffic management,

*Major costs:* traffic cameras and equipment for processing. The system exploits infrastructure put in place by the city which can be used for Traffic management.

*Major risk:* alternative business model in which camera detection directly integrated with traffic light control

#### 5.1.2.8 Quality of life

Test users will participate in iteration 1. There will be a total number of 30-50 participants, from different groups: developers, company employees with AD project experience, company employees without AD project experience, general public/specific groups and general public sample. Recruitment will be achieved through the following means: public web site, through press release (at public event), company internal, social media.

**Table 20: Finnish Urban Driving pilot participants' groups per iteration**

Participant group	Iteration 1
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	<b>NO</b>
Company employees (involved in AD projects)	<b>YES</b>
Company employees (not involved in AD projects)	<b>YES</b>
General public (specific groups, e.g. family members of employees, students, etc.)	<b>YES</b>
General public (generalised sample)	<b>YES</b>
Total	30-50

The tests will be mostly carried out in public urban environment with regular traffic. The following tasks and characteristics have been determined:

**Table 21: Finnish pilot Urban Driving – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	driver is from VTTs Automated Vehicle team, and he is responsible for the vehicle during the test
Is the driver monitored by the system? (e.g. by cameras in car)	no
Are passengers monitored by the system? (e.g. by cameras in car)	no
Is there an HMI / display / app for non-professional passengers? What does it show?	no; on the vehicle HMI will potentially see status of traffic light and detection
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	when driver takes hands off wheel

Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	similar
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	no video are planned for all tests since they may contain personal data; video for selected demonstrations may be provided, e.g. taken by drone
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	VRU
If people outside of vehicles are involved: Are they employees only or can they be general public?	personnel
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	no

## 5.2 French pilot

The French pilot site is located in Versailles city centre. Two car sharing stations will be deployed in Versailles city centre. The aim of the French pilot is to provide high level mobility/transportation services to tourists who visit the city and the castle, using the IoT and progress in automated driving.

The French pilot will also focus on the added value of IoT and automated driving for intelligent fleet management (automated rebalancing fleet).

The map bellow presents the overall localization of the French pilot, located in the city center for Versailles.





**Figure 7 Overview of the French PS in Versailles city centre and the gardens of the Castle**

Overall, three use cases will be tested on the French pilot site:

- Car sharing for touristic applications.
- Urban driving, referring to connected and automated driving in the city centre and the castle's gardens with point of interest notifications (audio/video format) and VRU detection (collaborative perception).
- Platooning for automatic fleet rebalancing.

Responsibility for the French pilot is split between Versailles Grand Parc and VEDECOM who also has the role of technical leader, vehicle provider and cloud services provider in the project. Further to that, the following table depicts the names and roles of the supporting partners.

**Table 22: Partners involved in the French PS and their roles**

Short	Name	Role
AKKA	AKKA Technologies	Platooning and data management
CEA	CEA	In-vehicle connectivity / IoT platform
CONTI	Continental	HMI and smartphone application and cloud services
SEN	Sensinov	IoT platform
CERTH	CERTH	VRU detection with IoT
VGP	Versailles Grand Parc	Logistics, infrastructure adaptations

### 5.2.1 Car sharing and urban driving

#### 5.2.1.1 Scope

The car sharing use case refers to providing tourists with car sharing services for their visit in Versailles and the castle's gardens. The scope of the use case is to perform car sharing for touristic application. Urban driving will be considered only for connected driving (PoI notification). We will consider the added value of IoT for VRU detection in the gardens of the Castle (autonomous driving part of the trip).

#### 5.2.1.2 Storyboard definition

The storyboard is described in section 3.2.1.1.

#### 5.2.1.3 Baseline

The baseline scenarios of this use case are:

- VRU detection without the use of IoT technology, meaning that the only sensors used will be the vehicles' sensors.
- Car sharing without PoI notification.

#### 5.2.1.4 Pilot planning

*Iteration 1* will be held in M19 of the project (July 2018), without the hosting of a VIP event. It will last a week and will include 1 vehicle. As a best case, its target is car sharing, PoI notification, automated driving in the gardens (with VRU detection through IoT). The worst case of iteration 1 is to focus on automated driving in the gardens.

*Iteration 2* might be accompanied by stakeholders' workshops and VIP events. It will be held in M21 of the project (October 2018). It will last one week and will include 1 vehicle. The best case aims to Car Sharing, PoI notification and automated driving in the gardens (full storyboard). The worst case of iteration 2 corresponds to car Sharing, PoI notification and automated driving in the gardens (without VRU detection through IoT).

Finally, *Iteration 3* will be held in M29 of the project (May 2019), might have VIP events and stakeholders' workshops and will have a duration of one week. The best and worst cases of iteration 3 are Car Sharing, PoI notification and automated driving in the gardens (full storyboard). For its best case, 3 vehicles will be used while for its worst case only 2.

A *4th iteration* can be planned in September 2019, if needed, for evaluation purposes. The content will be the same as iteration 3.

#### 5.2.1.5 Technical evaluation

The technical evaluation of this use case focuses on car sharing and urban driving with VRU detection.

The necessary precondition is to have a group of people (pedestrians and cyclists). The following actions/events will take place:

- A pedestrian needs to cross the street in front of a vehicle.
- A bicycle needs to cross the street in front of the vehicle.
- A large group of pedestrians should linger in the middle of the street and near the vehicle.

The relevant situation anticipated is for the vehicle to adapt its behaviour regarding the three situations stated above. The baseline for this use case is the exact same situation without connectivity (only with on-board sensors). One tour of baseline will be performed with each participant.

The hypotheses to be tested are the following:

1. IoT helps the vehicle to detect VRUs.
2. IoT helps the vehicle to anticipate dangerous situations and unexpected events.

Upon completion, the vehicle is expected to brake more smoothly at the crossing and slow down before reaching the group.

#### 5.2.1.6 User acceptance

User 1 in this use case is the “customer/tourist” who uses the car sharing service to tour around the Versailles area. The characteristics of user 1 are the following:

- Age must be over 18 years old
- Male of Female (but no pregnant women)
- Any level of education
- Any level of income
- Have a legacy driving experience of minimum 5 years driving license valid in France/EU
- No Automated driving experience is requested.

User 1 uses the smartphone app to book the vehicle, as explained in the corresponding storyboard. The user will be welcomed by VGP for a short briefing. Then, he/she will perform the complete storyboard with VEDECOM assistance. After the test run, VGP will be in charge of the debriefing and questionnaire. The duration of one complete test run is approximately 60 minutes and the number of complete test runs per day is approximately 4 to 5. For safety reasons, the user cannot be alone in the vehicle without a VEDECOM engineer and is necessary to be fluent in English or French. The driving environment must have dry weather conditions, urban roads with mixed and rather dense traffic and ranging, time-wise, from 9h30 to 16h30. In the first round, there will be no use of IoT while in the second round there will be.

User 2 is the VRU (pedestrian or cyclist) that moves in the castle’s gardens. The characteristics of user 2 are the following:

- Age must be over 18 years old
- Male of Female (but no pregnant women)
- Any level of education
- Any level of income

The role of user 2 is to walk/drive around the lane where the vehicle will be in AD mode. The user will drive on the lane and cross in front of the vehicle. The VRU will be wearing smart devices (smartphones, smart glasses, and smart watches). The duration of one complete test run is approximately 30 minutes and around 5 test runs are estimated to be conducted within one day. For safety reasons, the VRU on the bicycle has to wear a helmet and be fluent in French or English. The weather should be dry. The pilot is going to take place on a road only accessible to VRUs within a time range from 9h30 to 16h30. In the first round, there will be no use of IoT while in the second round there will be.

User 2 will be only people involved in the project for all iteration of 2018. VEDECOM will consider general public as user 2 in 2019.

General notes include the following:

- There should be a clear distinction between test runs carried out with and without IoT assistance.
- Test runs should be conducted in a random order with different variables
- The differences in these variables should not be explained to passengers in the pre-trial briefing.
- There should be a description of artificial obstacles and traffic density.
- The different variables of the driving environment should be logged in each test run. It should be

possible to link these to individual users. This data should be made available to the interviewer to be taken into account in the interviews.

#### 5.2.1.7 Business impact

Offering tourists a broader experience when visiting Versailles: driving through the city centre in a connected vehicle, receiving point of interest notifications and turn on AD mode in the Castle's gardens.

#### 5.2.1.8 Quality of life

Participants (test users) will be involved in all three iterations. Iteration 1 will have approximately 12 participants and iterations 2 and 3 will have approximately 25 participants each.

Relevant participants will be different in each iteration:

- Iteration 1: VEDECOM's employees not involved into the AUTOPILOT project.
- Iteration 2: expert public from VEDECOM and AUTOPILOT network.
- Iteration 3: general public (recruitment method to be confirmed).

**Table 23: French pilot Car Sharing & Urban Driving participants' groups per iteration**

Participant group	Iteration 1	Iteration 2	Iteration 3
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	6		
Company employees (involved in AD projects)	6		
Company employees (not involved in AD projects)		5	5
General public (specific groups, e.g. family members of employees, students etc)		10	10
General public (generalised sample)		10	10

The tests will be carried out in closed track (open to pedestrians and cyclists), in public urban environment (regular traffic) and in public parking ground (regular traffic) for all 3 iterations.

The following tasks and characteristics are set for this use case:

**Table 24: French pilot Car Sharing & Urban Driving – QoL related information**

What are the tasks of the participant? What does he/she do during the test drive?	Book the vehicle via the app, get into the vehicle at the car sharing station, drive the vehicle, listen to the PoIs, switch to AD mode, follow the AD route, switch back to manual driving mode, park the vehicle at the car sharing station
Is the driver monitored by the system? (e.g. by cameras in car)	No
Are passengers monitored by the system? (e.g. by cameras in car)	No (passengers are not in the scope of the French Pilot)
Is there an HMI / display / app for non-professional passengers? What does it show?	Yes / it show the navigation system of the vehicle, PoI notification and automated driving information
Can non-professional participants detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	Yes

Can non-professional participants detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	Yes
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	Yes (embedded camera for ground truth)
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	Yes: Cyclists and pedestrians. Will be only employees during the first iteration, then employees and general public.
If people outside of vehicles are involved: Are they employees only or can they be general public?	See previous line
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	a) yes b) yes

## 5.2.2 Platooning

### 5.2.2.1 Scope

The scope of the use case is to perform platooning for automated fleet rebalancing. The goal is to evaluate the impacts of IoT and automated driving on car sharing business models.

### 5.2.2.2 Storyboard definition

The storyboard is described in section 3.2.2.1.

### 5.2.2.3 Baseline

The baseline in this use case refers to:

- Fleet rebalancing without the use of cloud services
- Platooning without traffic light assist cloud service.

### 5.2.2.4 Pilot planning

The French pilot for the use case of platooning consists of 2 iterations overall.

Iteration 1 will be held in M24 of the project (December 2018), it might be accompanied by a Stakeholder workshop and a VIP event. It will last one week and will include 3 vehicles. Its target is fleet management, platooning and parking manoeuvres (full storyboard). For the worst case of iteration 1, the aim is fleet management and platooning without parking manoeuvres and will include 2 vehicles.

Iteration 2 will be held in M29 of the project (May 2019), might have VIP events and stakeholders and will have a duration of one week. In any case, the full storyboard will be considered with the use of 3 vehicles.

### 5.2.2.5 Technical evaluation

The technical evaluation of this use case focuses on platooning with and without cloud services related to traffic light crossroads.

The necessary precondition is to have all traffic lights crossroads equipped with IoT platforms. We will consider two different kinds of crossroads:



- Simple crossroads: the lead vehicle of the platoon needs to know the time to red in order to adapt its speed to be able to cross safely without breaking the convoy.
- Complex crossroads: the platoon needs to change the traffic lights configuration in order to cross safely.

The relevant situation anticipated is for the platoon to be able to cross safely (and without breaking the convoy) each kind of crossroads. The baseline for this use case is the exact same situation without IoT services (the convoy might not be able to perform the use case). One tour of baseline will be performed with each participant (if relevant).

The hypotheses to be tested are the following:

1. The vehicles successfully follow the lead vehicle.
2. The inter-vehicle distance is respected in order to ensure the security of the platooning.
3. The convoy is able to cross the traffic lights crossroad safely and without breaking the convoy.
4. The convoy is able to cross the traffic lights crossroad safely and without passing a red light.

Upon completion, the vehicle is expected to brake more smoothly at the crossing and slow down before reaching the group.

#### 5.2.2.6 User acceptance

The user is the operator in charge of the fleet management and has the following traits:

- Age must be over 18 years old
- Male or Female
- Has a driving licence for long vehicle's (trucks, buses...) since more than 5 years
- No Automated driving experience is requested.

The user uses the tablet operator app to unplug the vehicles that have to be moved. The user then sits in the lead vehicle and forms the platoon, drives it from one station to another while making sure that every vehicle is parked on the right parking spot. The user plugs in the charging cables once the vehicles are rebalanced (see storyboard for details).

The user will be welcomed by VGP for a short briefing. Then, he/she will perform the complete storyboard with VEDECOM assistance. After the test run, VGP will be in charge of the debriefing and the questionnaire. The duration of one complete test is about 60 minutes and the number of test runs per day is set to approximately 5. For safety reasons, a VEDECOM engineer has to be present in each vehicle of the platoon for each test run (including the lead vehicle). The user cannot be alone without a VEDECOM engineer. The weather should be dry and the test should be conducted in urban roads with mixed to rather dense traffic and a time range from 9h30 to 16h30. One test round should be conducted with IoT applied.

#### 5.2.2.7 Business impact

Rebalancing the fleet of car sharing vehicles in an automated manner by using a platoon of AD vehicles driven by a fleet operator. Information on which vehicles have to be moved to another car sharing stations comes from the intelligent fleet management system.

#### 5.2.2.8 Quality of life

Test passengers can be involved in both iterations of the Platooning use case for Versailles. In both iterations, approximately 25 people will participate. The group remain to be confirmed. To recruit the participants, the existing network of connections will be used.

**Table 25: French platooning pilot participants' groups per iteration**

Participant group	Iteration 1	Iteration 2
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	5	0
Company employees (involved in AD projects)	0	2
Company employees (not involved in AD projects)	0	2
General public (specific groups, e.g. family members of employees, students, etc.)	-	1
General public (generalised sample)	-	-

The tests will be carried out in the public urban environment (in regular traffic conditions) and in public parking ground (in regular traffic conditions), for both iterations. The following table summarises the tasks and characteristics set.

**Table 26: French platooning pilot – QoL related information**

What are the tasks of the participant? What does he/she do during the test drive?	Identify the vehicles that have to be moved to the other station (info coming from FMS), monitor the platoon formation process, driving the lead vehicle of the platoon, bringing the vehicles to the other station.
Is the driver monitored by the system? (e.g. by cameras in car)	No
Are passengers monitored by the system? (e.g. by cameras in car)	No
Is there an HMI / display / app for non-professional drivers/participants? What does it show?	Yes (navigation system and platoon monitoring)
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	Yes
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	Yes
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	Yes, embedded camera for ground truth
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	No
If people outside of vehicles are involved: Are they employees only or can they be general public?	No
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	No
<b>For AVP:</b>	



Is the parking operated from inside the vehicle only or also remotely? Is there always someone inside the car during the whole parking procedure?	
What speed range does the AVP support?	

### 5.3 Italian pilot

#### 5.3.1 Highway pilot

The Italian highway pilot site and its sub use cases will be tested in the Florence-Livorno highway also known as FI-PI-LI. There are two sub-use cases:

- Hazard on the roadway which will be performed around km 69;
- Road Works Warning which will be performed at km 73.

More VMS towards Florence will also be involved.



Figure 8 Area of the highway pilot of the Italian PS

Responsibility for the Italian pilot lies with CNIT who also has the role of Pilot site leader / Road side equipment/ Networking/ Data Management. Further to that, the following table depicts the names and roles of the supporting partners.

Table 27: Partners involved in the Italian highway pilot and their roles

Short	Name	Role
AVR	AVR SPA	Road management/Road side equipment/Vehicle provider (Connected cars)/Data test server/ Data Management
CONTI	CONTINENTAL	Connected-eHorizon application
CRF	CRF	Vehicle provider (AD cars and Connected cars)/HMI/AD function adaptations/ Data Management
ISMB	ISMB	In-vehicle IoT Platform/vehicle

		sensors/Data collection/Smart traffic light/connected bicycle
THA	Thales Italia spa	Security risk assessment
TI	TELECOM ITALIA SPA	Management and adaptation of IoT oneM2M platform / Networking / Data Management

#### 5.3.1.1 Scope

The scope of these tests involves cars with IoT-enhanced AD functions, driving in a "smart" highway. The cars are Jeep Renegades with on-board equipment, the so-called IoT open vehicular platform, enabling IoT-triggered AD functions: speed adaptation, lane change, lane keeping. Some cars have special sensors also, such as the IoT based pothole detector.

The "smart" highway is a freeway where a pervasive IoT ICT system is deployed based on a network of roadside sensors or other sources, capable of collecting information and making it available to cloud-based applications. Connected cars and the traffic control centre have an important role. For safety reasons, connected cars drive in a convoy, following the AD car.

The goal is to show how the combined use of IoT and C-ITS can mitigate the risk of accident for an AD car when hazards occur on the road. Here, we deal with two types of hazards: (1) puddles and (2) road works.



Figure 9 Location of the road hazard puddles on the Italian PS



Figure 10 Location of the roadwork hazard on the Italian PS

#### 5.3.1.2 Storyboard definition

The storyboard definition is described in 3.3.1.1.

#### 5.3.1.3 Baseline

The baseline is highway piloting without IoT and cloud services.

#### 5.3.1.4 Pilot planning

The Highway piloting use cases at Livorno PS will be demonstrated during 2018 by means of four iterations; other iterations will be performed during the 2019, but not yet planned:

*Iteration 1* will take place in M18 of the project (18-22 June 2018), will have a duration of 1 week and will involve 1 AD vehicle (CRF) and 2 connected cars (AVR) in the best-case scenario and 1 connected car (CRF) and 1 connected car (AVR) for the worst scenario. There will be no VIP events or stakeholder workshops for this iteration. The best-case addresses hazard warning for puddle with either 6LoWPAN and NB-IoT. Hazard warning also includes roadworks by TCC. In the worst-case scenario, hazard warning for puddle is still addressed with either 6LoWPAN or NB-IoT.

*Iteration 2* will take place in M19 of the project (16-20 July 2018), will have a duration of 1 week and will involve 1 AD vehicle (CRF) and 3 connected cars (2 AVR and 1 CRF). The best-case scenario addresses hazard warning for puddle with 6LoWPAN and NB-IoT, hazard warning for roadworks by TCC as well as include pothole sensors on connected cars. The worst-case scenario addresses hazard warning for puddle with 6LoWPAN and NB-IoT and hazard warning for roadworks by TCC. In the worst case, 1 AD vehicle (CRF) and 1 connected vehicle (AVR) will participate. There will be no VIP events or stakeholder workshops for this iteration.

*Iteration 3* will take place in M21 of the project (10-14 September 2018) with a duration of 1 week. There will be no VIP events or stakeholder workshops for this iteration. The best case for iteration 3 is hazard warning for puddle with 6LoWPAN and NB-IoT, hazard warning for roadworks by TCC as well as with pothole sensors installed on connected cars. It will involve 1 AD vehicle (CRF) and 3 connected cars (2 AVR and 1 CRF). The worst case addresses the same aspects but only 2 vehicles will participate: 1 AD vehicle (CRF) and 1 connected car (AVR).

*Iteration 4* will take place in M22 of the project (15-19 October 2018), will last for 1 week and will host both, a stakeholder workshop and a VIP event (the 18<sup>th</sup> and the 19<sup>th</sup>). The best case for iteration 4 is hazard warning for puddle with 6LoWPAN and NB-IoT, hazard warning for roadworks by TCC as

well as with pothole sensors installed on connected cars. It will involve 1 AD vehicle (CRF) and 4 connected cars (3 AVR and 1 CRF). The worst-case scenario addresses the same issues as the best-case scenario but with the participation of only 2 vehicles: 1 AD vehicle (CRF) and 1 connected car (AVR).

