Preparatory action — User-friendly information tool on urban and regional vehicle access regulation schemes 2
UVAR Exchange

Demonstrations activities

Final Report

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FOR THE
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INTRODUCTION

This draft final report was prepared for the European Parliament Preparatory action — User-friendly information tool on urban and regional vehicle access regulation schemes 2 – UVAR EXCHANGE, based on contract No MOVE/B3/SER/2020-716/SI2.852092 implementing the No MOVE/2020/OP/0012, as outlined in the Terms of Reference.

Objective of the report

This report presents the demonstration activities done within the scope of UVAR Exchange on signage, VMS, C-ITS and on cross border data exchange.

Structure of the report

The report is structured as follows:

- Chapter 1 focuses on the demonstration activities on signage, presenting the refined approach, the UVAR signage demo, the UVAR VMS demo and the UVAR C-ITS demo. For each demo it presents the aim of that demo, the process and consultation activities, demonstration activities, challenges, barriers and benefits/opportunities encountered and the findings and recommendations.
- Chapter 2 focuses on the demonstration activities on cross border data exchange. For each demo it presents the aim of that demo, the process and consultation activities, demonstration activities, challenges, barriers and benefits/opportunities encountered and the findings and recommendations.

1. DEMONSTRATION ACTIVITIES ON SIGNAGE

1.1. Refined approach

The UVAR Exchange **demonstrator on road signs** was aimed to enable completeness, clarity and harmonization of UVAR physical road signs as well as to share and agree on a set of common practices of UVARs' information provision through signage.

Representatives of EU cities having different characteristics in terms of UVAR schemes had the opportunity to join the Demo either as **dry run** (to take part in collaborative activities and discussions but without any practical implementation) or **real-life testing.**

The **dry run** part of the demo focused on the collection of local practices and shared analysis of elements affecting UVAR information provision such as use of mandatory signs and symbols, basic/minimum information and wording on main and supplementary panels. It also emcompasses the design of improved and harmonised UVAR signs.

The **real-life** testing demo focused on the provision of harmonised messages on Variable Message Signs (VMS) and is partly linked to the demo on C-ITS.

Participating authorities have been asked to share their views, experience and resources (including photos of installed signs at different locations) and took part in bilateral and plenary discussions.

1.2. UVAR Signage Demo

1.2.1. Aim of this demo

The demo was aimed at collecting information and photos on existing UVAR signs and discussing as well as elaborating improved signage both in terms of main and additional panels.

The target audience of the demo involved city officials dealing with traffic management and UVARs (also including the local police and/or the mobility agency), different city authority departments but also key representatives from the Transport Ministries, regional authorities, road safety agencies as well as enforcement bodies.

Key participants were experts and officials responsible for the design, adoption and implementation (installation, operation and maintenance) of the UVAR signs.

1.2.2. Process and consultation activities

The process was based on the following 5 steps:

- **Step 1.** Preliminary discussions with the cities to engage them;
- **Step 2.** Bilateral meetings to set the scene for each city on signs, rules & governance: UVARs currently used, information they provide, their location, practical application of national/regional guidelines, different type of entities involved, etc.
- **Step 3.** Plenary sessions/Workshop or Bilateral meetings: where examples of UVAR signs/rules from each country were presented and discussed among the participants together with newly designed or improved panels and information.
- **Step 4.** Final design of improved UVAR signs, VMS testing and driver evaluation

Preliminary discussions and engagement activities led to the final involvement of 9 Cities, 1 Region and 1 Ministry from 6 EU Member States as in the following list:

1. **City of Milan (IT)**
   - Valentino Sevino, Paolo Campus, Giuseppina Mauceri (AMAT Mobility Agency)
2. **Lombardy Region (IT)**
   - Gianluca Guerrieri, Matteo Lazzarini
3. **City of Monza (IT)** – involved also in the VMS demo
   - Carlo Vaghi (Monza Mobility Agency)
4. **City of Verona (IT)** – *observer; involved in the data exchange demo*
   - *Bruno Pezzuto*
5. **Barcelona Metropolitan Barcelona (ES**)
   - *Jordi Jové Palou (AMB)*
6. **City of Vitoria-Gasteiz (ES)**
   - Jon Ruiz de Infante Anton
7. **City of Lisbon (PT)** – *involved also in the VMS demo*
   - Pedro Ladeira. Ricardo Costa (CML traffic unit)
8. **City of Rotterdam (NL) -** *observer; involved in the data exchange demo*
   - Berco Verhoek
9. **NL Ministry of Transport and Waterways (NL)**
   - Evrim Akar
10. **City of Brno (CZ)** – *observer*
    - Jiří Stratil, Brněnské komunikace a.s.
11. **City of Krakow (PL)** – *observer*
    - Lukas Franek

Italian and Spanish Ministries were involved in preliminary discussion but did not participate in following activities and consultations. Observers contributed with their materials (information on the UVAR schemes in place and collection of signage photos as explained in the following) but did not participate in the development of harmonised/improved signs. The city of Rotterdam declared the interest to be part of the demo as observer but produced ideas of improved signs and was part of the full exchange together with the NL Ministry.