Finally, *iteration 5* will take place on M24 of the project (10-14 December 2018), will last for 1 week and will host a stakeholder workshop. In this iteration users will also be involved. The best case for iteration 5 is hazard warning for puddle with 6LoWPAN and NB-IoT, hazard warning for roadworks by TCC as well as with pothole sensors installed on connected cars. It will involve 1 AD vehicle (CRF) and 4 connected cars (3 AVR and 1 CRF). The worst case for this scenario would involve its delay for 2019.

#### 5.3.1.5 Technical evaluation

The first use case “**Road Hazard Puddle**” will address the AD service of Dynamic speed adaptation due to a puddle on the road. The technical evaluation concerns the following issues:

- IoT sensors of different kind (WSN and/or NB-IoT) placed along the highway send an alert to the closest RSU and to the oneM2M platform in case of puddles.
- The RSU consumes that information and broadcasts the warning to vehicles by DENM. At this time the information quality is the lowest, as it is not validated by the TCC.
- TCC consumes the info. from the oneM2M platform, validates the alert, forwards the validated DENM message to further away RSUs and updates the OneM2M cloud platform with a temporary update of the speed limit in the interested area;
- AD car is assisted by the C-eHorizon application. It adapts the speed using information obtained from both oneM2M and DENM.

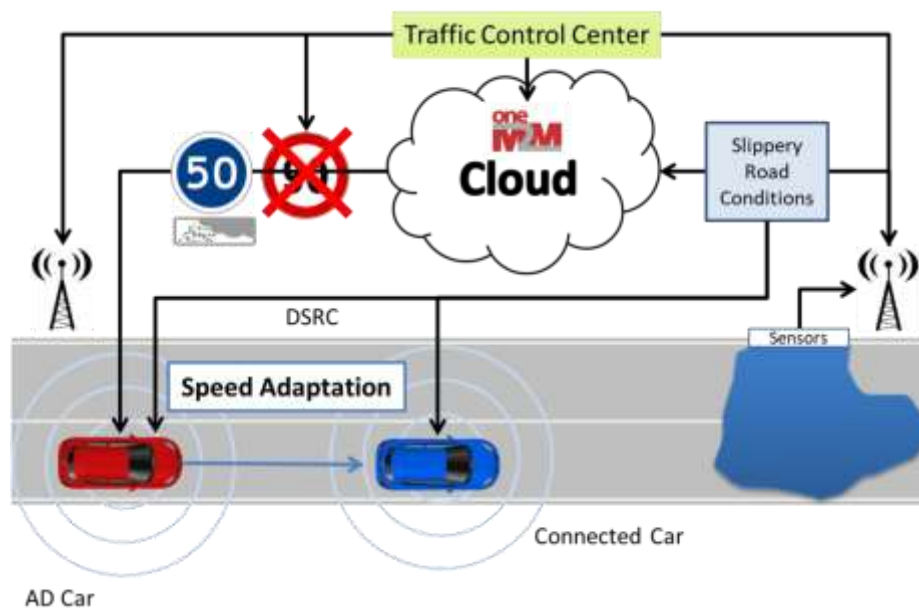


Figure 11 IoT enabled AD speed adaptation when approaching a puddle

A precondition is for the vehicle to drive in the first lane of a "smart highway" at 90 km/h with all the devices working correctly and connected to all services needed.

The subsequent actions/events that take place during the performance of this use case are the following:

- The puddle monitoring system of the highway triggers a puddle hazard warning for a specific extended zone.



- The AD car receives the information by IoT based services and sets a speed limitation according to the area interested by hazard conditions: it smoothly decelerates in order to enter in the area at the proper speed.
- At the end of dangerous area, as notified by the "smart road", the vehicle will recover the legally allowed cruise speed.

The relevant situations that could appear within this scenario of how the AD function interacts with different IoT input are from:

- oneM2M platform (temporary speed limit due to RW);
- I2V (DENM, Roadwork position and extension);
- V2V (CAM with info from other vehicles).

The baseline situation is the following:

- Reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How does IoT add value to positioning, localisation and navigation for AD functions?
- How is data communication enhanced by IoT?
- How are the environment detections enhanced by IoT?
- Can IoT be an enabler for safety applications?
- How can external information provided by IoT enhance the AD car?
- How can IoT weather information improve the behaviour of the AD car?
- How can IoT enhance Highway Pilot?
- Can IoT enhance the functionality of AD?
- Is IoT suitable for AD?
- Can automated vehicles also act as IoT devices (e.g. to Smart Cities' IoT platform)?
- Can IoT extend the horizon of AD (or C-ITS) functions?

Expected results are:

- AD vehicles, supported by IoT, have to dynamically **adapt their speed** to signalized speed limits, to the presence of other vehicles moving in front and temporary road hazard such as **puddles**.
- With the IoT data, the vehicle should improve the accuracy of anticipating the hazard and enable smoother driving experience.
- The effect of different real traffic conditions (DATEX II) and the TCC validation of the alert are considered in the experimentation.
- The OneM2M platform is able to store and share data for running applications (C-eHorizon, TCC monitoring) including data management for evaluation.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle Sensors Data
2. CAN Data Log
3. In-vehicle IoT Platform data
4. GPS Log Data
5. OneM2M IoT platform data & metadata
6. ITS-G5 Data Log
7. V2X Data log
8. DATEX 2 events

For the second sub use case "Roadworks Warning" the technical evaluation addresses the IoT-

enabled **Speed adaptation manoeuvre** as follows:

- TCC publish on the OneM2M platform the information about road works (DATEX 2 DENM).
- The RSUs along the highway consume the information from the oneM2M platform and broadcast the DENM message to the vehicles;
- The information of RWW generates a dynamic reduction of the speed limit transmitted from the FCA Cloud to the Connected e-Horizon (CeH) installed inside the FCA prototypes.
- AD car can instantiate the IoT-enabled **Speed adaptation manoeuvre**.

The main precondition here is for the vehicle to drive in the first lane of a "smart highway" at 90 km/h with all the devices working correctly and connected to all services needed.

The subsequent actions/events that take place during the performance of this use case are the following:

- The TCC publish on the OneM2M platform the information about road works (DENM); the RSUs broadcast the DENM to the vehicles.
- The AD car receives the information by IoT based services and sets a speed limitation according to the RWW DENM: it smoothly decelerates in order to enter in the area at the legal speed.
- At the end of dangerous area, as notified by the "smart road", the vehicle will recover the legally allowed cruise speed.

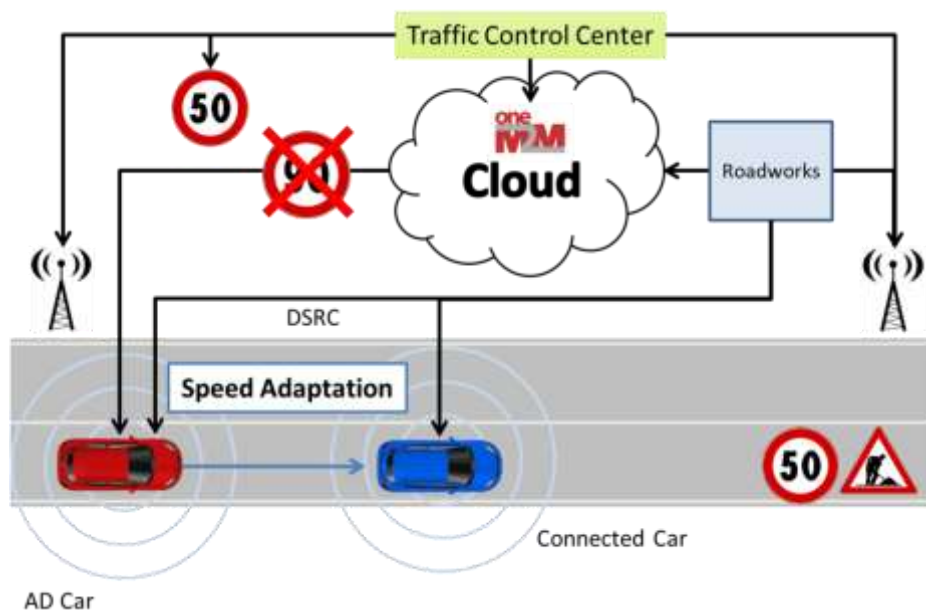


Figure 12 IoT enabled AD speed adaptation when approaching roadworks

The relevant situations that could appear within this scenario of how the AD function interacts with different IoT input are from:

- oneM2M platform (temporary speed limit due to RW);
- I2V (DENM, Roadwork position and extension);
- V2V (CAM with info from other vehicles).

The baseline situation is the following:

- Reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.



The hypotheses that will be tested in this use case are stated below:

- How does IoT add value to positioning, localisation and navigation for AD functions?
- How is data communication enhanced by IoT?
- How are the environment detections enhanced by IoT?
- Can IoT be an enabler for safety applications?
- How can external information provided by IoT enhance the AD car?
- How can IoT weather information improve the behaviour of the AD car?
- How can IoT enhance Highway Pilot?
- Can IoT enhance the functionality of AD?
- Is IoT suitable for AD?
- Can automated vehicles also act as IoT devices (e.g. to Smart Cities' IoT platform)?
- Can IoT extend the horizon of AD (or C-ITS) functions?

Expected results are:

- AD vehicles, supported by IoT, have to dynamically adapt their speed to signalized speed limits, to the presence of other vehicles moving in front and temporary road hazard such as roadworks.
- With the IoT data, the vehicle should improve the accuracy of anticipating the hazard and enable smoother driving experience.
- The effect of different real traffic conditions (DATEX II) and the TCC DATEX to DENM conversion of the warning are considered in the experimentation.
- The OneM2M platform is able to store and share data for running applications (C-eHorizon, TCC DATEX II node) including data management for evaluation.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle Sensors Data
2. CAN Data Log
3. In-vehicle IoT Platform data
4. GPS Log Data
5. OneM2M IoT platform data & metadata
6. ITS-G5 Data Log
7. V2X Data log
8. DATEX 2 events

Finally, a third technical evaluation will take place to examine Highway Pilot / Lane Keeping and Lane Changing approaching Roadworks.

A precondition is for the vehicle to drive in the first lane of a "smart highway" at 90 km/h with all the devices working correctly and connected to all services needed.

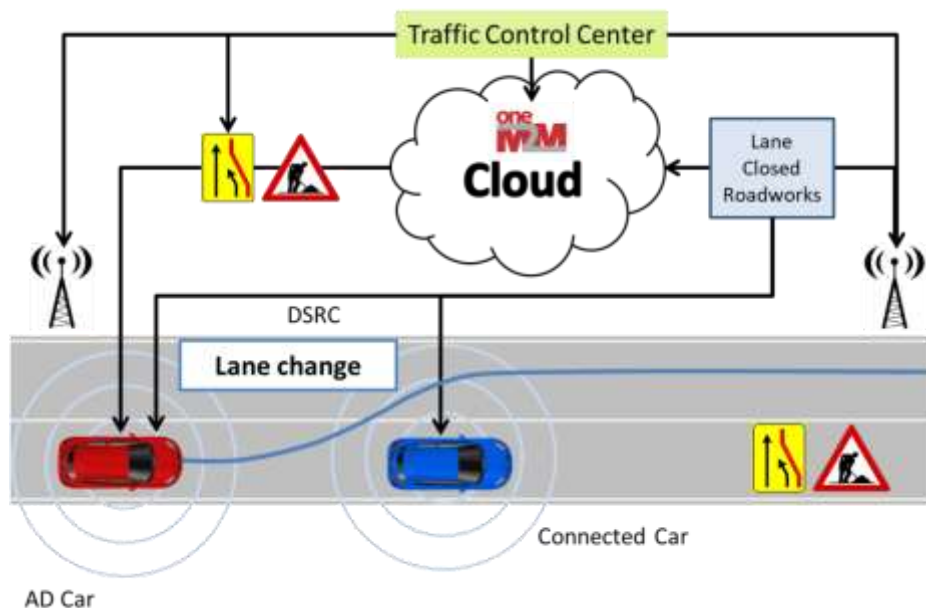


Figure 13 IoT enabled AD lane changing when approaching roadworks

The subsequent actions/events that take place during the performance of this use case are the following:

- The TCC publish on the OneM2M platform the information about road works (DENM); the RSUs broadcast the DENM to the vehicles.
- At a given point in the stretch, the AD vehicle is notified by IoT services of a lane closed due to roadworks.
- The AD vehicle has to check if the rear blind spot is free and it starts the lane change manoeuvre.
- Inside the roadworks area, the AD vehicle moves on the adjacent lane and at the end of roadworks, according with the traffic condition, it performs an autonomous lane change and it comes back to the right lane.

The relevant situations that could appear within this scenario is how the AD function interacts with different IoT input that are from:

- I2V (DENM, Roadwork position and extension);
- V2V (CAM with info from other vehicles).

The baseline situation is the reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How does IoT add value to positioning, localisation and navigation for AD functions?
- How is data communication enhanced by IoT?
- How are the environment detections enhanced by IoT?
- Can IoT be an enabler for safety applications?
- How can external information provided by IoT enhance the AD car?
- How can IoT weather information improve the behaviour of the AD car?
- How can IoT enhance Highway Pilot?
- Can IoT enhance the functionality of AD?
- Is IoT suitable for AD?
- Can automated vehicles also act as IoT devices (e.g. to Smart Cities' IoT platform)?
- Can IoT extend the horizon of AD (or C-ITS) functions?

Expected results are:

- AD vehicles, supported by IoT, have to keep the current lane applying a steering torque, completely excluding the human steering actuation.
- The AD system, thanks to IoT information, must plan and smoothly perform a lane change if it detects an obstacle in front, e.g. a lane closed due to roadworks.
- For safety reasons the vehicle has to check if any other vehicle is coming from the rear blind spot before performing the overtaking manoeuvre and in case of detection of another vehicle it has to inhibit the manoeuvre.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle Sensors Data
2. CAN Data Log
3. In-vehicle IoT Platform data
4. GPS Log Data
5. OneM2M IoT platform data & metadata
6. ITS-G5 Data Log
7. V2X Data log
8. DATEX 2 events

#### 5.3.1.6 User acceptance

The drivers are those who drive the AD vehicles along the test track. For safety reasons, drivers must be CRF project team members. The virtual drivers/passengers are those who are on board the following vehicle and may either drive themselves or be passengers. They will be welcomed for a short briefing and then will be requested to perform the complete storyboard, with the assistance of the CRF team. Users can only experience the use case from the following vehicle. Upon completion of the test, there will be a debriefing and they will be given a questionnaire to fill. The duration of one complete test run is estimated to be about 1 hour with the following structure: 45 minutes in the vehicle, of which 15 minutes watching and syncing with the preceding vehicle runs and 30 minutes of driving, and 15 minutes of debriefing. The maximum number of tests per day is 6 to 8. There are no safety limitations to be applied as users can be regular citizens.

Finally, the operators are those who are in the control centre, monitoring the traffic in the highway and participating in broadcasting RH information. The safety limitation in this case is that the operator must be an AVR professional employee working at Control Centre.

#### 5.3.1.7 Business impact

Business impact will be discussed in workshop and public event the 18th and the 19th of October 2018 and in forthcoming events to be planned yet in 2019.

The identified stakeholders and the respective business cases are:

1. Telecom companies, expected to offer:
  - “data roaming” services for connected and AD cars
2. Road maintenance companies, expected to achieve:
  - improvement in hazard alerting services
  - better tracking of roads degradation
  - better planning of zones and timing for intervention
3. Public administrations (Regions, Cities, Port Authorities), expected to strive for:
  - improved service for citizen
  - simplified road management (less reliance on road signalling)
  - better traffic performance
  - leverage on road construction / maintenance companies

4. Vehicle manufacturers anticipated to work for the provision of:
  - advanced features to propose (ex: active safety option)
  - premium comfort on higher-end models
5. Insurance companies expected to lower insurance fees for a suitably equipped vehicle:
  - insurance fee for mechanical breaks
  - insurance fee on transported merchandise
6. SME, to contribute in:
  - novel IoT sensors and devices
  - added value digital services
  - new telematics systems for AD cars

#### 5.3.1.8 Quality of life

The highway piloting can address a number of aspects related to quality of life. These are categorised into two main groups, as follows:

1. Ecological benefits
2. Driver stress reduction

As far as ecological benefits are concerned, the avoidance of hazards is equal to reduced mechanical wear. This means that fewer new part and components will be needed and vehicles will have an extended lifetime. Further to that, smoother driving contributes towards a more ecological driving for the environment and for fuel consumption. When referring to stress reduction, achieving seamless driving leads to less aggression among drivers, while higher comfort leads to more relaxed trips and higher quality of time within the vehicle. Finally, driver wellbeing is expected to improve and IoT enabled Automated driving is anticipated to contribute towards fewer worries on the road and less vehicle maintenance.

**Table 28: Italian pilot Highway – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	1) driver is from CRF Automated Vehicle team, and she/he is responsible for the vehicle during the test 2) driver is from AVR Connected Vehicle team, and she/he is responsible for the vehicle during the test
Is the driver monitored by the system? (e.g. by cameras in car)	possibly
Are passengers monitored by the system? (e.g. by cameras in car)	possibly
Is there an HMI / display / app for non-professional passengers? What does it show?	no; on the vehicle HMI will potentially display the hazard warnings and advisory speed limit
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	when driver takes hands off wheel
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	when driver takes hands off wheel
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	no video is planned for all tests; video from TCC videowall for selected demonstrations may be provided
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	TCC operators

If people outside of vehicles are involved: Are they employees only or can they be general public?	employees
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	no
<b>for AVP:</b>	
Is the parking operated from inside the vehicle only or also remotely? Is there always someone inside the car during the whole parking procedure?	N/R
What speed range does the AVP support?	N/R

Test passengers will be involved next year (2019) in the iterations yet to be planned.

They will be recruited among the following groups:

- Developers (directly involved in development of the AUTOPILOT vehicles/systems)
- Company employees (involved in AD projects)
- Company employees (not involved in AD projects)
- General public (specific groups, e.g. family members of employees, students, etc.)
- General public (generalised sample)

### 5.3.2 Urban driving

The Italian urban driving and its sub use cases will be tested in Livorno Sea Port landside. The test track is a loop encompassing the public roads for embarkment on ferries. The testbed is equipped with a “Smart Traffic Light” (point A) and two IoT RSU (points B, C).

Responsibility for the Italian pilot lies with CNIT who also has the role of Pilot site leader / Road side equipment/ Networking/ Data Management. Further to that, the following table depicts the names and roles of the supporting partners.

**Table 29: Livorno Urban Driving pilot- involved partners and their roles**

Short	Name	Role
AVR	AVR SPA	Vehicle provider (Connected cars)/Data Test server/ Data Management
CONTI	CONTINENTAL	Connected-eHorizon application
CRF	CRF	Vehicle provider (AD cars and Connected cars)/HMI/AD function adaptations/ Data Management
ISMB	ISMB	In-vehicle IoT Platform/vehicle sensors/Data collection/Smart traffic light/Connected bicycle
THA	Thales Italia spa	Security risk assessment
TI	TELECOM ITALIA SPA	Management and adaptation of IoT oneM2M platform / Networking / Data Management



Figure 14 Area of the urban driving use case of the Italian PS

#### 5.3.2.1 Scope

This use case demonstrates how IoT may impact the safety of VRUs in an urban-like scenario (instantiated at a harbour settlement) with AD cars, connected cars, pedestrians at a traffic light crossing, connected bicycles, and a sea port monitoring centre. IoT can provide redundant information that can be fused with other sensors data in order to produce a robust and reliable description of the surrounding environment.

In some cases, IoT information is not detectable from common sensing devices, e.g. the remaining time before the traffic light phase change and in some other cases IoT can provide information in advance with respect other devices, for preventively acting on the vehicle dynamics, avoiding or mitigating crashes and increasing safety.

#### 5.3.2.2 Storyboard definition

The storyboard definition is described in 3.3.2.1.

#### 5.3.2.3 Baseline

The baseline is urban piloting without IoT and cloud services.

#### 5.3.2.4 Pilot planning

The activities at Livorno PS pilot for the use case Urban Driving will take place in 5 iterations during the 2018, starting from June. Other iterations will be performed in the next year, but yet to be planned.

*Iteration 1* will take place in M18 of the project (18-22 June 2018), will have a duration of 1 week and will involve 1 AD vehicle (CRF) and 2 connected cars (AVR) in best case and worst case. There will be no VIP events or stakeholder workshops for this iteration. The best case addresses urban driving with 1) AD speed adaptation at intersection; 2) with pedestrian traffic light violation; MoniCA port monitoring system display events; In the worst case, there is a delay in July.

*Iteration 2* will take place in M19 of the project (16-20 July 2018), will have a duration of 1 week and



will involve 1 AD vehicle (CRF), 2 connected cars, (2 AVR and 1 CRF) for best and worst cases. There will be no VIP events or stakeholder workshops for this iteration. The best case addresses urban driving with: 1) AD speed adaptation at intersection; 2) with pedestrian traffic light violation; MoniCA port monitoring system display events; pothole sensors on connected cars. The worst-case scenario deals with urban driving with 1) AD speed adaptation at intersection; 2) with pedestrian traffic light violation; MoniCA port monitoring system display events.

*Iteration 3* will take place in M21 of the project (10-14 September 2018) with a duration of 1 week. The best case for iteration 3 is urban driving with: 1) AD speed adaptation at intersection; 2) with pedestrian traffic light violation (Smart Traffic Light by ISMB); 3) AD speed adaptation with fallen bicyclist; MoniCA port monitoring system display events; pothole sensors on connected cars and 1 AD vehicle (CRF), 2 Connected Cars (AVR) and a connected bicycle (ISMB). The worst-case scenario deals with urban driving with 1) AD speed adaptation at intersection; 2) with pedestrian traffic light violation (Smart Traffic Light by ISMB); MoniCA port monitoring system display events and 1 AD vehicle (CRF) and 1 Connected Car (AVR).

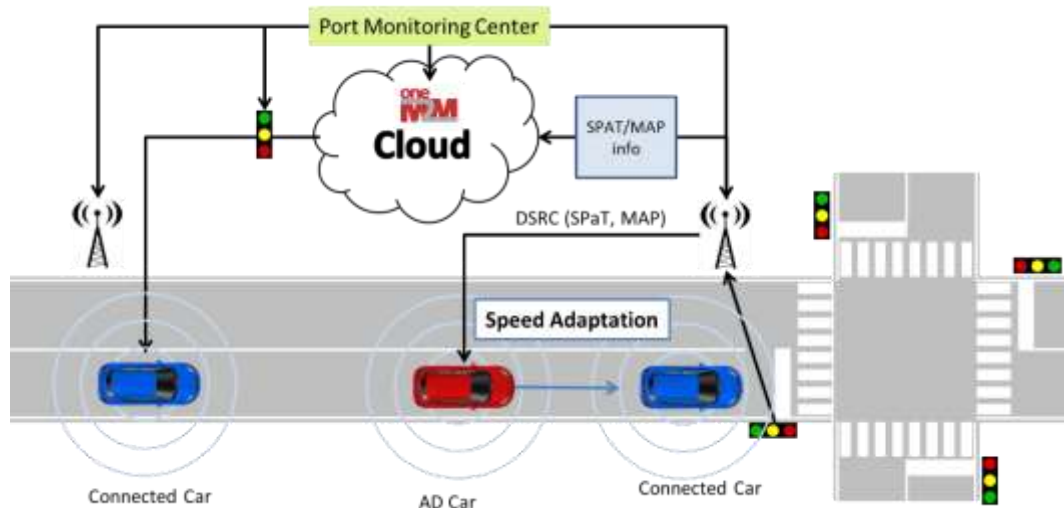
*Iteration 4* will take place in M22 of the project (15-19 October 2018), will last for 1 week and will host a stakeholder workshop and VIP event. The best case for iteration 4 is urban driving with: 1) AD speed adaptation at intersection; 2) with pedestrian traffic light violation (Smart Traffic Light by ISMB); 3) AD speed adaptation with fallen bicyclist; MoniCA port monitoring system display events; pothole sensors on connected cars and it will involve 1 AD vehicle (CRF), 2 Connected Cars and a connected bicycle (ISMB). The worst-case scenario for this iteration is highway driving with hazard warning, puddle with either 6LoWPAN or NB-IoT; hazard warning, roadworks by TCC; pothole sensors on connected cars and 1 AD vehicle (CRF) and 1 Connected Car (AVR). The worst case is the delay in 2019.

Finally, *iteration 5* will take place in M24 of the project (10-14 December 2018), will last for 1 week and will host a stakeholder workshop and no VIP event. The best case for iteration 5 is urban driving with: 1) AD speed adaptation at intersection; 2) with pedestrian traffic light violation (Smart Traffic Light by ISMB and ITRI); 3) AD speed adaptation with fallen bicyclist; MoniCA port monitoring system display events; pothole sensors on connected cars and it will involve 1 AD vehicle (CRF), 2 Connected Cars (AVR) and a connected bicycle (ISMB). The worst case for this scenario is to be delayed for 2019.

#### 5.3.2.5 Technical evaluation

The first technical evaluation addresses the following points:

- A "smart" traffic light sends SPaT and MAP messages describing the topology, actual status of the traffic light to other connected vehicles and to the oneM2M platform on the cloud.
- An AD vehicle consumes the information and autonomously adapts its speed in order to cross the intersection without violating the traffic light phases, considering also other vehicles moving ahead



**Figure 15 Scenario for the 1<sup>st</sup> technical evaluation of the urban driving use case in Livorno (smart traffic light)**

The case examined here refers to Urban Driving / Speed adaptation approaching an intersection regulated by traffic light. A precondition is for the vehicle to approach an intersection regulated by a "smart" traffic light that sends SPAT, MAP messages.

The actions that take place are the following:

1. The AD car receives the information of phase, timing and topology of the intersection by DSRC or by cloud.
2. The AD vehicle automatically adapts its speed in order to cross the intersection when the traffic light is green, depending also on the traffic status (presence of other vehicles moving in front).
3. If it is not possible to cross with green, the AD vehicle will smoothly reduce its speed until it will stop at the stop line sign.

The relevant situations that could appear within this scenario of how the AD function interacts with different IoT input are from:

- oneM2M platform (traffic lights phases and timing, road description and topology)
- oneM2M platform (traffic lights phases and timing, road description and topology, crowd at cross road);
- I2V (SPaT, MAP provide traffic lights phases and timing, road description and topology);
- I2V (SPaT, MAP, DENM provide traffic lights phases and timing, road description and topology, jaywalking occurrence);
- V2V (CAM provides info from other vehicles).
- In-vehicle sensors and published to the cloud improves the driving style of the AD car approaching to road defects.

The baseline situation is the following:

- Reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How is data communication enhanced by IoT?
- How are the environment detections enhanced by IoT?
- Can IoT be an enabler for safety applications?
- How can VRUs be detected by IoT?
- How can external information provided by IoT enhance the AD car?

- How can IoT enhance Urban Driving?
- Can IoT enhance the functionality of AD?
- Is IoT suitable for AD?
- Can automated vehicles also act as IoT devices (e.g. to Smart Cities' IoT platform)?
- Can IoT extend the horizon of AD (or C-ITS) functions?

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle Sensors Data
2. CAN Data Log
3. In-vehicle IoT Platform data
4. GPS Log Data
5. OneM2M IoT platform data & metadata
6. ITS-G5 Data Log
7. V2X Data log

Expected results are:

- AD vehicle has to approach an intersection adapting its speed to the traffic condition and to the traffic light phase.
- IoT information on the traffic light phase and remaining time can be used from AD vehicles to adapt their speed in order to cross the intersection with the traffic light green or if not possible to safety stop at the traffic light or queue behind other vehicles.

The **second** technical evaluation addresses the following points:

- A "smart" traffic light (with camera or LIDAR) sends SPaT and MAP messages describing the topology, actual status of the traffic light, presence of pedestrian, and jaywalking occurrence to other connected vehicles and to the oneM2M platform on the cloud.
- An AD vehicle consumes the information and autonomously adapts its speed in order to cross the intersection without violating the traffic light phases, or even stop to avoid collision with pedestrian. The influence of other vehicles moving in front is considered too.

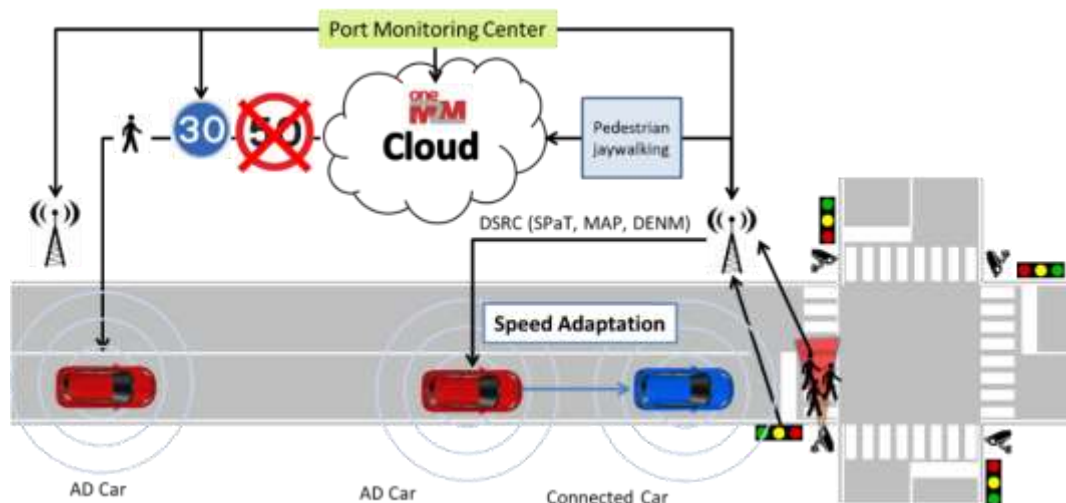


Figure 16 Scenario for the 2<sup>nd</sup> technical evaluation of the urban driving use case in Livorno (smart traffic light + pedestrian)

The case examined here refers to Urban Driving / Speed adaptation with pedestrians' traffic light violation. A precondition is for the AD vehicle to approach an intersection regulated by a "smart" traffic light that sends SPAT, MAP messages, pedestrian presence and jaywalking.

The actions that take place are the following:

1. The AD car receives the information of phase, timing and topology of the intersection by DSRC or by cloud.
2. The AD vehicle automatically adapts its speed in order to cross the intersection when the traffic light is green, depending also on the traffic status (presence of other vehicles moving in front and/or crowd at cross road).
3. If AD car receives a jaywalking alert, it smoothly reduces its speed and stops at traffic avoiding collision with pedestrians.

The relevant situations that could appear within this scenario of how the AD function interacts with different IoT input are from:

- oneM2M platform (traffic lights phases and timing, road description and topology, crowd at cross road);
- I2V (SPaT, MAP, DENM provide traffic lights phases and timing, road description and topology, jaywalking occurrence);
- V2V (CAM provides info from other vehicles).

The baseline situation is the following:

- Reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How is data communication enhanced by IoT?
- How are the environment detections enhanced by IoT?
- Can IoT be an enabler for safety applications?
- How can VRUs be detected by IoT?
- How can external information provided by IoT enhance the AD car?
- How can IoT enhance Urban Driving?
- Can IoT enhance the functionality of AD?
- Is IoT suitable for AD?
- Can automated vehicles also act as IoT devices (e.g. to Smart Cities' IoT platform)?
- Can IoT extend the horizon of AD (or C-ITS) functions?

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle Sensors Data
2. CAN Data Log
3. In-vehicle IoT Platform data
4. GPS Log Data
5. OneM2M IoT platform data & metadata
6. ITS-G5 Data Log
7. V2X Data log

Expected results are:

- AD vehicle has to approach an intersection adapting its speed to the traffic condition (including crowd at cross road) and to the traffic light phase.
- Smart camera on test site provides information on jaywalking occurrence.
- AD cars use this information to decelerate and to stop at the traffic light even if the traffic light in its side is green.

The **third** technical evaluation addresses the following points:

- A bicyclist falls in a "smart" urban environment.
- The hazard warning is broadcasted to the vehicles by IoT based services.

- AD cars, approaching the accident area have to reduce their speed and to stop.

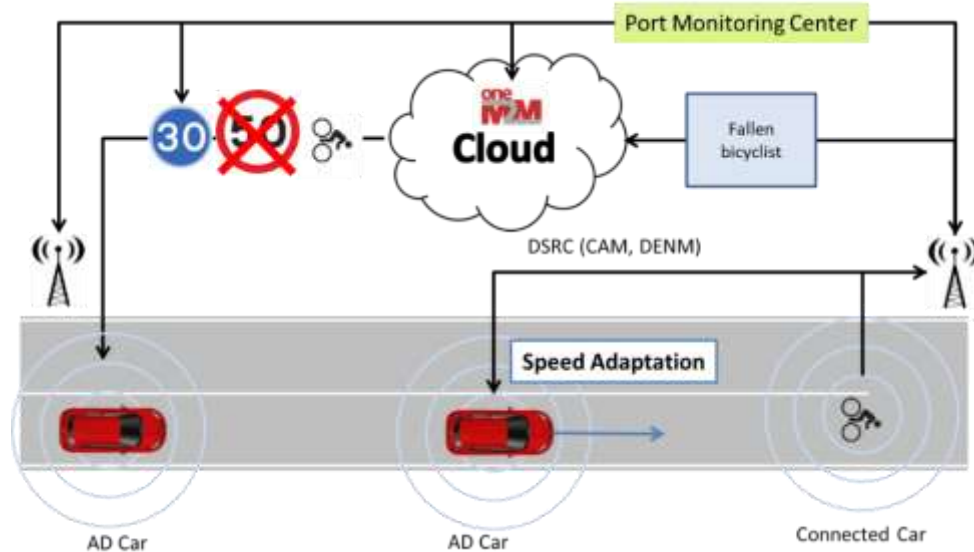


Figure 17 Scenario for the 3<sup>rd</sup> technical evaluation of the urban driving use case in Livorno (cyclist)

The case examined here refers to Urban Driving / Speed adaptation with a fallen bicyclist. A precondition is for the AD vehicle to approach an intersection regulated by a "smart" traffic light that sends SPAT, MAP messages.

The actions that take place are the following:

1. The AD car receives the information of phase, timing and topology of the intersection by DSRC or by cloud.
2. The AD vehicle automatically adapts its speed in order to cross the intersection when the traffic light is green, depending also on the traffic status (presence of other vehicles moving in front).
3. If it is not possible to cross with green, the AD vehicle will smoothly reduce its speed until it will stop at the stop line sign.

The relevant situations that could appear within this scenario of how the AD function interacts with different IoT input are from:

- oneM2M platform (traffic lights phases and timing, road description and topology, crowd at cross road);
- I2V (SPaT, MAP, DENM provide traffic lights phases and timing, road description and topology, jaywalking occurrence);
- V2V (CAM provides info from other vehicles).

The baseline situation is the following:

- Reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How is data communication enhanced by IoT?
- How are the environment detections enhanced by IoT?
- Can IoT be an enabler for safety applications?
- How can VRUs be detected by IoT?
- How can external information provided by IoT enhance the AD car?
- How can IoT enhance Urban Driving

- Can IoT enhance the functionality of AD?
- Is IoT suitable for AD?
- Can automated vehicles also act as IoT devices (e.g. to Smart Cities' IoT platform)?
- Can IoT extend the horizon of AD (or C-ITS) functions?

Expected results are:

- AD vehicle has to approach an intersection adapting its speed to the traffic condition and to the traffic light phase.
- A bicyclist falls down and a hazard warning is generated and broadcasted by IoT based services.
- The AD vehicle receives a DENM notification and controls its speed in order to stop before crash with the fallen bicyclist.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle Sensors Data
2. CAN Data Log
3. In-vehicle IoT Platform data
4. GPS Log Data
5. OneM2M IoT platform data & metadata
6. ITS-G5 Data Log
7. V2X Data log

The **fourth** technical evaluation addresses the following points:

- The cars detect a pothole using the combination of one or more of the following sensors: smartphone, 6LoWPAN vibration sensor, IMU.
- The information is sent to the cloud and can be sent back to other connected vehicles for warning.
- The information is also transmitted via V2V to AD cars that can automatically adapt the speed.

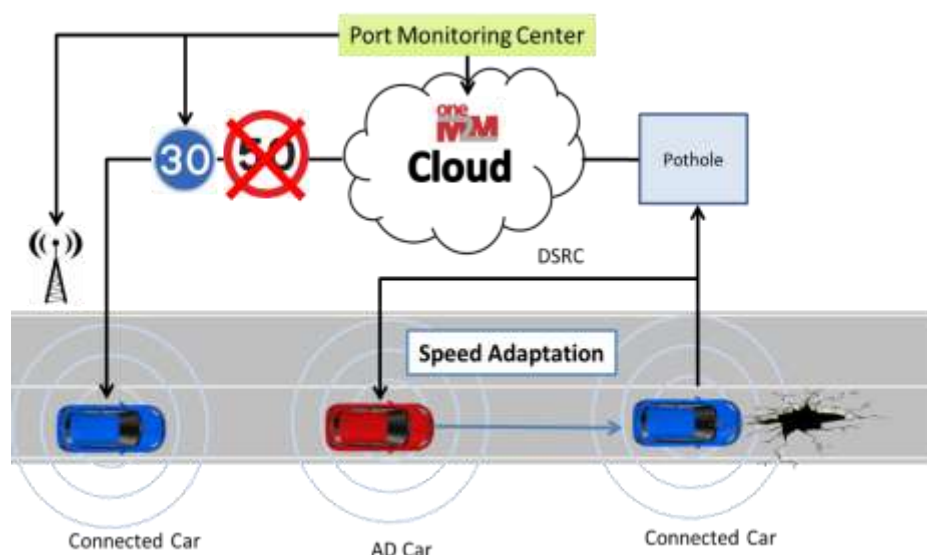


Figure 18 Scenario for the 4<sup>th</sup> technical evaluation of the urban driving use case in Livorno (pothole)

The evaluation addresses the case of urban driving with speed adaptation when potholes are detected. A precondition is for the connected vehicles and AD cars to drive in the test track with all the devices working correctly and connected to all services needed.



The actions that take place are the following:

1. The sensors of the vehicle detect a pothole, the information is published to the oneM2M platform and sent to other vehicles via V2V.
2. The vehicle adapts its speed to avoid the hazard in way as much comfortable as possible
3. The vehicle avoids the hazard and continues the route.

The relevant situations that could appear within this scenario is how IoT data generated by in-vehicle sensors and published to the cloud improves the driving style of the AD car approaching to road defects.

The baseline situation is the following:

- Reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How is data communication enhanced by IoT?
- How are the environment detections enhanced by IoT?
- Can IoT be an enabler for safety applications?
- How can VRUs be detected by IoT?
- How can external information provided by IoT enhance the AD car?
- How can IoT enhance Urban Driving
- Can IoT enhance the functionality of AD?
- Is IoT suitable for AD?
- Can automated vehicles also act as IoT devices (e.g. to Smart Cities' IoT platform)?
- Can IoT extend the horizon of AD (or C-ITS) functions?

Expected results are:

- The vehicle should reduce its speed and avoid the road hazard.
- With the IoT data, the vehicle should improve the accuracy of anticipating the hazard and enable smoother driving experience.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle Sensors Data
2. CAN Data Log
3. In-vehicle IoT Platform data
4. GPS Log Data
5. OneM2M IoT platform data & metadata
6. ITS-G5 Data Log
7. V2X Data log

#### 5.3.2.6 User acceptance

The drivers are those who drive the AD vehicles along the test track. For safety reasons, drivers must be CRF project team members.

User 1 is the virtual driver/passenger who is on board the connected vehicle and may either drive himself or be a passenger. They will be welcomed for a short briefing and then will be requested to perform the complete storyboard, with the assistance of the CRF team.

User 1 can only experience the use case from the vehicle following the AD car. Upon completion of the test, there will be a debriefing and they will be given a questionnaire to fill. The duration of one complete test run is estimated to be about 1 hour with the following structure: 45 minutes in the vehicle, of which 15 minutes watching and syncing with the preceding vehicle runs and 30 minutes

of driving, and 15 minutes of debriefing. The maximum number of tests per day are 6 to 8. There are no safety limitations to be applied as users can be regular citizens.