All confirmed/participating entities received the draft versions of the reports "*Practical aspects of UVAR information provision through signage"* (Task 1.1) and *"Guidelines for UVAR Variable Message Signs (VMS)"* (Task 1.3) which formed the basis for the discussion.

During step 2 a first bilateral virtual meeting was organized between the responsible UVAR Exchange partner and each participating entity.

The city/region/Ministry was asked to provide signage-related information – particularly on zonal entry/exit signs, road marking, advance warning signs and VMS - on all those UVAR typologies present in their local context and targeted by UVAR Exchange.

Key information/topics were included in a tailored template. The entities had the chance to fill in the template in advance or directly answer questions during the meeting.

Designs and georeferenced photos of currently installed UVAR signs were collected prior to the following bilateral meetings intended to discuss of potential implementation of the demo such as run of harmonised/improved messages on VMS or installation of adapted UVAR signs. In all but one demo real implementation was not possible because of legal barriers: without the adaptation of national

norms or guidelines, cities cannot introduce changes in road signs and the layout. Designs of new signs and panels layouts were simply discussed and finalised as prospected improvements. It's worth mentioning that the only improved UVAR sign that will be adopted as a result of the UVAR Exchange demo is the one developed for the Limited Traffic Zone of Vitoria-Gasteiz in Spain: the country has not ratified the 1968 UN Vienna Convention on Road Signs and Signals and so cities have more flexibility to adapt road signs; Vitoria was also in the process of designing new signs for its LTZ and therefore the demo was extremely helpful

The bilateral meetings took place between July and September 2022 and had a duration of 1 hour/1hour and half. Some plenary meetings with the entities of one sole country also took place to agree to share their practice/experience of UVAR signage and to discuss possible ways of improving clarity and information provision to drivers, also in the light of tentative harmonisation of both main and supplementary panels.

Due to both time and resources constraints of the participating entities, plenary meetings in workshop format were not organised to focus more on the bilateral exchanges.

The tentative harmonisation was checked against national rules and guidelines and having as fundamental reference the 1968 UN Convention on Road Signs and Signals (and the European Agreement supplementing the Convention). An expert of signs and signals (Mr Stefan Egger, member of the UNECE Working Group on Road Sign and Signal) attended the meetings and provided support to the attendants.

The approach follows the same methodology adopted to discuss of LEZ sign harmonisation across the EU during the workshops organised between December 2021 and May 2022.

A digital workspace for visual collaboration (https://miro.com/app/board/uXjVOdiVRqE=/) allowed participants to contribute with their ideas, upload materials and photos and provide feedbacks.

As a final step, the UVAR Exchange consortium presented a final proposal for improved and harmonised UVAR signs to feed the final version of the reports.

The results have been transposed in a brief visual survey addressed to EU drivers and mobility professionals to assess level of comprehension, clarity and completeness of information provided. (see Annex 2 of Task 1 report).

In connection with the UVAR Exchange demo on Collaborative ITS, messages were displayed on Variable Message Signs in Lisbon (PT) and Monza (IT) as advance warning messages in the vicinity and inside a Low Emission Zone.

1.2.3. Demonstration activities

Annex 1 of Task 1 report provides the full set of collected materials and improved UVAR signs resulting from demonstration activities.

Here below, the relevant information and some key photos from each investigated context is reported following the organisation of the template provided to the demonstrators and the information they provided. The results of the elaborations, in terms of improved and harmonised UVAR signs is also showed for some cities.