User 2 is the pedestrian that moves in the harbour test track. The characteristics of user 2 are the following:

- Age must be over 18 years old
- Male or Female (but no pregnant women)
- Any level of education
- Any level of income

The role of user 2 is to walk across the crossroad with the “smart” traffic light when the vehicle is approaching in AD mode. The duration of one complete test run is approximately 30 minutes and around 5 test runs are estimated to be conducted within one day.

User 3 is a cyclist driving in the harbour test track, with the same characteristic than User 2.

The user will simulate a falling in front of the vehicle. The bicycle is equipped with a smart device (IoT OBU).

For safety reasons, the VRU on the bicycle has to wear a helmet and be fluent in Italian/English. The weather should be dry and have a side lane accessible only to VRUs, normal traffic conditions and a time range from 9h30 to 16h30. In the first round, there will be no use of IoT while in the second round IoT will be used.

General notes include the following:

- There should be a clear distinction between test runs carried out with and without IoT assistance.
- Test runs should be conducted in a random order with different variables
- The differences in these variables should not be explained to passengers in the pre-trial briefing.
- There should be a description of artificial obstacles and traffic density.
- The different variables of the driving environment should be logged in each test run. It should be possible to link these to individual users. This data should be made available to the interviewer, should there be interviews after the test run.

#### 5.3.2.7 Business impact

The business impact will be evaluated according to 5.3.1.7

#### 5.3.2.8 Quality of life

Test users for quality of life evaluation will participate in the iterations to yet to be planned in the next year (2019). The total number of participant should be statistically meaningful and will be decided according to the outcome of WP4. Many different groups will be encompassed: developers (directly involved in development of the AUTOPILOT vehicles/systems), company employees with AD project experience, company employees without AD project experience, general public/specific groups and general public sample. Recruitment will be achieved through the following means: public web site, through press release (at public event), company internal, social media. The tests will be carried out in public urban environment with regular traffic. The following tasks and characteristics have been determined:

**Table 30: Italian urban driving pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	1) driver is from CRF Automated Vehicle team, and she/he is responsible for the vehicle during the test 2) driver is from AVR Connected Vehicle team, and she/he is responsible for the vehicle during the test
Is the driver monitored by the system? (e.g. by cameras in car)	possibly
Are passengers monitored by the system? (e.g. by cameras in car)	possibly
Is there an HMI / display / app for non-professional passengers? What does it show?	no; on the vehicle HMI will potentially see status of traffic light, VRU detection, advisory speed limit
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	when driver takes hands off wheel
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	when driver takes hands off wheel
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	no video is planned for all tests since they may contain personal data; video for selected demonstrations may be provided
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	VRU
If people outside of vehicles are involved: Are they employees only or can they be general public?	personnel
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	no

## 5.4 Dutch pilot

The Dutch pilot is taking place in Brainport Automotive Campus and in TUE campus. It addresses all five AUTOPILOT Use Cases, namely:

- Platooning
- Automated Valet Parking
- Highway pilot
- Urban Driving
- Car sharing/ride sharing

The partners involved in the Dutch pilot and their roles are presented in the following table:

**Table 31: Partners involved in the Dutch pilot and their roles**

Short	Name	Role
<b>DLR</b>	DLR	Use case leader Automated Valet Parking (UC-AVP)
<b>GTO</b>	Gemalto	Driver authentication for various use cases
<b>HELM</b>	Gemeente Helmond	Host of UC-AVP, adaptations of AVP test site
<b>HUA</b>	Huawei	IoT platform for car sharing and car relocation
<b>IBMIE</b>	IBM Ireland	IoT platform for car sharing, use case leader car sharing
<b>IBMRE</b>	IBM research	Use case contributor car sharing (dash cam)
<b>NEC</b>	NEC Europe	IoT platform AVP and Platooning use cases
<b>NEVS</b>	NEV Sweden	Vehicle provider and vehicle system integrator
<b>NXP</b>	NXP semiconductors	Hybrid V2x communication technology for platooning
<b>SEN</b>	SENSINOV	OneM2M platform support
<b>TASS</b>	TASS	Test site services, enhanced GPS localisation, back office for AVP and Platooning
<b>TECHN</b>	Technolution	Vehicle Communication platform for cooperative applications [V2x, V2i, traffic centre (cellular/DSRC)] and speed advice
<b>TNO</b>	TNO	Pilot site leader, use case leader platooning, support UC-AVP, vehicle system integrator
<b>TT</b>	TomTom	HD maps and advance localisation support, vehicle integrator
<b>TUE</b>	Techn. Univ. Eindhoven	Use case leader Relocation
<b>VCDA</b>	Valeo	Use case leader Highway Pilot, vehicle system integrator
<b>VICOM</b>	VICOMTECH	On-vehicle camera technology

#### 5.4.1 Platooning

##### 5.4.1.1 Scope

The use case of Platooning in Brainport consists of two phases: the platoon formation phase and the platooning phase. In the first phase, platoon planning is enabled through the interaction of platooning service with car sharing service (i.e. ride sharing with own vehicles in a platoon) and the platoon forming process is enhanced using a Platooning service. In the second phase, the platooning performance is enhanced using a platooning service and the development of safe and efficient highly automated platooning is accelerated via the following:

- interaction with road authority by IoT: lane and speed limit and electronic lane allocation service;
- IoT based information exploitation by platooning service
- redundant information exchange:
  - V2V communication (802.11 OCB/ITS-G5 and UWB) and the V2I technologies LTE and pre-5G, the latter including support for Mobile Edge Computing;
  - localisation (RTK GPS service, HD map service).

As a result of the above, new services (Platooning service, CarSharing service) that enable and enhance platooning are formed, and for which customers are willing to pay. Moreover, the “digital” road authority that is established through IoT can significantly contribute to cost savings as opposed to the traditional placement of dynamic road signs.

##### 5.4.1.2 Storyboard definition

The storyboard is described in section 3.4.1.1.

#### 5.4.1.3 Baseline

The baseline against which the scenario will be compared consists of two parts – platoon forming and platooning without the use of IoT.

Platoon forming without IoT is tested while driving and at standstill. When driving, the driver of vehicle 1 uses ITS-G5 manoeuvring to close the gap with vehicle 2, manually positions vehicle 1 behind vehicle 2 and initiates platooning via an appropriate HMI. When at standstill, vehicle 2 is required to locate vehicle 1 at the Automotive campus and proceed to vehicle coupling through ITS-G5.

The second part refers to platooning without IoT support, meaning that the vehicle cannot access services nor use information regarding traffic lights, traffic state, dynamic speed limits, lane allocation, redundant communication and redundant information on localisation.

#### 5.4.1.4 Pilot planning

The Dutch pilot for the use case of platooning consists of 4 iterations in total.

*Iteration 1* will be held in M21 of the project (September 2018), without the hosting of a VIP event. It will last a week and will include 2 vehicles for its best case and 2 for its worst. As a best case, its target is to conduct separately controlled tests for the platoon formation and the platooning phases. The worst case for iteration 1 would be the absence of any IoT information about legacy traffic on/off ramp and bus lane.

*Iteration 2* will be accompanied by a local event with workshops and interviews and will be held in M24 of the project (December 2018). It will last one week and will include 2 vehicles for its best case and 2 for its worst. The best case aims to integrate platooning with car sharing while the worst case refers to no integration with car sharing.

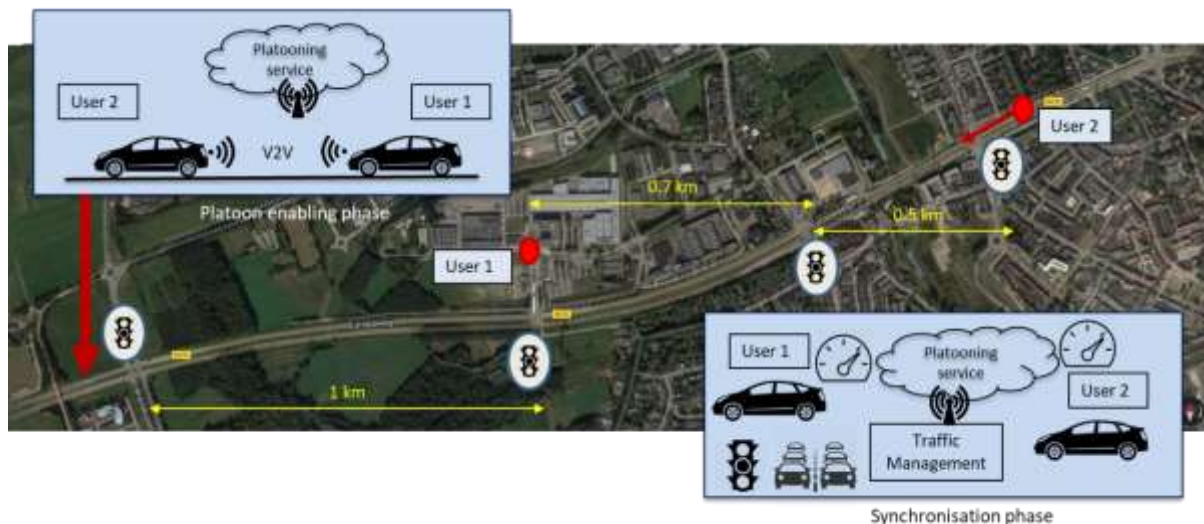
*Iteration 3* will be held in M27 of the project (March 2019), will not have any VIP events and will have a duration of one week. The best case of iteration 3 aims for the integration of platooning with Car Sharing and with Automated Valet Parking whereas the worst case corresponds to different vehicles requiring different Automated Valet Parking and Platooning services, thus not achieving integration. For its best case, 3 vehicles will be used while for its worst case only 2.

Finally, *iteration 4* will be co-hosted with local events with workshops, interviews and demonstrations, taking place in M30 of the project (May/June 2019). The duration of iteration 4 will be 2 weeks. For the best case, where 3 vehicles will be used, the final pilot will be presented in the first week and the demonstrations will take place at ITS Europe. For the worst case of iteration 4, where 2 vehicles will be used, different vehicles will require different AVP and Platooning services.

Possible restrictions on automated steering and/or emergency lane usage in mixed traffic may apply for safety reasons.

#### 5.4.1.5 Technical evaluation

The technical evaluation that takes place in each pilot and use case aims to clarify and showcase the added value of IoT in automated driving. Two technical evaluations for platooning are conducted in Brainport.



**Figure 19 Scenario for the 1<sup>st</sup> technical evaluation of the platooning use case in Brainport (platoon formation)**

The first technical evaluation for platooning addresses the platoon formation phase, which incorporates the platooning and car sharing services. The precondition for the technical evaluation is for User 2 to drive in Helmond towards Eindhoven while User 1 is at a standstill at the Automotive campus. Both users plan to drive to Eindhoven and want to be matched as platooning partners, where User 2 will be the leader and User 1 the follower.

The following actions/events need to happen:

- The vehicles must first submit a request for platoon matching to the platooning service.
- The vehicles must exchange state information with the platooning service and receive speed advice.
- The vehicles receive speed advice from the platooning service.
- The vehicles follow the speed advice they received from the platooning service.
- Vehicle 2 is in front of vehicle 1 and both vehicles are now in V2V distance for platooning.

Platooning must be successful in all cases presented below:

- Platoon formation at standstill
- Platoon formation between traffic lights
- Platoon formation at stopping at traffic light
- Platoon formation on highway

The relevant situations that could appear in terms of interaction with traffic lights, different traffic congestion, car/ride sharing services and traffic management are the following:

- With traffic light state information
- Different traffic states (low traffic density/volume and congestion traffic)
- Dynamic speed limit
- Ride-sharing service coupling

The baseline situations are two:

- While driving, the driver of vehicle 1 uses ITS-G5 manoeuvring to close the gap with vehicle 2, manually positions vehicle 1 behind vehicle 2 and initiates platooning via an appropriate HMI.
- When at standstill, vehicle 2 is required to locate vehicle 1 at the Automotive campus and proceed to vehicle coupling through ITS-G5.

The hypotheses that will be tested in this use case are stated below:



1. The IoT will extend the distance at which platooning between the two vehicles is initiated
2. The IoT will facilitate the detection of other vehicles as members for platooning
3. The IoT will allow a better anticipation on legacy traffic, traffic lights etc.
4. The IoT will enable the integration of platooning in a mobility service concept (such as Car Sharing)

Upon completion of the technical evaluation, vehicle 2 is expected to be in front of vehicle 1 and both vehicles are expected to be in such a V2V distance that enables smooth platooning (through gap closing manoeuvre) without compromising the acceptable distance, disturbing legacy traffic etc.

Throughout the process, a number of log files are generated. More specifically:

1. Communication logging
2. Vehicle state logging
3. Platoon state logging
4. IoT logging (traffic management, ride sharing, platooning service)

To ensure maximum safety, potential safety interventions that might be observed include driver braking and driver accelerating.

The second technical evaluation for platooning addresses the platooning phase along with the platooning service, the RTK DGPS service, the HD map service and the priority lane allocation service.

The precondition for the second technical evaluation is for the platoon formation to be established and the vehicles to be platooning, i.e. vehicles are following each other at close distance.

Vehicle 1 is manually being driven and supported by ADAS (Advanced Driver Assistance Systems) and receives instructions (e.g. speed advice, lane advice). Vehicle 2 is driven on a fully automated mode (C-ACC and automated steering).

The actions/events that need to take place are the following:

1. The road authority is monitoring the traffic on the highway and decides to allocate lanes and maximum speed limit. This information will be published through IoT.
2. The traffic management service collects and provides information regarding the highway (max. speed, lane allocation, traffic light info, etc.)
3. The platooning service facilitates the platooning operation (interaction with services, speed advice for lead vehicle, lane allocation, etc.)
4. The lead vehicle follows the ADAS instruction it receives with the relevant information: speed advice, lane advice
5. The following vehicle follows the lead vehicle on the chosen headway without violating the received max. speed
6. When traffic lights come up, platoon break up is avoided (i.e. platoon stops or continues driving)

The relevant situations that could appear in terms of interaction with traffic lights, different traffic congestion, ca/ride sharing services and traffic management are the following:

- With traffic light state information
- Different traffic states (low traffic density/volume and congestion traffic)
- Dynamic speed limit
- Use of redundant information (to improve quality of service, enhance safety, alternatives and cost)
  - RTK GPS for localization w.r.t. camera + radar (RTK DGPS service)
  - V2V communication: IoT technologies UWB and (Pre-)LTE-V (Pre-5G)) w.r.t. ITS-G5
  - HD map (HD map service)

The baseline situations are two:

- Not using the information of traffic lights, traffic state, dynamic speed limit, lane allocation
- Not using the redundant information, as specified above.

The hypotheses that will be tested in this use case are stated below:

1. The IoT will allow a better anticipation on legacy traffic, traffic lights etc.
2. The IoT will contribute towards a higher level of automation by enhancing safety as a result of redundant information
3. The IoT will provide communication alternatives for platooning
4. The IoT will improve the quality of platooning as a result of redundant information
5. The IoT will enable the integration of platooning in a mobility service concept (such as Car Sharing)

Upon completion of the second technical evaluation, platooning is expected to be performed in a smooth manner, without conflicts with legacy traffic, following the appropriate instructions (lane allocation, speed limit), ensuring smooth transition across traffic light intersections, and achieving improved performance due to redundancy (quality of service, safety, alternative communication options).

Throughout the process, a number of log files are generated. More specifically:

1. Communication logging
2. Vehicle state logging
3. Platoon state logging
4. IoT logging (traffic management, ride sharing, platooning service)

To ensure maximum safety, potential safety interventions that might be observed include driver braking, driver accelerating and driver grabbing the steering wheel.

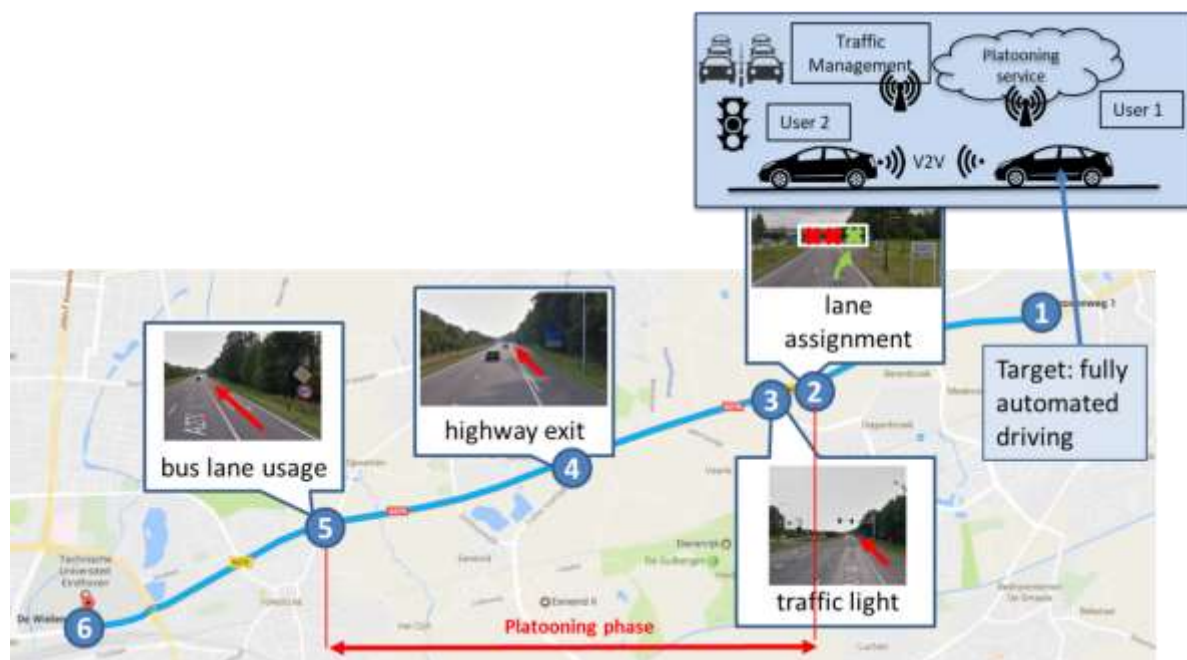


Figure 20 Scenario for the 2<sup>nd</sup> technical evaluation of the platooning use case in Brainport (platooning service)

#### 5.4.1.6 User acceptance

Iterations 1 and 3 share the same user acceptance approach in terms of user definition, roles, test runs and safety limitations. More specifically, in iterations 1 and 3, the drivers will be TNO engineers and the traffic manager will be a TNO/TASS engineer. The role of the driver includes using the operator app and driving one of the platooning vehicles, as described in the respective storyboard.

The traffic manager will be monitoring the traffic, lane access and speed. The test scenarios that will be applied are controlled and include briefing and debriefing with questionnaire. The safety limitations for the iterations foresee that the drivers must be TNO engineers with a special driver training. The driving environment should be arbitrary and to allow logging conditions afterwards.

As far as iterations 2 and 4 are concerned, the users will be drivers and passengers of the platooning vehicles. For safety reasons, the drivers must be TNO engineers. There will also be a traffic manager (road operator) and two to three passengers per vehicle. The driver will either use the operator app and drive one of the platooning vehicles, as described in the platooning storyboard, or will be a passenger in one of the platooning vehicles. The traffic manager conducts traffic monitoring, lane access and speed advice. The test run is based on the use case storyboard, according to which users will drive from Helmond to Eindhoven. At the beginning, the user will be welcomed for a short briefing. Then, he/she will perform the complete storyboard with TNO assistance. Users can experience the use case from different perspectives due to them being in different vehicles (lead vehicle, following vehicle). Upon completion of the test run, there will be a debriefing and the user will be requested to complete a questionnaire. The traffic manager will be instructed and interviewed at a later stage. The duration of one complete test run is approximately 15 minutes one way driving from start to finish, depending on road congestion. Additional time should be considered to allow the use of the platooning service, boarding the vehicles, etc. Overall, the complete test run is expected to have a duration of 1 hour, without briefing and debriefing being included. The number of test runs per day will be defined. However, given the fact that one test can be held per hour, the maximum number ranges between 6 and 8 tests per day. Safety limitations state that the drivers must be TNO engineers with special driver training. The traffic operator is responsible for deciding the use of the emergency lane and speed limits. The driving environment should be arbitrary and to allow to log conditions afterwards.

#### 5.4.1.7 Business impact

Of the four iterations that the platooning use case deals with, only iterations 2 and 4 include workshops concerning the business impact. To better consider and assess the value proposition, the following should be taken into account:

Platooning technology has a number of benefits; it improves traffic throughput and homogeneity (safe headway time e.g. 0.5 – 1 s), it enhances traffic safety due to small speed variations and relatively low impact velocities in collisions and it also reduces fuel consumption and emissions due to homogeneity (constant velocity driving) and lowering of the air drag (slipstreaming). Further to that, the following vehicles can be automated with relatively low automation costs compared to e.g. solo autopilot vehicles, due to easier environmental perception and lower safety risks. Where time-to-market is concerned, automation complexity for the following vehicles is reduced compared to e.g. solo autopilot vehicles, indicating that it could lead to earlier market introduction. On the other hand, a certain level of market penetration of platooning vehicles is required in order to make platooning effective. Another significant advantage relates to the available time that users have, meaning they can do other activities while the lead vehicle (platoon leader) guides the vehicles.

To encourage platooning on a business level, a number of actions need to be taken. Authorities should give incentives to people for using platooning (such as social benefits etc.) and a reasonable fee should be set and applied to be given to the lead vehicle driver for acting as a “taxi driver” for the following vehicles. Moreover, insurance companies should consider reducing insurance fees for travelled km in platooning mode, due to enhanced safety and lower accident risks. Finally, service providers (platooning service, car sharing service) should also receive a compensation for facilitating platooning and the platooning business overall.

When addressing the penetration rate of platooning vehicles, a key issue is the “chicken-egg problem”. For low or medium penetration rate, IoT platoon formation could be more beneficial for

relatively large distance. For high penetration rate, meaning that all vehicles are capable of platooning, large distance platoon formation is considered to be less important. Moreover, in the event that all vehicles are, finally, capable of autonomous driving, automation costs for platooning vehicles basically diminishes and platooning remains a feature of these vehicles.

The technologies that could be assessed are: IoT and UWB communication, RTK GPS, HD maps, while the value proposition should be considered separately for each technology. The benefits potentially involve enhancing safety (functional, operational, cybersecurity) with the aim of reaching a higher level of automation, improving the quality of service, e.g. robustness, additional information as well as having different options and lower cost solutions in communication and positioning than the ones currently available.

As far as government and road authorities are concerned, the use of IoT technology could significantly help save costs regarding the placement of dynamic road signs, achieving, as a result, electronic lane allocation.

#### 5.4.1.8 Quality of life

Test passengers will be involved in all 4 iterations; more specifically, in each iteration, there will be 1 driver and maximum 3 passengers per vehicle. At least 2 vehicles will participate in the testing (the leader and the following vehicle). People from the developers' group will participate in all iterations. Company employees with AD project experience, company employees without AD project experience and general public will be considered for iterations 2 and 4.

**Table 32: Dutch platooning pilot participants' groups per iteration**

Participant group	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	1 driver and <sup>5</sup> maximum passengers	1 driver and maximum passengers	1 driver and maximum passengers	1 driver and maximum passengers
Company employees (involved in AD projects)	-	1 driver and maximum passengers	-	x
Company employees (not involved in AD projects)	-	t.b.d.	-	t.b.d.
General public (specific groups, e.g. family members of employees, students etc)	-	t.b.d.	-	t.b.d.
General public (generalised sample)	-	-	-	

The tests will be carried out in closed track (with no other traffic allowed) and in public motorway (in regular traffic conditions).

The following have been determined for this use case:

**Table 33: Dutch platooning pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Operate the system, monitor the system during automated driving, possibly act in case of system failure
Is the driver monitored by the system? (e.g. by cameras in car)	No active monitoring, camera possibly be available for video capturing
Are passengers monitored by the system? (e.g. by cameras in car)	No active monitoring, camera possibly be available for video capturing

<sup>5</sup> This is per vehicle. At least 2 vehicles are involved in the testing: leader and following vehicle

Is there an HMI / display / app for non-professional passengers? What does it show?	Vehicle HMI and App are under development, current versions cannot be used by non-professional passengers. User-friendliness might improve in the future. It shows and is used for: speed advice, control settings, etc.
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	Yes
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	Yes
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	Traffic cameras are installed along the test site. In principle video data is available, but conditions should be checked.
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	It is intended to conduct tests in regular traffic. In that case people in other vehicles are involved.
If people outside of vehicles are involved: Are they employees only or can they be general public?	Mostly the other people will be general public, but it is also possible to have selected people driving in a normal vehicle during the pilot tests in the close proximity of the platooning vehicles.
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	No.

## 5.4.2 Automated Valet Parking

### 5.4.2.1 Scope

The scope of the use case is to conduct automated valet parking at the Automotive Campus in Helmond (Brainport) to improve parking efficiency by using IoT platforms and IoT devices.

### 5.4.2.2 Storyboard definition

The storyboard is described in section 3.4.2.1

### 5.4.2.3 Baseline

The baseline against which the scenario will be compared is AVP without roadside camera and without drone (MAV).

### 5.4.2.4 Pilot planning

AVP pilot planning consists of 4 iterations overall.

*Iteration 1* will take place in M21 of the project (September 2018), will last for 1 week and will not host a VIP event or stakeholder workshop. The best case addressed in iteration 1 is the complete AVP storyboard with the participation of one vehicle, while the worst case refers to partial elements of the storyboard (e.g. without the use of MAV that locates parking spots and informs vehicles). One vehicle will take part.

*Iteration 2* will take place in M24 (December 2018) and will include a VIP event and a stakeholder workshop. The duration is set to be 1 week and 2 vehicles will participate. The content of the best case is, again, the complete AVP storyboard, while the worst case concerns partial elements of the storyboard (e.g. without the use of MAV that locates parking spots and informs vehicles) and the participation of one vehicle.

*Iteration 3* will take place in M27 (March 2019), will not include a VIP event nor a stakeholder workshop and will have a duration of 1 week, with the participation of 3 vehicles. The content of the best case is, again, the complete AVP storyboard, while the worst case concerns partial elements of the storyboard (e.g. without the use of MAV that locates parking spots and informs vehicles) and the participation of one vehicle.

Finally, *iteration 4* will take place in M30 (June 2019) and will include a VIP event and a stakeholder workshop. The duration is set to be 1 week and 3 vehicles will participate. The content of the best case is, again, the complete AVP storyboard, while the worst case concerns partial elements of the storyboard (e.g. without the use of MAV that locates parking spots and informs vehicles) and the participation of one vehicle.

#### 5.4.2.5 Technical evaluation

The technical evaluation for the AVP use case addresses the services of AVP Drop Off.

The precondition required for the evaluation to take place is that vacant parking spots and a MAV are available when the vehicle approaches the parking area.

The actions/events that take place are the following:

- The vehicle is sent to the parking area through the use of a smart phone app
- The MAV identifies vacant parking spots
- The vehicle determines the optimal route to reach the vacant parking spot
- The vehicle parks

The relevant situations that could appear within this scenario refer to the different routes and parking spots available for automated vehicle.

The baseline situations are having AVP without roadside camera and without MAV (drone).

The hypotheses that will be tested in this use case are stated below:

- Parking
- Detection of parking spots available
- Entire parking duration
- Optimal parking route

Upon completion of the technical evaluation, a reduction in time needed for parking is expected to be documented.

Throughout the process, a number of log files are generated. More specifically:

1. Velocity logging
2. Vehicle position logging
3. AVP duration logging

#### 5.4.2.6 User acceptance

In this use case, user acceptance is divided according to 2 phases – the first phase refers to the vehicle's drop off to complete AVP and the second phase refers to vehicle collection.

In the first phase, the user is defined as the person/driver who drops the vehicle off at the drop-off point. The role of the user in this context is to simply drive the vehicle and use the app to initiate



AVP functions. The user will receive a short briefing of approximately 5 minutes as well as a smart phone device with the AVP app installed. The user enters the vehicle at the driver seat and drives the vehicle to the drop-off location. Then, the user exits the vehicle and activates the AVP-Drop-off with the smartphone app. The vehicle is then expected to autonomously drive towards a vacant parking spot and park. The process is expected to take 15 minutes and the number of tests per day is yet to be determined. For safety reasons, the user must have a valid driving license and a safety driver must be seated at the vehicle's front seat at all times. Further limitation is to be determined.

In the second phase, the user is defined as the driver who requests vehicle pickup. In this context, the role of the user is to initiate AVP-Pickup and drive the vehicle after pickup is completed. The user will receive a short briefing and a smart phone device with the AVP app installed. The user then requests AVP pickup using the app and walk towards the pickup area. The vehicle, having received the request through the AVP app, drives to the pickup area. The user enters the vehicle when it stops and begins driving it manually. The duration is expected to be 15 minutes and the number of test runs per day will be determined. For safety reasons, the user must have a valid driving license and a safety driver must be seated at the vehicle's front seat at all times. Further limitation is to be determined.

#### 5.4.2.7 Business impact

AVP is expected to save time and space for both, end-users and parking providers. When looking for available parking spot, the user has to pay for using the AVP service to save time. As an incentive to use the AVP application, compared to traditional valet parking, a smaller fee should be requested to ensure competitiveness. Further to that, better space allocation is expected due to the fact the vehicles can be automatically parked closer one to another, seeing as no doors open for drivers to exit the vehicle. As a result, the AVP service provider at a controlled parking area will have more parking spots available in the same area, as opposed to traditional valet parking, this increasing their income.

#### 5.4.2.8 Quality of life

Test passengers can be involved in iterations 2 and 4, with the number of 10 and more than 20 accordingly. The following table depicts which groups participate in each iteration.

**Table 34: Dutch AVP pilot participants' groups per iteration**

Participant Group	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	YES	YES	YES	YES
Company employees (involved in AD projects)	NO	YES	NO	YES
Company employees (not involved in AD projects)	NO	YES	NO	YES
General public (specific groups, e.g. family members of employees, students etc.)	NO	YES	NO	YES
General public (generalised sample)	NO	YES	NO	YES
Other, please specify:	NA	NA	NA	NA
Total	0	10	0	>20

Passengers are to be recruited from conferences, automotive campus etc. The tests will be carried out in a closed track (with no other traffic allowed) as well as in a private parking ground (with no other traffic allowed). The following tasks and characteristics will be set for this use case and are depicted in the table below.

**Table 35: Dutch AVP pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Monitoring the AD function. No manual driving.
Is the driver monitored by the system? (e.g. by cameras in car)	NO
Are passengers monitored by the system? (e.g. by cameras in car)	NO
Is there an HMI / display / app for non-professional passengers? What does it show?	NO
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	NO
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	NO
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	NO
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	YES
If people outside of vehicles are involved: Are they employees only or can they be general public?	Employees and general public possible
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	NO
<b>For AVP:</b>	
Is the parking operated from inside the vehicle only or also remotely? Is there always someone inside the car during the whole parking procedure?	Parking is operated remotely. A safety driver will always be in the vehicle due to legal reasons.
What speed range does the AVP support?	0-15 km/h

### 5.4.3 Highway pilot

#### 5.4.3.1 Scope

The scope of the highway pilot is to detect road hazards for autonomous driving, focusing on surface defects / features (potholes, bumps, cobblestones, puddles, etc.) and using regular sensors that are commonly found on AD vehicles (such as LiDAR, camera, IMU, etc.). Further to that, the highway pilot aims to rely on a collaborative approach to encourage better detection accuracy and to share consolidated and acknowledged information with third parties that are interested, via an open IoT platform. Moreover, the pilot will include the broadcasting of hazard warnings and driving instructions to autonomous vehicles that move along the allocated corridors, will enhance users experience and will prevent vehicles' maintenance in autonomous driving.

#### 5.4.3.2 Storyboard definition

The storyboard is described in section 3.4.3.1.

#### 5.4.3.3 Baseline

The baselines to be used in this use case are the highway pilot without IoT and the highway pilot with IoT technology.

In the first case, the highway pilot does not entail IoT technology, in-vehicle IoT integration or online IoT platform. Leading vehicles detect road hazards through the vehicle's sensors, and the raw data can be individually collected and sent to the Cloud. The following vehicles have no access to information, thus not anticipating the hazards.

In the highway pilot with IoT technology applied (meaning there is in-car IoT integration and online IoT platform), the leading vehicles use their sensor to collect raw data and process it for anomalies detection; an in-car module can bundle Anomalies (grouping detections in short range, inserting vehicle data, inserting media files, archiving records with timestamps). The following vehicles receive information about road hazards warnings and related ADAS instructions, coming from multiple vehicles and external sources (like RSU cameras).

#### 5.4.3.4 Pilot planning

The highway pilot consists of 4 iterations:

*Iteration 1* will take place in M21 of the project (September 2018), will have a duration of 1 week and will host a local event with workshops and interviews. The best case involves 2 vehicles in the highway pilot storyboard, limited to 2 hazards. The worst case involves 1 vehicle and faces the possible restriction on the accuracy of the localisations of hazards.

*Iteration 2* will take place in M24 of the project (September 2018), will have a duration of 1 week and will host a local event with workshops and interviews. The best case involves 2 vehicles in the highway pilot storyboard with the inclusion of RSU cameras but still limited to 2 hazards. The worst case involves 1 vehicle and faces possible restrictions on RSU cameras.

*Iteration 3* will take place in M27 of the project (March 2019), will have a duration of 1 week and will host a local event with workshops and interviews. The best case involves 2 vehicles in the highway pilot storyboard with the integration of road signaling and one extra manual vehicle, displaying road hazard warnings and ADAS instructions. The worst case involves 1 vehicle and faces possible absence of road signaling and restrictions on the classes of hazards.

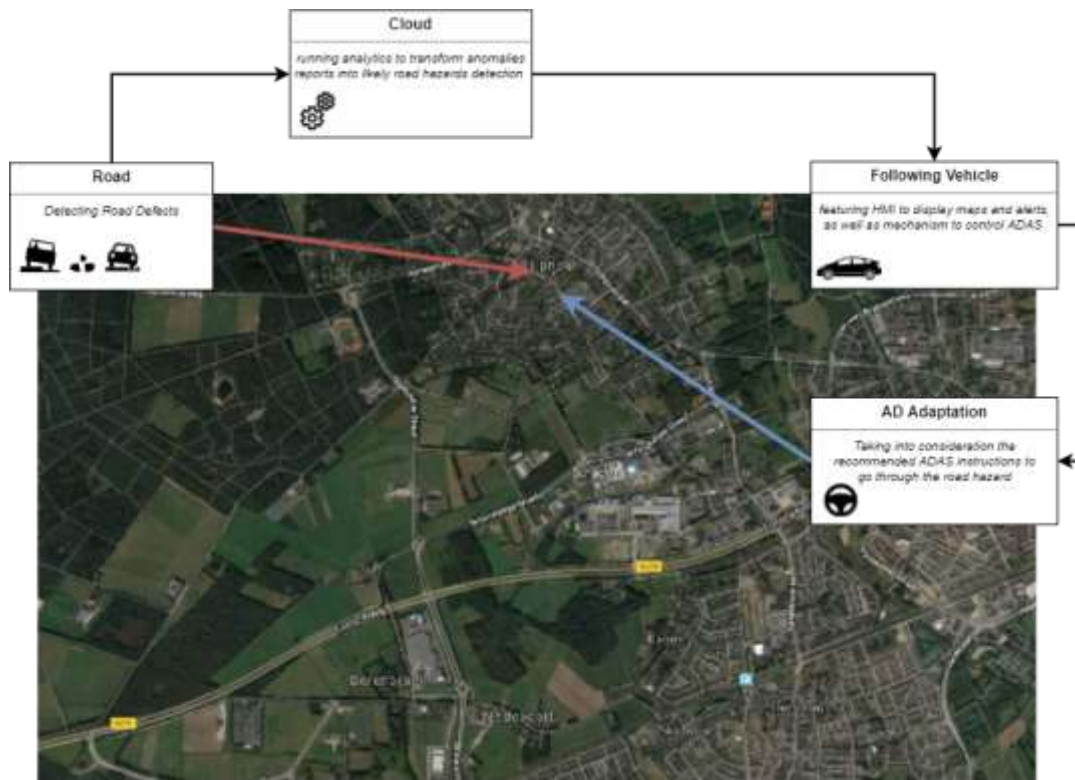
*Iteration 4* will take place in M30 of the project (May/June 2019), will have a duration of 2 weeks and will host a local event with workshops and interviews. During the first week, the focus will be on the final pilot and during the second week the appropriate demos will take place for ITS Europe. Iteration 4 involves 2 vehicles and its worst-case deals with possible restrictions on hazards available for demo. One vehicle participates in the worst-case scenario.

In terms on AD adaptation, Speed / TIV / forced-handover features will be implemented. For safety reasons, it is recommended that the vehicle operates in Lane Keeping mode and the Lane Change feature will be simulated with HMI and turning lights.

#### 5.4.3.5 Technical evaluation

The technical evaluation addresses the detection of road hazard (RH) and the application of ADAS instructions (ADASIN).

The precondition required for the evaluation to take place is that the road has been identified as containing some classes of HR. The vehicle of User 1 should be able to detect RHs and the vehicle of User 2 should be able to apply ADASIN. Both users are at the beginning of the road. User 3 is an operator that will be located at the Control Centre.



**Figure 21 Dutch highway pilot technical evaluation**

The actions/events that take place are the following:

- User 1 drives through RH present on that Road, multiple times (number to be defined according to Cloud trigger), possibly in both directions.
- With every run, the Cloud receives anomalies (ANO) reports from the vehicle of User 1. The Cloud also receives ANOs from road CCTV camera (through Traffic Control Centre).
- The Cloud processes the ANOs and characterizes geolocalized RH.
- User 3 receives a RH notification on his HMI and decides to publish an ADASIN.
- User 2 starts driving on the road and receives the ADASIN as he gets close to RH.
- The vehicle of User 2 applies the ADASIN as it goes through the RH.
- The vehicle of User 2 restores previous settings of the AD unit.

The relevant situations that could appear within this scenario refer to the detection of the detection of different RHs classes and the management of different ADASIN:

- Detect and select routes with different classes of RH.
- Detect and select routes with RH located elsewhere.
- Manage different ADASIN (speed, TIV, lane changes, takeover, range of effect).
- Detect and select routes where RH were previously reported but are no longer there.

The baseline situations the two following:

1. User 2 driving on the road before user 1.
2. User 3 does not publish any ADASIN at all.

The hypotheses that will be tested in this use case are stated below:

- During detection phase, any anomalies from multiples sources (different sensors / algos / devices) can be merged to trigger specific hazard warnings.
- During detection phase, IoT will facilitate the integration of 3r party sources of ANOs.
- During detection phase, IoT will facilitate the broadcast of Hazard warnings across interested

parties.

- During adaptation phase, the control centre accesses novel information that can help better manage traffic.
- During adaptation phase, Hazard warnings and Driving recommendations can target relevant vehicles based on their location.
- During adaptation phase, the proposed driving recommendations eventually result in better management of the Hazardous situation by the vehicles.

Upon completion of the technical evaluation, the received ADASIN are expected to increase driving safety thanks to known road hazard, indicating ADASIN are well designed to go through.

Throughout the process, a number of log files are generated. More specifically:

1. Communication logging
2. Vehicle state logging
3. Vehicle ANO detections logging
4. Vehicle ADASIN computation logging
5. IoT PF logging (for ANO, RH, ADASIN objects)
6. Cloud computation logging

Potential safety interventions that can be observed are driver braking, driver accelerating, driver steering and driver turning off ACC. Takeover would happen during the tests and a human driver is to supervise all tests.

#### 5.4.3.6 User acceptance

The drivers are those who drive the AD vehicles along pre-defined corridors. For safety reasons, drivers must be VALEO project team members. The virtual drivers/passengers are those who are on board the following vehicle and may either drive themselves or be passengers. They will be welcomed for a short briefing and then will be requested to perform the complete storyboard, with the assistance of the VALEO team. Users can only experience the use case from the following vehicle. Upon completion of the test, there will be a debriefing and they will be given a questionnaire to fill. The duration of one complete test run is estimated to be about 1 hour with the following structure: 45 minutes in the vehicle, of which 15 minutes watching and syncing with the preceding vehicle runs and 30 minutes of driving, and 15 minutes of debriefing. The maximum number of tests per day is 6 to 8. There are no safety limitations to be applied as users can be regular citizens.