Lisbon

<table>
<tr><td colspan="4">City/Region</td></tr>
<tr><td colspan="4">Lisbon, Portugal</td></tr>
<tr><td colspan="4">Name of the UVAR scheme & Typology (PED, LEZ, LTZ, etc.)</td></tr>
<tr><td>LEZ (ZER – Zona de Emissões Reduzidas - ZER 1 and ZER 2)</td><td>LTZ (ZAC- Bairro Alto, Alfama, Santa Catarina/Bica, Castelo, Parque das Nações) maps in the same order</td><td>Pedestrian Zone</td><td>Priority Pedestrian Zone</td></tr>
<tr><td colspan="4">Map with scheme boundaries</td></tr>
<tr><td> 
ZER 1
 
ZER 2</td><td> 
 
 
  </td><td>No map available</td><td>No map available</td></tr>
</table>

Entry/Exit zonal signs + road marking

- *Convention on Road Signs and Signals (1968) – Vienna Convention*
- *Decreto Regulamentar n.o 22-A/98 – Regulamento de Sinalização do Trânsito*

(informative/non-binding)

1

(translation: pedestrian zone)

No road marks available

No end zone available

[1] https://www.google.pt/maps/@38.7073516,-9.1440748,3a,15y,149.67h,95.81t/data=!3m6!1e1!3m4!1sg8yrVz-dde5WtyA2PTwUhg!2e0!7i13312!8i6656?hl=pt-PT

No road marks available No end zone available	No road marks available No end zone available		  Road marks available only for 20km/h zone (3rd fig)
Advance warning signs			
Not present	Not present	Not present	Not present
Variable Message Signs			
Not present (will be available for the signage demo)	Not present	Not present	Not present
Time validity of the scheme			
Working days 07h-21h	Always (24h/365 days)	Always (24h/365 days)	Always (24h/365 days)
Vehicles affected / minimum standards			
Entry only permitted to: Zona 1 - >= euro III Zona 2 - >= euro II	All vehicles affected	All vehicles affected	All vehicles affected
Is preliminary registration needed to access the area? What about foreign vehicles?			
Permission can be asked at informacoeseservicos.lisboa.pt Same for foreign	A visitor card can be acquired in 3 physical places. The card allows entrance and parking for 30 min, after that, charges are applied. https://www.emel.pt/pt/onde-estacionar/zonas-	Not applicable	Not applicable

	de-acesso-condicionado/cartao-visitante/		
User/vehicle categories eligible for a permit or exempted			
• transport of disabled people • Road maintenance or construction (special vehicle) • city logistics (special vehicle) • Motorcycle • permanent resident • historical vehicle • emergency services • LPG • liquid gas	• residents of the area • vehicles owned by the municipality • delivery vehicles • construction vehicles • vehicles that have to go to schools, retirement homes or health services in the area		
Enforcement method used (e.g. manual check, cameras/ANPR, bollards, other physical elements)			
Manual (police), ZAC bollards			
Amount of the penalty fee and road charges (also if associated to permits)			
€60-€300	€60-€300		
Governance & Operation *If tomorrow a city wants to put in place this UVAR typology, who has to approve/authorize the scheme? Who has responsibility for its operation and enforcement? Who takes care of signage-related aspects?*			
CML (Lisbon municipality) is responsible for implementation and management (approval from the mobility councilor might be needed in some situations) ANSR (national road safety authority) may carry out inspections			

Lisbon: complete LEZ and LTZ proposals

Vitoria-Gasteiz

Pedestrian Zones (PED)	In 1976, work began to pedestrianize the city's urban centre; in 1983 the Medieval Quarter was pedestrianised and in 1993 the pedestrianisation was expanded to include more than 20 streets and an area of 40,000 m2. In recent decades, the pedestrianisation of different streets in the city has continued. Currently, pedestrian streets total 55,600 linear metres, corresponding to 524 street sections (a section is the length between two blocks).
Limited Traffic Zone (LTZ)	The actual LTZ consists of four routes (1,5 km) where no transit traffic is allowed. This is enforced with cameras. If the vehicle has driven straight through the route it is sent a fine – unless it has an exemption. Vehicles that use this route to access somewhere just of the route will take longer to travel between the two cameras, and therefore will not be fined.
Low Emission Zone (LEZ)	Work is currently underway on the implementation of the LEZ, which legally has to be in place by 2023.
Congestion Charge Zone (CC)	No CC in Vitoria-Gasteiz.
Pedestrian Priority Zone (PPZ) such as 30 km/h Zones, Home Zones, Residential Areas, Superblocks	The SUMP of Vitoria-Gasteiz bases the mobility of the city on the superblock scheme. Two are currently fully implemented and numerous traffic calming actions have been carried out in the last decade following the approval of the SUMP, in 2007. Throughout Spain (cities): 20 km/h on roads that have a single roadway and sidewalk platform. 30 km/h on single lane roads in each direction of travel.

	50 km/h on roads with two or more lanes in each direction of traffic.