Finally, the operators are those who are in the control centre, monitoring the reception of RH and sending relevant ADASIN, when needed. The safety limitation in this case is that the operator must be a Control Center or TASS professional trained for the use case.

#### 5.4.3.7 Business impact

The business impacts that IoT applications will bring in Highway driving will be assessed at the beginning of 2019. More specifically, one assessment will take place after validation from the 2<sup>nd</sup> Pilot Test week and another assessment will take place during or just before the 3<sup>rd</sup> Pilot Test week.

The identified stakeholders and the respective business cases are:

1. Insurance companies, expected to lower insurance fees for a suitably equipped vehicle:
  - a. insurance fee for mechanical breaks
  - b. insurance fee on transported merchandise
2. Road maintenance companies expected to achieve:
  - a. better tracking of roads degradation
  - b. better planning of zones and timing for intervention
3. Cities and Agglomeration, expected to strive for:

- a. improved service for citizen
  - b. simplified road management (less reliance on road signalling)
  - c. better traffic performance
  - d. leverage on road construction / maintenance companies
- 4. Vehicle manufacturers, anticipated to work for the provision of:
  - a. advanced features to propose (ex: active safety option)
  - b. premium comfort on higher-end models
- 5. Map providers, to contribute
  - a. added value services
  - b. enrichment of HD / Live maps

#### 5.4.3.8 Quality of life

Test passengers will be involved in iterations 2, 3 and 4, with the number of 6, 8 and 16 accordingly. Iteration 1 will consist of developers only. The following table depicts which groups participate in each iteration.

**Table 36 Dutch highway pilot participants' groups per iteration**

Participant group	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	4	4	4	4
Company employees (involved in AD projects)	0	0	0	2
Company employees (not involved in AD projects)	0	0	0	2
General public (specific groups, e.g. family members of employees, students etc.)	0	0	0	0
General public (generalised sample)	0	2	4	8
Other, please specify:	NA	NA	NA	NA

Passengers are to be recruited through picking into the pool of other use cases. The tests will be carried out in a closed track (with no other traffic allowed) on the Helmond automotive campus. The following tasks and characteristics will be set for this use case and are depicted in the table below.

**Table 37 Dutch highway pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Car #1: Driving normally over/around hazards, Car #2: Monitoring the driving adaptation in order to take back control at any time
Is the driver monitored by the system? (e.g. by cameras in car)	No monitoring, but a streaming video may be set up for demo
Are passengers monitored by the system? (e.g. by cameras in car)	No monitoring, but a streaming video may be set up for demo
Is there an HMI / display / app for non-professional passengers? What does it show?	Maps pf Hazards/Driving Instructions + Warnings messages
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	Yes (ACC on)



Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	Yes (ACC off)
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	No
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	Pedestrians for closing the demo track
If people outside of vehicles are involved: Are they employees only or can they be general public?	Employees or Partners
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	Yes
for AVP:	
Is the parking operated from inside the vehicle only or also remotely? Is there always someone inside the car during the whole parking procedure?	
What speed range does the AVP support?	

#### 5.4.4 Urban Driving

##### 5.4.4.1 Scope

The scope of the use case is to assess Urban Driving within the concept of Car Rebalancing.

In Urban Driving, demand for car sharing services will be the main drive for car rebalancing. The driverless cars will relocate themselves across the TU/e campus based on the demand and the number of vulnerable road users on the road. While self-driving, the vehicle will detect VRUs using IoT information & ITS-G5, which is the main topic to be evaluated in the Technical Evaluation during the pilot period.

##### 5.4.4.2 Storyboard definition

The storyboard is described in section 3.4.4.1.

##### 5.4.4.3 Baseline

The baseline addresses rebalancing without the use of IoT and with IoT. More specifically:

- Without IoT: Car sharing vehicles are parked on several parking spots around the campus. People who wish to use a vehicle will have to walk to the nearest vehicle and the driverless vehicle could potentially have inefficient routing (blocked by students walking over campus).

- With IoT: Demand and VRUs density can be estimated, based on lecture schedule and crowd estimation.

In the context of Urban Driving, the use of IoT will enable VRU detection in combination with in-vehicle camera detection while VRU detection without IoT corresponds to the use of in-vehicle camera.

#### 5.4.4.4 Pilot planning

The Urban Driving use case has 4 iterations:

*Iteration 1* is scheduled to begin in M21 of the project (August/September 2018), have a duration of one weekend and involve 1 AD vehicle (Prius). The best case refers to the pretest case, meaning examining urban driving across the campus as well as VRU detection using ITS G5 and 4G technologies. It will take place within a close road which only one instructed VRU will be allowed to access. The worst case addresses possible restrictions on the automated steering which could lead to driving only in a straight line as well as any restrictions for the general public on campus. In this case, the vehicle to be used is one AD vehicle Prius, which will be IoT equipped and manually driven. No VIP events or stakeholder workshops will be help in iteration 1.

*Iteration 2* will take place in M24 of the project (December 2018), will have a duration of 1 week and will be accompanied by a local event with workshops and interviews. The best case involves one AD vehicle (Prius) and addresses urban driving across the campus as well as VRU detection using ITS-G5 and 4G technologies. It will take place within a close road which only one instructed VRU will be allowed to access. The worst case addresses possible restrictions on the automated steering which could lead to driving only in a straight line as well as any restrictions for the general public on campus. In this case, the vehicle to be used is one AD vehicle Prius, which will be IoT equipped and manually driven.

*Iteration 3* will take place in M27 of the project (March 2019), will have a duration of 1 week and will involve 3 AD vehicles (1 Prius and 2 VFLEX). The best case of iteration 3 addresses urban driving and its integration with car rebalancing service. The worst case addresses possible restrictions on the automated steering which could lead to driving only in a straight line, restrictions for the general public on campus as well as any restrictions on the availability and use of VFLEX vehicles. In this case, the one vehicle to be used is an AD vehicle Prius, which will be IoT equipped and manually driven, and the other 2 will be simulated vehicles (ITS-G5 beacons).

*Iteration 4* will take place in M30 of the project (May/June 2019), will have a duration of 2 weeks and will be accompanied by a local event with workshops and interviews. Three vehicles will participate in iteration 4: one Prius and two VFLEX. The final pilot will take place in the first week and the demos at ITS Europe will take place in the second week. The worst case refers to possible restrictions on the automated steering which could lead to driving only in a straight line, restrictions for the general public on campus as well as any restrictions on the availability and use of VFLEX vehicles. In this case, the one vehicle to be used is an AD vehicle Prius, which will be IoT equipped and manually driven, and the other 2 will be simulated vehicles (ITS-G5 beacons).

August is considered to be the best option for closing the roads to general public.

#### 5.4.4.5 Technical evaluation

The technical evaluation addresses VRU detection within the concept of Urban Driving.

The precondition required for the evaluation to take place is that the vehicles are parked at pre-defined parking spots and that the rebalancing service, as soon as it checks that there is demand for one vehicle to move from parking A to parking B, initiates the vehicle to start moving.

The actions/events that take place are the following:

- The vehicle receives information about the crowd from the CEMA & TU/e lecture schedule and checks optimal time and route to drive (possibly manually set)
- The vehicle drives to another parking spot
- VRUs are crossing the street in front of the vehicle

The relevant situations that could appear within this scenario refer to the detection of the VRU on the go:

- The vehicle detects Vulnerable Road Users on route towards the other parking spot
- VRUs receive warning on their smartphone informing them of the approaching AD vehicle

The baseline situations the two following:

1. Detection of VRU equipped with an ITS-G5 unit instead of a smart phone app. This takes place while driving.
2. Vehicle 2 awaits to receive a trigger from the rebalancing service (IoT cloud) to begin its itinerary. This takes place without driving.

The hypotheses that will be tested in this use case are stated below:

- The IoT technology will extend the detection of VRUs over longer distance (from blocked view of in-vehicle camera)
- The IoT technology will warn VRUs of the approaching AD vehicle (GeoFetching service)

Upon completion of the technical evaluation, VRU detection out of line of sight of the in-vehicle sensors is expected to be achieved. The technology used is ITS-G5 as well as 4G of smartphones.

Throughout the process, a number of log files are generated. More specifically:

1. Communication logging
2. Vehicle state logging
3. IoT logging (GeoFetching, CEMA, rebalancing service)

Potential safety interventions that can be observed are driver braking, driver accelerating and driver grabbing the steering wheel.

#### 5.4.4.6 User acceptance

In this use case there are 3 user profiles to be examined – the driver, the VRU and the fleet manager.

*The driver* is seated inside the vehicle strictly for safety reasons, as within the concept of rebalancing, the vehicle is expected to be completely driverless. The driver will be a trained driver with Automated Driving experience. Drivers must be TU/e - TASS engineers for safety reasons. The role of the driver is to monitor the environment and take over control in safety critical situations while they will receive a full briefing for executing the VRU test scenario. The duration of one complete run is set to 30 minutes and the number of tests per day is 5. Safety limitations require that the driver holds a valid driving license and is trained for the use case scenario as well as for driving an AD vehicle.

*The VRU* will be instructed to execute the VRU detection tests. For this purpose, the users recruited will be mainly students. The VRU will walk across the TU/e campus, on the side of the road and on the roads where the AD vehicle will drive, simulating normal VRU behaviour on campus. One complete test includes the VRU arriving, receiving briefing about the test to be conducted, downloading and installing the smartphone app on their Android smartphone and walking across the campus terrain. The duration of a complete test is set to 30 minutes and the number of tests per day is set to 5. Safety limitations require that the users will be briefed about the use case scenario and test to be executed and will be asked to sign a letter of consent for using their smartphone. Finally, the third user profile in this use case is *the fleet manager*.

For all tests, driving conditions require mainly good weather with no legacy traffic (trial 1, 2, possible with trial 3 & 4) and with tests running from 9:00 to 16:00.

#### 5.4.4.7 Business impact

Rebalancing with driverless cars can be enabling for free flow car sharing business case. Car shared vehicle do not have to be parked anymore at dedicated parking lots but will autonomously drive themselves to the requested place where the actual demand for the vehicle is. Currently this is already done manually.

During the driving of the AD vehicle (driverless) when relocating itself, VRU detection can possibly decrease the travel time as well as the risk of collision with VRUs, by intelligently rerouting on basis of crowd estimation on route.

#### 5.4.4.8 Quality of life

The vehicle itself will only be driven by trained test drivers and an extra engineer for monitoring the AD system. In the Prius it is able to have 2 passengers for evaluation.

Mainly students will be recruited to act as VRUs in the use case. Possibly also maximum 2 passengers can be involved in iterations 2 and 4 during each test round. The following table depicts which groups participate in each iteration.

**Table 38: Dutch Urban Driving pilot participants' groups per iteration**

Participant Group	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	5	5	5	5
Company employees (involved in AD projects)	5	5	5	5
Company employees (not involved in AD projects)		5		5
General public (specific groups, e.g. family members of employees, students etc.)		10	5-10 (students)	20
General public (generalised sample)		-		-
Other, please specify:	-	-	-	-

The following tasks and characteristics will be set for this use case and are depicted in the table below.

**Table 39: Dutch Urban Driving pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Operate the system, monitor the system during automated driving, possibly act in case of system failure
Is the driver monitored by the system? (e.g. by cameras in car)	NO
Are passengers monitored by the system? (e.g. by cameras in car)	NO
Is there an HMI / display / app for non-professional passengers? What does it show?	NO
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	YES, small LED lights on dash only & hands-off wheel

Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	YES, small LED lights on dash only & hands on wheel
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	Only in-vehicle video data available, not external
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	Yes, as VRUs, only instructed (students)
If people outside of vehicles are involved: Are they employees only or can they be general public?	only instructed students
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	yes, smartphones with AUTOPILOT application installed on it for VRU detection & AD vehicle warning (approaching)

### 5.4.5 Car sharing /ride sharing

#### 5.4.5.1 Scope

The scope of the use case is to perform and evaluate ridesharing, showing at the same time the difference between IoT-enabled information and without IoT information as well as showing how to best integrate ridesharing with other AD use cases. The IoT information will be in the form of events that affect the route of the ridesharing fleet (e.g., road closure).

Integration of ridesharing with the other use cases in the Brainport area will be sought with:

- Rebalancing use case, to instruct AD vehicles to relocate themselves to accommodate ride requests [worst case goal];
- AVP use case, to retrieve a vehicle from a parking before a ride [best case goal];
- Platooning use case, to automatically discover platooning possibilities [best case goal];
- Highway use case, to integrate event detection as an additional option in the ridesharing service [best case goal].

#### 5.4.5.2 Storyboard definition

The storyboard is described in section 3.4.5.1. The gist of the storyboard is to create an event that could possibly disrupt the ridesharing service. The event will be detected by IoT devices, and the ridesharing service will reroute the vehicles accordingly, thereby maintaining a high quality of service.

#### 5.4.5.3 Baseline

The baseline against which the scenario will be compared is ridesharing without the use of IoT, meaning there will be scheduling and driving with no real-time event information. Since we are going to simulate (or create) a road block, we expect that the vehicle will get stuck in traffic, with no information to make a better routing choice.

#### 5.4.5.4 Pilot planning

For this use case, 4 iterations have been determined.

*Iteration 1* will take place in M21 of the project (September 2018), will last 1 week and involves one vehicle. The best case for iteration 1 refers to ridesharing with and without IoT technology applied

while at the same time, achieving full ridesharing integration with end-to-end booking service. The worst case involves no IoT and no end-to-end integration. No VIP or stakeholder events will take place.

*Iteration 2* will take place in M27 of the project (March 2019), will last 1 week and involves two vehicles. The best case for iteration 2 refers to ridesharing with and without IoT technology applied while at the same time, achieving full ridesharing integration with end-to-end booking service and full integration with either AVP service or rebalancing service. The worst case involves one vehicle and no integration with AVP services/ rebalancing services. Iteration 2 will host a local event with workshops and interviews.

*Iteration 3* will take place in M27 of the project (March 2019), will last 1 week and involves two vehicles. The best case for iteration 3 refers to ridesharing with and without IoT technology applied while at the same time, achieving full ridesharing integration with end-to-end booking service and full integration with either AVP service or rebalancing service. The worst case involves one vehicle and no integration with AVP services/ rebalancing services. No VIP or stakeholder events will take place.

*Iteration 4* will take place in M30 of the project (May/June 2019), will last 2 weeks and involves three vehicles. The first week of iteration 4 will focus on the final pilot and the second week will host the demos at ITS-Europe. The worst case involves only one vehicle. Iteration 4 will host a local event with workshops, interviews and demonstrations.

#### 5.4.5.5 Technical evaluation

Technical evaluation will report on the benefit of IoT for the ridesharing service. In order to assess said benefits, we will run the same test with and without IoT.

##### **Without IoT**

With reference to the storyboard, we will create a road block on the highway (best case, or on TU/e campus in the worst case): this simulates high traffic congestion. Without IoT information, the ridesharing service will not be informed of the varied traffic conditions and will not instruct the vehicles to reroute. This will cause large delays. In this case, the driver may also attempt at reroute the vehicles, but sub-optimally, which would cause large travel distances.

Delays would cause large waiting times for customers downstream, and possibly service loss (e.g., arriving too late for a pick-up or a delivery).

##### **With IoT**

In the case of IoT, the cameras on the highway (best case), or users on the campus (worst case), would push an event on the IoT platform, which would be picked up by the ridesharing service. The ridesharing service will then react accordingly to best reroute the vehicles to avoid the obstruction. This would limit delays, travel distances, and service loss, considerably.

In summary, we will test the benefit of IoT with respect to:

- Cumulative travel times;
- Cumulative travel distance;
- Average waiting time for customers (outside the specified time window);
- Distribution of waiting times;
- Probability of constraint violation (pick-up and drop-off outside the specified time windows);
- Cumulative fuel usage.

##### **Case with multiple vehicles**

In the best-case scenario, multiple vehicles with multiple customers will be employed. We will run similar tests, with the same KPIs with and without IoT. An additional KPI that will be considered is:



- The minimal number of required vehicles to satisfy a certain quality of service (i.e., number of served customers).

Failing to test the multi-vehicle scenario with real vehicles, we will test it in a dedicated simulation environment, as discussed below.

#### **Dedicated simulation environment**

Simulations will be set up to test the benefit of IoT in a controlled environment, in parallel to real pilots. The simulations will run the same tests (road blockages, traffic) to test the benefit of IoT, in much more challenging situations. At the moment, we are running tests on simulated requests with hundreds of vehicles.

##### **5.4.5.6 User acceptance**

In this use case, user acceptance is divided according to 3 categories – the driver, the passenger and the ridesharing owner. The driver drives the vehicle according to the storyline. The duration of one complete test run is estimated to range from 30 minutes to 1 hour while the number of test runs per day is not expected to be more than 5. The passenger is the person that books and rides the AD vehicles to reach his/her destination. Finally, the ridesharing owner is the person/organisation who sets up the app and monitors the smooth operation of the ride sharing service.

##### **5.4.5.7 Business impact**

As far as business is concerned, ridesharing has a great impact on various stakeholders. These involve city authorities that wish to set up a mobility-on-demand transportation system, OEMs and vehicle manufacturers that seek new services to offer their customers, companies in the mobility-on-demand sector, aiming to enter the market by offering cost effective and shared alternatives to traditional transportation. Potential customers range from citizens of the city to city authorities (if a company sets up the ridesharing) to car manufacturers (if they adopt the app).

##### **5.4.5.8 Quality of life**

It is reasonable to expect that, by carefully designing mobility-on-demand transportation systems, congestion and travel times will be significantly reduced, improving on the quality of life. In fact, the World is increasingly becoming urban-centric: living in cities poses a series of challenges to civic planners and governments, amongst which urban mobility. With the rise of IoT technology, ridesharing services could become a viable option to tackle (part of) the urban mobility challenge, in a way that would lower emission, travel times, and overall congestion. Our aim is to showcase the possibility to integrate and extend existing ridesharing concepts into the growing mobility-on-demand ecosystem.

Transport as a service (TaaS, aka mobility-on-demand) together with approval of autonomous vehicles will unleash a highly competitive market-share grab among existing and new ridesharing companies in expectation of the outsized rewards of trillions of dollars of market opportunities and network effects. TaaS will offer vastly lower-cost transport alternatives — 4 to 10 times cheaper per mile than buying a new car and 2 to 4 times cheaper than operating an existing vehicle in 2021 (source: RethinkX, 2017).

In the ridesharing use case, we plan the following participations.

**Table 40: Dutch Ridesharing pilot participants' groups per iteration**

<b>Participants Group</b>	<b>Iteration 1</b>	<b>Iteration 2</b>	<b>Iteration 3</b>	<b>Iteration 4</b>
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	NO	NO	YES	YES
Company employees (involved in AD projects)	NO	NO	NO	NO

Company employees (not involved in AD projects)	NO	NO	NO	NO
General public (specific groups, e.g. family members of employees, students etc.)	NO	NO	NO	NO
General public (generalised sample)	NO	NO	NO	NO
Other, please specify:	NA	NA	NA	NA

The following tasks and characteristics will be set for this use case and are depicted in the table below.

**Table 41: Dutch Ridesharing pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Drive and follow instruction
Is the driver monitored by the system? (e.g. by cameras in car)	Yes, by GPS tracks
Are passengers monitored by the system? (e.g. by cameras in car)	Yes, by GPS tracks
Is there an HMI / display / app for non-professional passengers? What does it show?	Tablet for driver, show the route to follow
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	There is no AD
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	There is no AD
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	No video data
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	Not specified
If people outside of vehicles are involved: Are they employees only or can they be general public?	Not specified
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	Not specified, besides the people who will book the vehicles

## 5.5 Spanish pilot

### 5.5.1 Urban Driving (UD)

Vigo is a city and municipality in the province of Pontevedra, in Galicia, northwest Spain on the Atlantic Ocean. It is the capital of the comarca of Vigo and Vigo metropolitan area. Vigo is the most populous municipality of Galicia, and the 14th in Spain. The city is located in the south-west of Galicia, in the southern part of Vigo Ria, in one of Europe's rainiest areas. The VIGO Spanish pilot site use cases are two, Urban Driving and Automated Valet Parking.