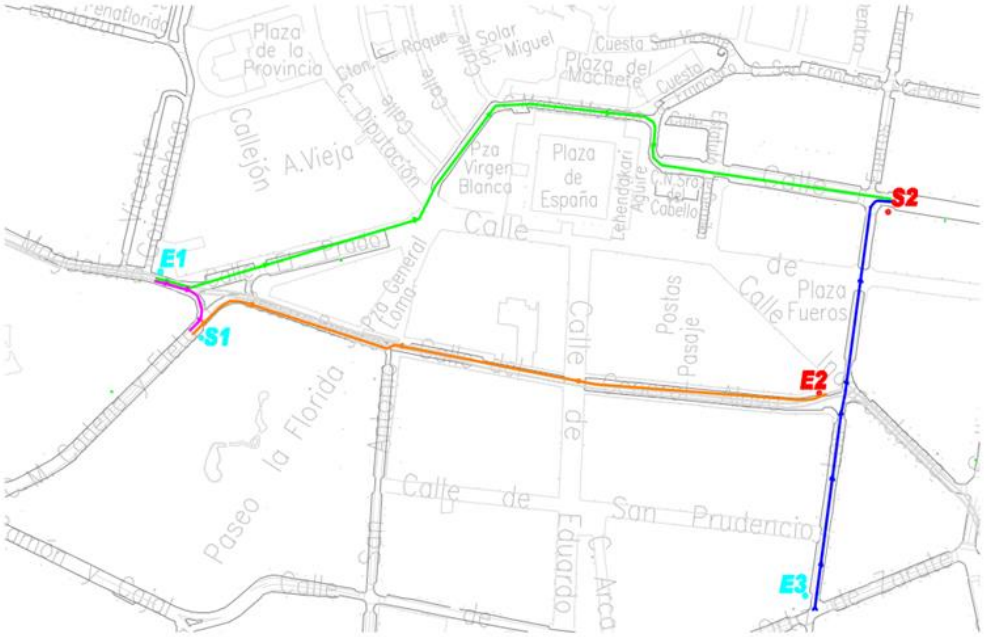
City/Region

VITORIA-GASTEIZ, BASQUE COUNTRY, SPAIN

Name of the UVAR scheme & Typology (PED, LEZ, LTZ, etc,)

LTZ

Map with scheme boundaries



https://www.vitoria-gasteiz.org/docs/wb021/contenidosEstaticos/adjuntos/es/33/88/53388.pdf

Entry/Exit zonal signs + road marking

https://goo.gl/maps/dhC18fm7rra4i4Yj9

https://goo.gl/maps/nP6ofCS5hgyxCSEd8

Advance warning signs
NO
Variable Message Signs
NO
Time validity of the scheme (Months, days and/or hours of operation) – please specify time windows for different users if any (e.g. delivery)
PERMANENT.
Vehicles affected / minimum standards
All type of vehicles
Is preliminary registration needed to access the area? What about foreign vehicles?
The scheme is based on the permits distribution concept and on the ground enforcement system that works by reading via the number plates of all vehicles entering and leaving the city centre.
User/vehicle categories eligible for a permit or exempted
Those of the Fire and Rescue Service, Police, ambulances and, in general, emergency vehicles. Those transporting sick or disabled persons. Those coming from or going to an authorised garage or car park located in the area. Authorised vehicles carrying out loading and unloading work in the streets and at the times authorised. Vehicles expressly excluded from this prohibition by a justified resolution of the municipal authority.
Enforcement method used (e.g. manual check, cameras/ANPR, bollards, other physical elements)
Enforcement that works by reading the number plates of all vehicles entering and leaving the city. If the vehicle entering in the regulated zone takes less than a certain time to exit the regulated area, it is considered a 'passing-through' (transit) vehicle and therefore the driver is fined.
Amount of the penalty fee and road charges (also if associated to permits)
According to the law.
Governance & Operation *If tomorrow a city wants to put in place this UVAR typology, who has to approve/authorize the scheme? Who has responsibility for its operation and enforcement? Who takes care of signage-related aspects?*
Spanish legislation grants competence for traffic, vehicle parking and mobility to local councils. Therefore, it is the municipality that has the competence to establish limited traffic zones. The implementation and management of such zones is the responsibility of the Department of Mobility and Public Space, which has the competence for traffic management and is responsible for urban

signage with regard to traffic. The enforcement of the law is the responsibility of the Local Police who, as agents of the authority, are competent to propose infractions and to impose sanctions.

Final comments

Clarity/completeness/comprehension → enough (according to the circulation code (law).

Intentional/unintentional behaviour foreign vehicles → not remarkable.

Ways of improving on road information provision → Currently in execution the project to improve informative signage (phase 1).