One use case VIGO Spanish pilot site is addressed to Urban Autopilot and the use case and its sub use cases will be tested in Gran Vía, between intersection with streets Islas Canarias and Bolivia. Automated vehicles will circulate by the left road (close to the boulevard) separated from the traffic in a closed circuit with 4 TL intersections.

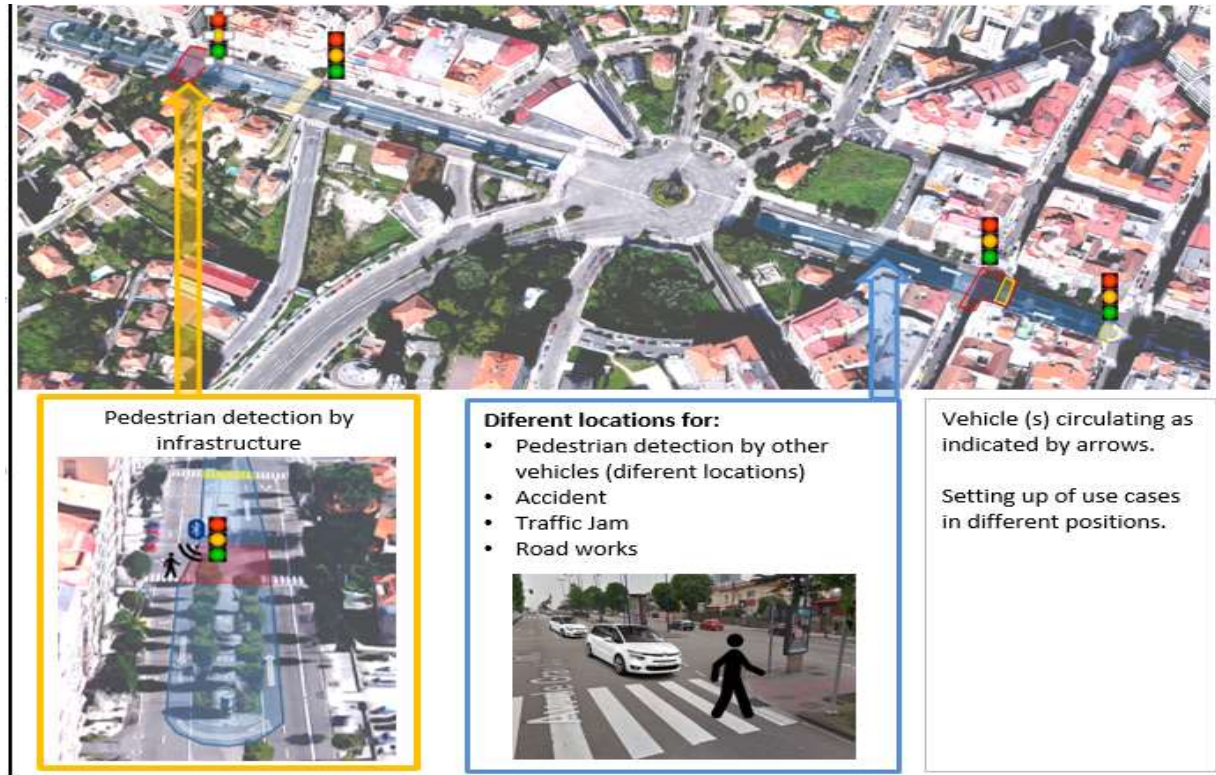


Figure 22 Overview of the urban driving use case in Vigo

The Pilot Side Leader is CTAG and is also responsible for in vehicle Platform/IoT Platform/HMI/AD function adaptations. Further to that, the following table depicts the names and roles of the supporting partners.

Table 42: Partners involved in the Spanish pilot site and their roles

Short	Name	Role
CTAG	CTAG	Pilot site leader
CTAG	CTAG	In-vehicle Platform/IoT Platform/HMI/AD function adaptations
PSA	PSA	In-vehicle IoT Platform/AD functions adaptations support
VGO	City of Vigo	Access to the infrastructure/road adaptations

#### 5.5.1.1 Scope

This case aims to demonstrate how IoT can enhance Automated Driving, increasing safety, performance and improving user experience under the most typical urban roads conditions:

- Driving through traffic light intersections
- Presence of VRUs (pedestrians)
- Traffic jams or other incidences

#### 5.5.1.2 Storyboard definition

The storyboard is described in section 3.5.1.1.

### 5.5.1.3 Baseline

The baseline for each of the following sub-use cases (see storyboard) can be summarised as follows:

- Driving through traffic light intersections: Without any kind of connectivity
- Driving through traffic light intersections: With ITS G5
- Presence of VRUs (pedestrians): pedestrian in the road without IoT
- Presence of VRUs (pedestrians): pedestrian crossing in an intersection without IoT
- Approaching to Traffic Jam without IoT
- Approaching to an accident without IoT
- Approaching to road works without IoT

In the case of approaching to a traffic light without any connectivity the vehicle will request to driver to take the control back in the approach to a traffic light.

In the case of approaching to a TL with ITS-G5 connectivity, the vehicle will request the driver to take the control back in the approach to a traffic light at those intersections without ITS-G5 connectivity

In the rest of sub use cases the vehicle detects the events by its own sensors.

### 5.5.1.4 Pilot planning

The Spanish pilot for the use case Urban Driving consists of 3 iterations in total. For all iterations, there will be morning sessions from 10:00 to 13:00.

*Iteration 1* will be held in M19-M20 of the project (July-August 2018), without the hosting of a VIP event and Stakeholders WS. It will last four weeks and will include 1 vehicle. It is going to take place in a scenario reproduced in CTAG facilities which imitates the real urban environment of the second iteration.



**Figure 23 1<sup>st</sup> iteration of the urban driving use case in Vigo**

*Iteration 2* will be held in M21-M23 of the project (September-November 2018). It will last eight weeks and will include 1 vehicle. Its target is the reduced trip including one TL intersection and specifically: Approaching to Traffic light and approaching to Hazard events. Hazard events conclude: traffic jam, an accident and road works and VRU.



Figure 24 2<sup>nd</sup> iteration of the urban driving use case in Vigo

*Iteration 3* will be held in M27-M29 of the project (March-May 2019), will have VIP events and stakeholders and will have a duration of four weeks. The best case of iteration 3 aims for the Urban Driving with full corridor trip (4 intersections): Driving through TL intersections, Pedestrian detection by infrastructure, approaching hazard events: traffic jam, an accident, road works and Pedestrian detection by other vehicles. For the worst case of iteration 3, there is a delay recovering, which will be held in M29-M31 (May – June 2019) and will have a duration of four weeks. Also, both for its best and worst case 2-3 vehicles will be used.

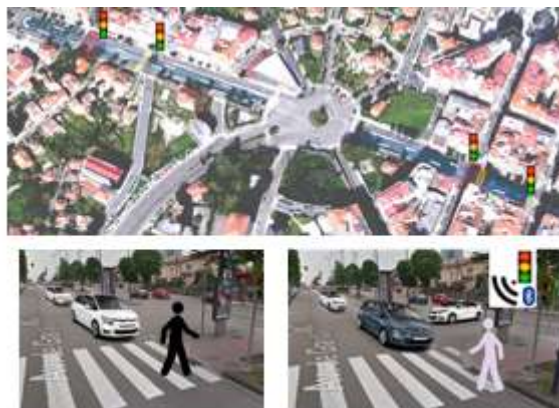


Figure 25 3<sup>rd</sup> iteration of the urban driving use case in Vigo

#### 5.5.1.5 Technical evaluation

The first part of the technical evaluation addresses Urban Driving in the context of speed adaptation approaching a traffic light.

The precondition required for the evaluation to take place is an AD vehicle to approach a traffic light connected to the IBM Watson IoT platform.

The actions/events that take place are the following:

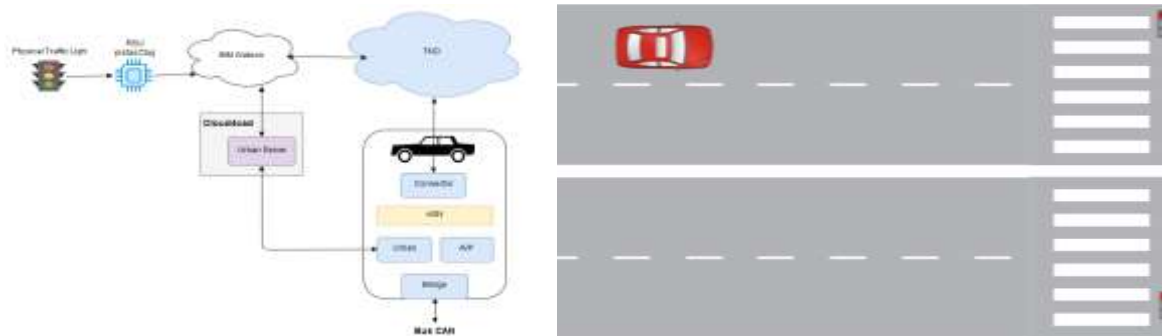
- The vehicle is constantly requesting from the Urban Server Service the status of the Traffic Lights in its area.
- The vehicle adapts acceleration to pass the traffic light in the most efficient way.
- If the vehicle cannot cross with green, it will stop at the traffic light



The baseline is reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How can VRUs be detected by IoT?
- How good can IoT predict travel times?
- How can IoT enhance urban driving?
- How is data communication enhanced by IoT?



**Figure 26 Urban driving in Vigo: speed adaptation when approaching a traffic light**

Upon completion of the technical evaluation, the expected result is for the AD vehicle to know the distance to the next traffic light, the time to change and the current status so that it adapts its acceleration to pass the traffic light in the most efficient way, e.g. reducing the speed if the traffic light is currently in red so that when the car reaches the traffic light it will be green, and the car will not need to stop.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle data (as in AUTOPILOT-VehicleLogFormat\_v0.2)
2. IoT data (TBD)
3. V2X data (as in AUTOPILOT\_CommonLogFormatDescription\_extention\_v0.7.7.)
4. Urban driving data (TBD)

The second part of the technical evaluation addresses Urban Driving in the context of approaching hazard.

The precondition required for the evaluation to take place is an AD vehicle to approach a hazard in an area with a Hazard Device Manager.

The actions/events that take place are the following:

- The vehicle is constantly requesting to the Urban Server Service the status of the Hazards in its area.
- The vehicle adapts its behaviour by reading the information about recommended speed in the area of the event and the distance to that area. Based on this the vehicle will reduce its speed when approaching that area.
- The vehicle resumes the normal speed after passing it.

The relevant situations refer to how the scenario interacts with different hazard situations. The baseline is reproduced with the same system without Internet of Things, using only the information from the sensors of the vehicle.

The hypotheses that will be tested in this use case are stated below:

- How can VRUs be detected by IoT?



Upon completion of the technical evaluation, the expected result is for the AD vehicle to know the distance to the next traffic light, the time to change and the current status so that it adapts its acceleration to pass the traffic light in the most efficient way, e.g. reducing the speed if the traffic light is currently in red so that when the car reaches the traffic light it will be green, and the car will not need to stop.

1. Vehicle data (as in AUTOPILOT-VehicleLogFormat\_v0.2)
2. IoT data (TBD)
3. V2X data (as in AUTOPILOT\_CommonLogFormatDescription\_extention\_v0.7.7.)
4. Urban driving data (TBD)

The role of the user will be as a driver in Iteration 1 (Controlled scenario) and co-pilot (observing) in the iterations 2 and 3 (Real environment):

- Male or Female (but no pregnant women)
- Any level of education
- Any level of income
- Have a legacy driving experience of 2 years and a valid driving license in Spain
- No Automated driving experience is requested.

The user will test the different use cases in the test track. The duration of one complete test run and the number of test runs per day will be confirmed. For safety reasons, the user cannot be alone in the vehicle without a CTAG engineer and an expert driver. Driving environment restrictions require to have dry weather conditions, use only 1 vehicle, have no traffic only for the traffic jam use case) and use one full morning for the test.

#### 5.5.1.7 Business impact

The impact of AD vehicles on a business level is expected to be significant and to contribute to a safer transport status. The large number of traffic accidents and pedestrian impacts in a city is a serious problem for the authorities. Last year, almost 200 people were run over in the City of Vigo. Automated driving vehicles, with the help of IoT devices in strategic locations, can reduce dramatically these figures. Therefore, Local Authorities are the main ones who should invest in this technology in order to get a safer city.

#### 5.5.1.8 Quality of life

Test passengers will participate in all 3 iterations and they will be company employees with no AD project experience. The number of participants is yet to be confirmed.

**Table 43: Spanish pilot Urban Driving participants groups per iteration**

Participant group	Iteration 1	Iteration 2	Iteration 3
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	no	no	no
Company employees (involved in AD projects)	no	no	no
Company employees (not involved in AD projects)	Yes	yes	yes
General public (specific groups, e.g. family members of employees, students etc)	no	TBC	TBC
General public (generalised sample)	no	TBC	TBC

The tests of iteration 1 will take place in closed tracks with no other traffic allowed. Tests for iterations 2 and 3 will take place in public urban environment with no other traffic allowed. The following traits and characteristics have been so far determined:

**Table 44: Spanish Urban Driving pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Monitoring the AD function
Is the driver monitored by the system? (e.g. by cameras in car)	No
Are passengers monitored by the system? (e.g. by cameras in car)	TBC
Is there an HMI / display / app for non-professional passengers? What does it show?	TBC
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	yes (by HMI information)
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	yes (by HMI information)
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	TBC

Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	no (Soft targets are going to be used)
If people outside of vehicles are involved: Are they employees only or can they be general public?	N/R
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	N/R

### 5.5.2 Automated Valet Parking (AVP)

The second use case VIGO Spanish pilot site is addressed to Automated Valet Parking (AVP). The use case and its sub use cases will be tested in the City Council Parking located in the underground of city council facilities.

The Pilot Side Leader is CTAG and is also responsible for in vehicle Platform/IoT Platform/HMI/AD function adaptations. Further to that, the following table depicts the names and roles of the supporting partners.

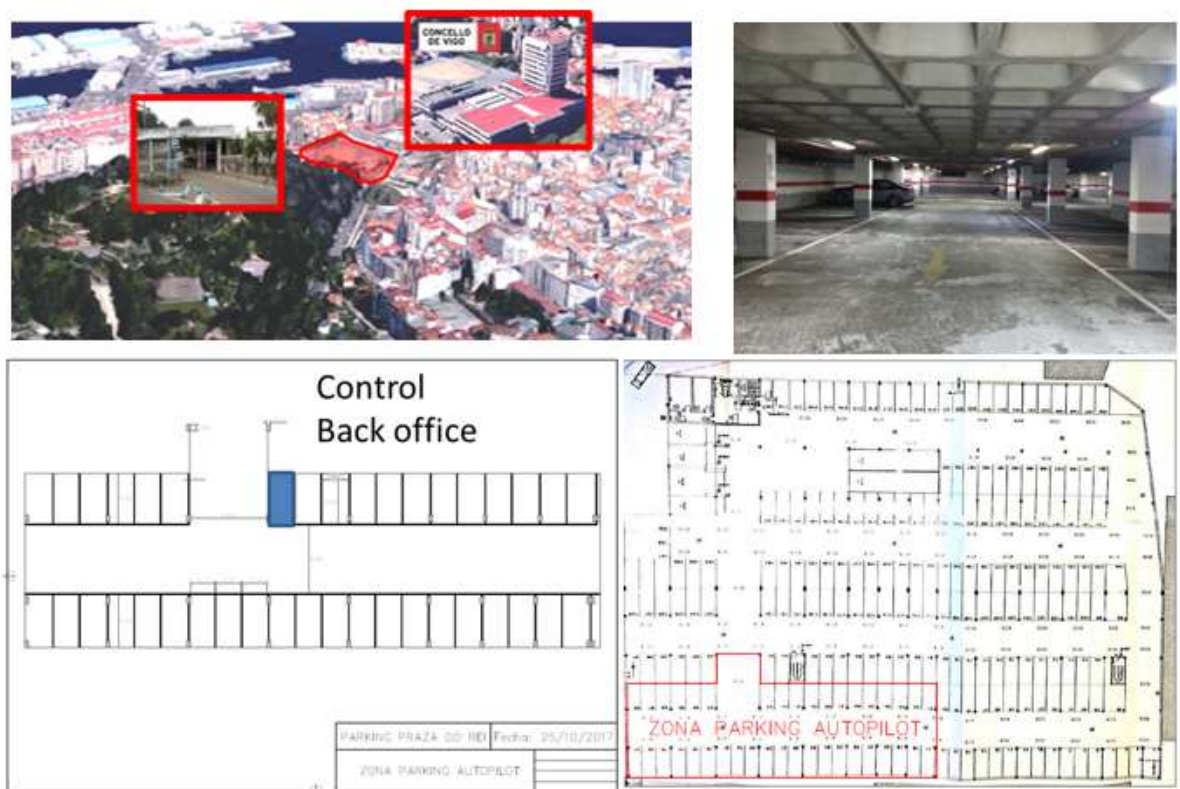


Figure 29 Area of the AVP pilot in Vigo

The Pilot Side Leader is CTAG and is also responsible for in vehicle Platform/IoT Platform/HMI/AD function adaptations. Further to that, the following table depicts the names and roles of the supporting partners.

**Table 45: Partners involved in the Vigo PS and their roles**

Short	Name	Role
CTAG	CTAG	Pilot site leader
CTAG	CTAG	In-vehicle Platform/IoT Platform/HMI/AD function adaptations
PSA	PSA	In-vehicle IoT Platform/AD functions adaptations support
VGO	City of Vigo	Access to the Parking infrastructure/parking lot adaptations

#### 5.5.2.1 Scope

This case aims to demonstrate how IoT can enable AVP within an indoor scenario allowing to the vehicle precise positioning and offering extra information in obstacles and other vehicles through the access to cameras and sensors by IoT.

- Delivery process
- Trip to parking space and parking manoeuvre
- Leaving parking space manoeuvre
- Pick up process

#### 5.5.2.2 Storyboard definition

The storyboard is described in section 3.5.2.1.

#### 5.5.2.3 Baseline

Conventional indoor parking should be taken as baseline.

#### 5.5.2.4 Pilot planning

The Spanish pilot for the use case Automated Valet Parking (AVP) consists of 3 iterations overall. For all iterations, there will be afternoon sessions from 14:30 to 17:30.

*Iteration 1* will be held in M19-M20 of the project (July-August2018), without the hosting of a VIP event and Stakeholders WS. It will last four weeks (12 days, see the calendar below) and will include 1 vehicle. Its target is IoT Positioning within parking lot and especially Vehicle delivery, driving to parking space, parking manoeuvre and Easy configurations. It is going to take place in CTAG facilities simulating the real environment.

*Iteration 2* will be help in M21-M23 of the project (September-November 2018). It will last eight weeks (twenty-four days, see the calendar below) and will include 1 vehicle. The best case aims to IoT Positioning within parking lot, Access to Cameras and sensors of parking lot, Vehicle delivery, driving to parking space, parking manoeuvre, leaving parking Space (supported by access to Parking camera), Driving to delivery area and Vehicle Delivery. For the worst case of iteration 2, are IoT Positioning within parking lot, Vehicle delivery, driving to parking space and Parking manoeuvre.

*Iteration 3* will be held in M27-M29 of the project (March-May 2019), will have VIP events and stakeholders and will have a duration of 4 weeks. The best case of iteration 3 aims at IoT Positioning within parking lot, Access to Cameras and sensors of parking lot, Vehicle delivery, Driving to parking space, Parking manoeuvre, Leaving parking Space (supported by access to Parking camera), Driving to delivery area, Vehicle Delivery and Multiple vehicle configurations. It is going to be used 3 vehicles.



### 5.5.2.5 Technical evaluation

The technical evaluation addresses Automated Valet Parking in 2 stages: drop off and pick up.

When evaluating the first phase of AVP – drop off, the actions/events that take place are the following:

- User uses the app to reserve a parking space.
- User parks manually at the DOP and leaves the vehicle.
- The vehicle parks in the parking space in autonomous mode.

There is no baseline situation in this use case since, without IoT, the scenario cannot be realized with the prototype vehicle.

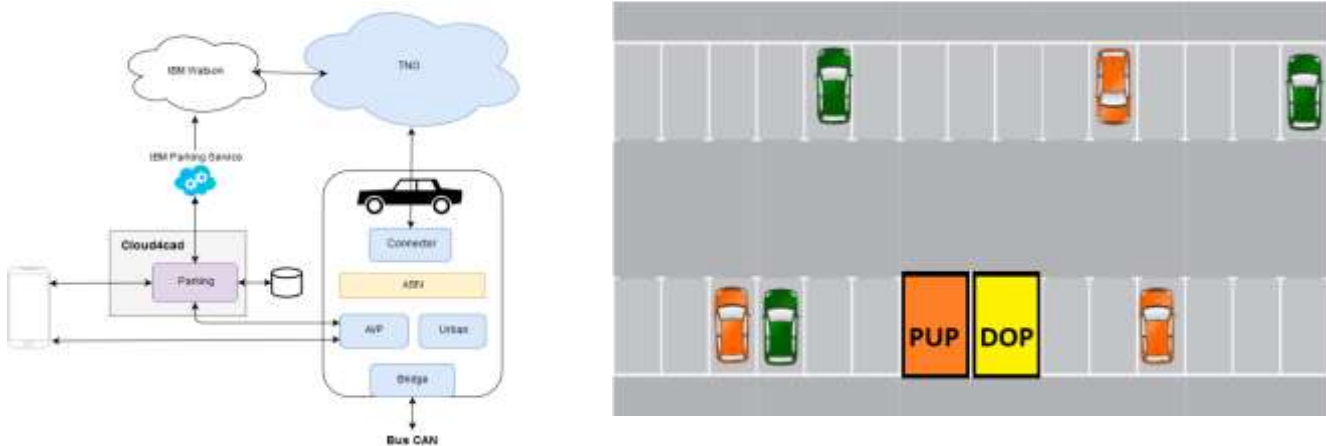


Figure 30 Detail of the AVP area in Vigo

The hypotheses that will be tested in this use case are stated below:

- How can IoT enhance the Automated Valet Parking?
- How IoT adds value to positioning, localisation and navigation for Automated Driving functions?
- How the IoT data management adds value to Automated Driving functions?

Upon completion of the technical evaluation, it is expected to that the vehicle should park in autonomous mode saving time to the user.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle data (as in AUTOPILOT-VehicleLogFormat\_v0.2)
2. IoT data (TBD)
3. V2X data (as in AUTOPILOT\_CommonLogFormatDescription\_extention\_v0.7.7.)
4. AVP data (TBD)

When evaluating the first phase of AVP – pick up, the precondition is for the vehicle to drive in the first lane at 70 km/h with all the devices working correctly and connected to all services needed.

The actions/events that take place are the following:

- User uses the app to request collection of the vehicle.
- The vehicle goes to the PUP in autonomous mode.
- The user picks up the vehicle.

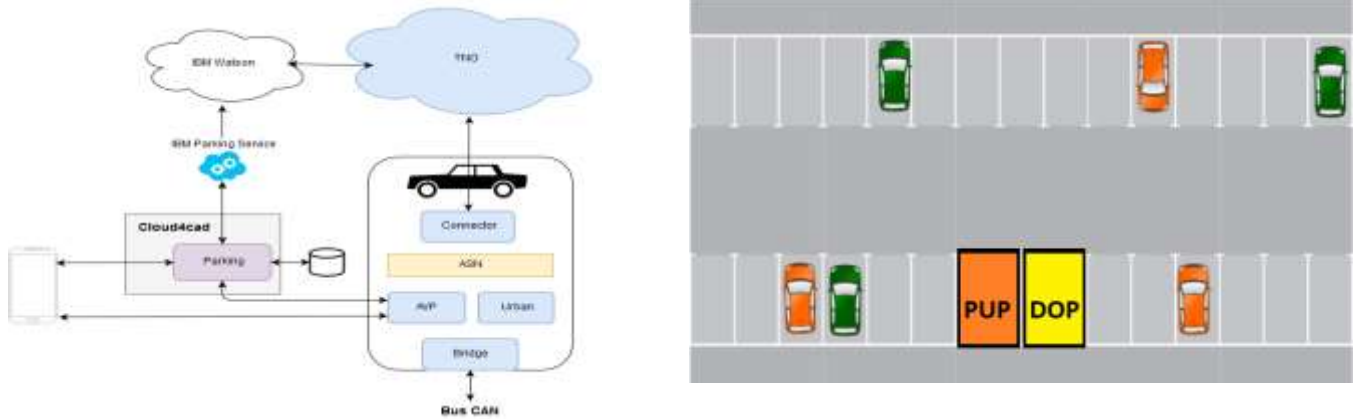


Figure 31 AVP pick-up in Vigo

There is no baseline situations in this use case due to the fact that, without IoT, the scenario cannot be realized with the prototype vehicle.

The hypotheses that will be tested in this use case are stated below:

- How can IoT enhance the Automated Valet Parking?
- How IoT adds value to positioning, localisation and navigation for Automated Driving functions?
- How the IoT data management adds value to Automated Driving functions?

Upon completion of the technical evaluation, it is expected to that the vehicle should go to the pick-up point in autonomous mode, saving time to the user.

Throughout the process, a number of log files are generated. More specifically:

1. Vehicle data (as in AUTOPILOT-VehicleLogFormat\_v0.2)
2. IoT data (TBD)
3. V2X data (as in AUTOPILOT\_CommonLogFormatDescription\_extention\_v0.7.7.)
4. AVP data (TBD)

#### 5.5.2.6 User acceptance

As there are two different scenarios, there are also 2 different users.

1<sup>st</sup> user books a parking spot and drives manually the car until the drop off zone, gets out and activates the AVP-drop off function with an app of the mobile. The driver observes the automated manoeuvres of the vehicle.

2<sup>nd</sup> user goes to the pick-up zone and activates the AVP-pick up function with the app of the mobile. The user observes the automated manoeuvres of the vehicle until the pick-up zone.

In the first iteration there will not be any obstacles in the path of the vehicle. However, in the 2<sup>nd</sup> and 3<sup>rd</sup> iterations, the smart camera of the infrastructure is going to detect obstacles and the user will see how the car avoids the collision thanks to the IoT information.

#### 5.5.2.7 Business impact

The Automated Valet Parking has a very clear use case since it has beneficial points for parking operators as well as for users.

- Users:
  - Save time: since the task of searching for a parking space and finally perform the manoeuvre is usually a tedious and stressful manoeuvre that can take more than 15

minutes. Even in very large car parks, there is the possibility that the user does not remember where it was his vehicle and spent a lot of time looking for it.

- Avoid scratches and accidents: Parking slots of indoor parking are normally very small, and they have columns everywhere. Besides, there is not too much light. Because of this, most of the scratches that a car suffers is performing the parking manoeuvre.
- Parking Operators:
  - Differential service: The parking operators can offer a differential service which brings many advantages for their users, so they can charge for it.
  - More parking slots: As there is no need to leave space to the driver to get out of the vehicle it is possible to make even smaller parking slots.

#### 5.5.2.8 Quality of life

All iterations will involve test passengers, the number of which remains to be confirmed. All passengers will be company employees with no AD project experience.

**Table 46: Spanish pilot Urban Driving participants groups per iteration**

Participant group	Iteration 1	Iteration 2	Iteration 3
Developers (directly involved in development of the AUTOPILOT vehicles/systems)	no	no	no
Company employees (involved in AD projects)	no	no	no
Company employees (not involved in AD projects)	Yes	yes	yes
General public (specific groups, e.g. family members of employees, students etc)	no	TBC	TBC
General public (generalised sample)	no	TBC	TBC

Tests for iteration 1 will be carried out in closed track (no other traffic allowed) while tests for iterations 2 and 3 will take place in public parking ground (in regular traffic conditions). The following traits and characteristics have been determined and depicted in the table below:

**Table 47: Spanish AVP pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Monitoring the AD function
Is the driver monitored by the system? (e.g. by cameras in car)	No
Are passengers monitored by the system? (e.g. by cameras in car)	TBC
Is there an HMI / display / app for non-professional passengers? What does it show?	TBC
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	yes (by HMI information)
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	yes (by HMI information)

Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	TBC
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	no (Soft targets are going to be used)
If people outside of vehicles are involved: Are they employees only or can they be general public?	N/R
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	N/R
<b>For AVP:</b>	
Is the parking operated from inside the vehicle only or also remotely? Is there always someone inside the car during the whole parking procedure?	Iteration 2 and 3 the vehicle is also controlled remotely. There is always an expert driver in the car
What speed range does the AVP support?	10 km/h

## 5.6 Korean pilot

The Korean pilot site will be run by ETRI in DAEJEON, which is 150km south of Seoul, and its use case addresses Urban Driving – Intersection Safety Information ((ISI) system. More specifically, the pilot includes a test road of 300m, a 2 lanes road and 1 intersection that will be equipped and used for the tests.

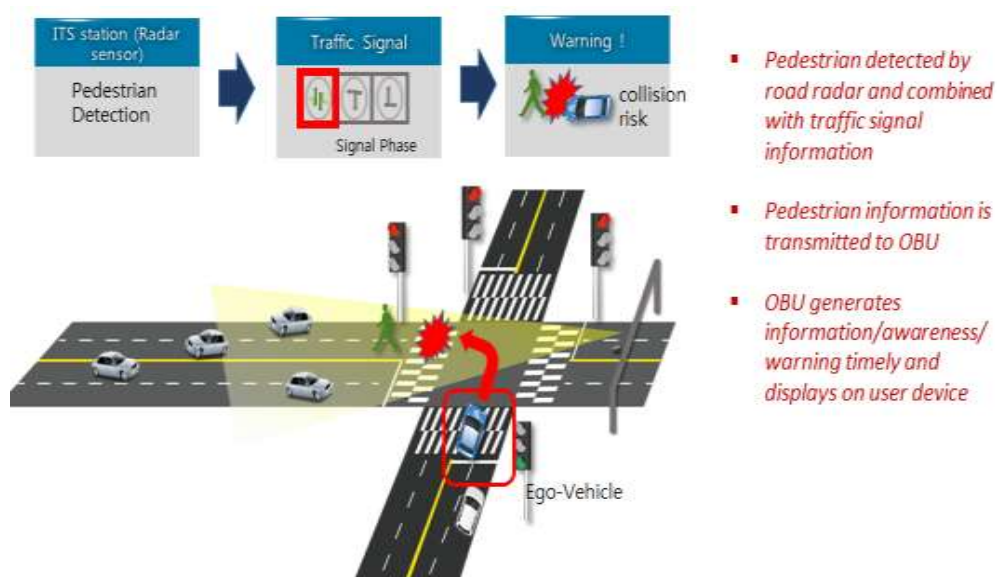


Figure 32 Illustration of the Korean PS

The partners involved in the Korean pilot are:

**Table 48: Partners involved in the Korean PS and their roles**

Short	Name	Role
ETRI	Electronics and Telecommunications Research Institute	Pilot site leader
METABUILD	METABUILD	Pilot site Partner

### 5.6.1 Urban driving

#### 5.6.1.1 Scope

The Korean pilot addresses only one use case, i.e. urban driving. The overall scope of the tests is to examine the Intersection Safety Warning for Urban Driving, with the use of IoT.

#### 5.6.1.2 Storyboard definition

The storyboard is described in section 3.6.1.

#### 5.6.1.3 Baseline

The baseline against which the scenario will be compared is the same scenario without the use of IoT sensors and the Intersection Safety Information system.

#### 5.6.1.4 Pilot Planning

The Korean pilot has two iterations that will take place in March 2019 and November 2019, with two and three connected vehicles respectively. The first iteration, which will run in March 2019, will not be accompanied by a VIP event nor a Stakeholder Workshop (WS), contrary to iteration 2, which will run in November 2019 and will include a VIP event and a Stakeholder Workshop (WS).

#### 5.6.1.5 Technical evaluation

The main precondition for the scenario is that the Intersection Safety Information system is installed and that a connected vehicle is approaching the intersection. A pedestrian is walking on the crosswalk while the traffic signal is red. The IoT sensor that is installed in the road infrastructure will detect the pedestrian and his/her location, transmitting this information to the vehicle, so as to inform the human driver of the pedestrian's presence.

A relevant situation would potentially take place during bad weather conditions or at night time, where the ISI system would be more effective, and more scenarios could be evaluated according to traffic status.

The hypotheses to be tested for the Korean pilot are:

1. The IoT sensors' ability to detect pedestrians or vehicles in real time and on a reliable basis
2. The intersection safety information system to gather IoT sensors' information and generate intersection safety information messages
3. The connected vehicle's ability to receive the detected information
4. The connected vehicle's ability to understand and know the location of the detected information
5. The intensity of the generated warning inside the vehicle to prevent the accident at the intersection.

Upon completion of the above, the vehicle driver is expected to have been informed of the

pedestrian's or vehicle's position at the intersection and reduce accidents.

#### 5.6.1.6 User acceptance

The main user profile in this use case is the driver, whose role is to drive and pass through the intersection. A complete test run includes the driver testing whether the pedestrian and the vehicle warnings are displayed or not. The duration of one complete test run is set to 10 minutes while the number of tests per day is 10. Safety limitations require the driver to hold a valid driving license.

#### 5.6.1.7 Business impact

- Contributes to creating new business with convergence of sensor information generated from vehicle / road
- Reduced traffic accident costs due to reduced car and road accident rates
- Pedestrian safety and accident prevention at intersections

#### 5.6.1.8 Quality of life

Test drivers will participate in all 2 iterations and they will be company employees. The number of participants is yet to be confirmed. The tests of iteration 1 and 2 will take place in private road with no other traffic allowed. Tests for iterations 2 also will take place in test urban environment with no other traffic allowed.

**Table 49: Korean Urban Driving pilot – QoL related information**

What are the tasks of the professional driver? What does he/she do during the test drive?	Operate the system, monitor the system during the test drive
Is the driver monitored by the system? (e.g. by cameras in car)	No
Are passengers monitored by the system? (e.g. by cameras in car)	No
Is there an HMI / display / app for non-professional passengers? What does it show?	Yes; Service Device displays warning or information about the intersection situations
Can non-professional passengers detect when the ADF is turned on? (e.g. by a message, sound, or when driver takes hands off wheel, other?)	No
Can non-professional passengers detect when the ADF is turned off? (e.g. by a message, sound, or when driver puts hands on wheel, other?)	No
Will video data be available to project partners (e.g. from traffic cameras intersections, zebra crossings)? (Video image or thermographic camera; low resolution sufficient)	no video is planned for all tests
Are people outside of vehicles involved in the tests? E.g. as pedestrians or cyclists? If yes, are they employees only or can they be general public?	N/R
If people outside of vehicles are involved: Are they employees only or can they be general public?	Employees or general public possible
If people outside of vehicles are involved: Do they carry any device which is used a) to help the vehicles detect them, and b) to give the pedestrian/cyclist information about the situation?	No



## 6 Conclusions

AUTOPILOT plans to initiate its pilots in M18 (June 2018). There are six pilot sites, elaborating six main use cases with several sub-cases. For the well-organised and effective implementation of the pilots there was the need first, to ensure that all pilot sites have the required specifications to implement the foreseen pilots, then, to plan the pilot execution in detail, and finally to define which outputs will come from the pilots to facilitate the assessment of the piloted use cases and hypotheses.

This led to the elaboration of a detailed work encompassing all these features in the form of the present deliverable. At the moment, all AUTOPILOT pilot sites are in a very advanced status and any details remaining for the initiation of the tests are under control of the pilot site leaders. An overall timeplan of all pilot activities is presented in Figure 30.

The work presented here has been elaborated within T3.1 of WP3 of AUTOPILOT, in close cooperation also with WP4.

M	M18				M19				M20					M21				M22					M23				M24				M25					M26					M27			
MONTH	JUNE				JULY				AUGUST					SEPTEMBER				OCTOBER					NOVEMBER				DECEMBER				JANUARY					FEBRUARY					MARCH			
WEEK	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11	12	13	
TAMPERE																																												
AVP																																												
Urban driving																																												
VERSAILLES																																												
Car sharing and urban driving																																												
Platooning																																												
LIVORNO																																												
Highway pilot																																												
Urban driving																																												
BRAINPORT																																												
Highway pilot																																												
Rebalancing (Urban driving)																																												
Ridesharing (Car sharing)																																												
Platooning																																												
AVP																																												
VIGO																																												
AVP																																												
Urban driving																																												
DAEJEON																																												
Urban driving																																												

	Iteration with public event (VIPs and stakeholders)
	Iteration with public event (VIPs and stakeholders) -> week to be confirmed
	Iteration for evaluation: without VIP nor stakeholders event
	Iteration for evaluation: without VIP nor stakeholders event -> week to be confirmed

#### Comments

- (1) MID-TERM REVIEW
- (2) PUBLIC EVENT without VIP, only stakeholders
- (3) ITS European congress in Brainport, NL

M	M28				M29				M30				M31				M32				M33				M34				M35				M36							
MONTH	APRIL				MAY				JUNE				JULY				AUGUST				SEPTEMBER				OCTOBER				NOVEMBER				DECEMBER							
WEEK	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	
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Urban driving																																								
VERSAILLES																																								
Car sharing and urban driving																																								
Platooning																																								
LIVORNO																																								
Highway pilot																																								
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Rebalancing (Urban driving)																																								
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VIGO																																								
AVP																																								
Urban driving																																								
DAEJEON																																								
Urban driving																																								

Table 50: Overall timeplan of AUTOPILOT pilot activities

## 7 Annexes

### 7.1 Annex 1: Pilot plans per PS and UC

#### Finnish Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-Tampere\\_AVP.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-Tampere_AVP.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-Tampere\\_Urban-Driving.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-Tampere_Urban-Driving.xlsx)

#### French Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN\\_VERSAILLES\\_Carsharing\\_Urbandriving.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN_VERSAILLES_Carsharing_Urbandriving.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN\\_VERSAILLES\\_Platooning.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN_VERSAILLES_Platooning.xlsx)

#### Italian Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-LIVORNO\\_UrbanDriving.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-LIVORNO_UrbanDriving.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN\\_LIVORNO\\_Highway.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN_LIVORNO_Highway.xlsx)

#### Dutch Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-Brainport\\_Platooning.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-Brainport_Platooning.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-Brainport\\_AVP.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-Brainport_AVP.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-Brainport-Ridesharing.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-Brainport-Ridesharing.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-Brainport-Highway-Pilot.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-Brainport-Highway-Pilot.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN-Brainport\\_Rebalancing.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN-Brainport_Rebalancing.xlsx)

#### Spanish Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN\\_Vigo-AVP.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN_Vigo-AVP.xlsx)

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN\\_Vigo\\_Urban\\_AD.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN_Vigo_Urban_AD.xlsx)

#### Korean Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_PILOT-PLAN\\_DAEJEON.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_PILOT-PLAN_DAEJEON.xlsx)

## 7.2 Annex 2: Pilot site specification table per PS

Finnish Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_Pilot\\_Site\\_Specs\\_Tampere.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_Pilot_Site_Specs_Tampere.xlsx)

French Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_Pilot\\_Site\\_Specs\\_Versailles.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_Pilot_Site_Specs_Versailles.xlsx)

Italian Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_Pilot\\_Site\\_Specs\\_LIVORNO.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_Pilot_Site_Specs_LIVORNO.xlsx)

Dutch Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_Pilot\\_Site\\_Specs\\_Brainport.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_Pilot_Site_Specs_Brainport.xlsx)

Spanish Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_Pilot\\_Site\\_Specs\\_Vigo.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_Pilot_Site_Specs_Vigo.xlsx)

Korean Pilot Site

[http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT\\_Pilot\\_Site\\_Specs\\_DAEJEON.xlsx](http://autopilot-project.eu/wp-content/uploads/sites/16/2018/06/AUTOPILOT_Pilot_Site_Specs_DAEJEON.xlsx)