According to the diagnosis of the Municipal Strategic Plan for Road Safety and Sustainable Mobility of Vitoria-Gasteiz 2018-2023 of Vitoria-Gasteiz 2018-2023:

The state of conservation of road markings in Vitoria-Gasteiz has room for improvement, especially in the signalling of some zebra crossings at intersections and in the delimitation of lanes within roundabouts.

Vertical signage in Vitoria-Gasteiz can clearly be improved. Many of the signs are in poor condition.

As a general rule, there is a lack of vertical signage at pedestrian crossings without traffic lights on the basic network.

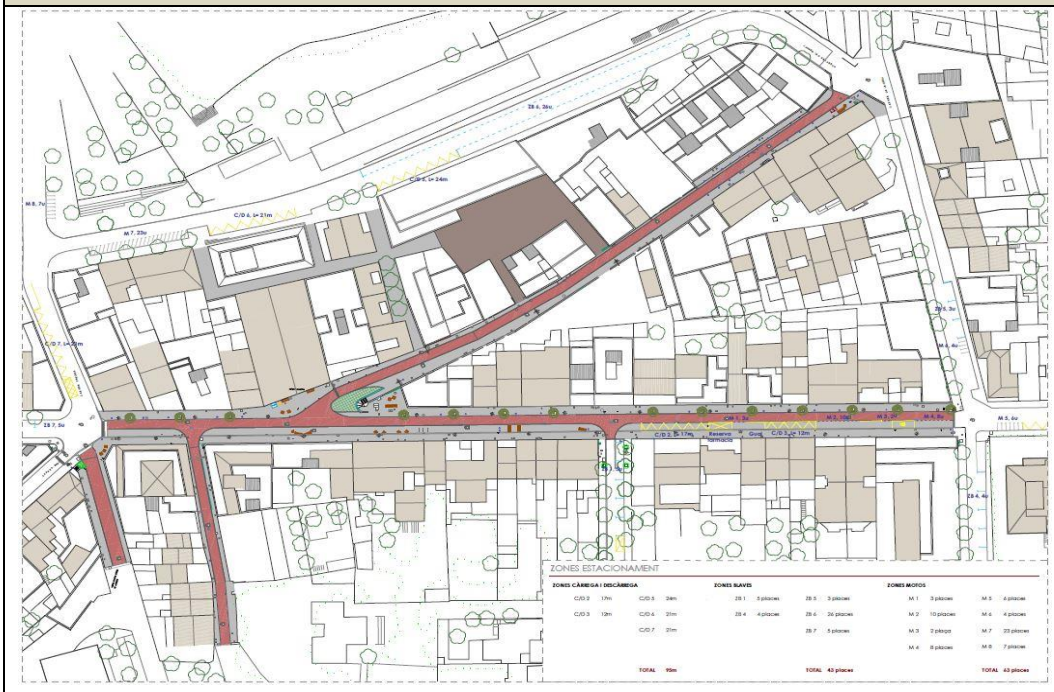
Vitoria-Gasteiz: complete LTZ proposals

More essential sign in Spanish & Basque

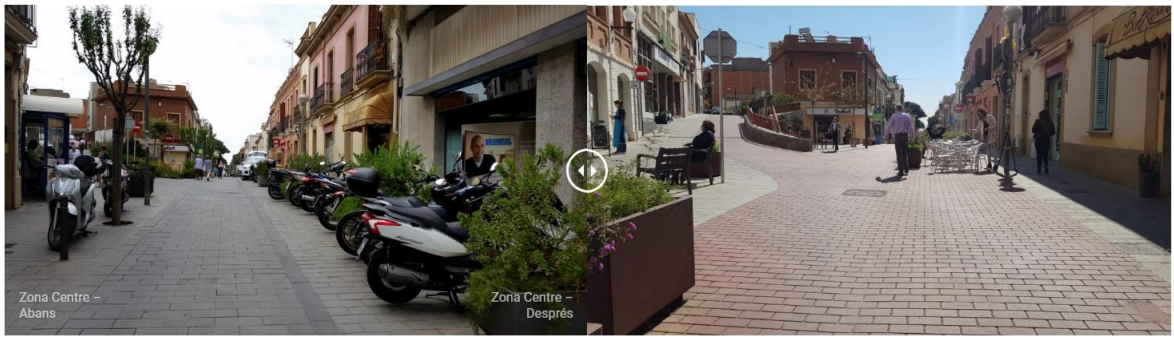
References to the phone number and the website could be placed on another more informative or advance warning sign, before the LTZ entry sign or just aside this one.

The problem with loading/unloading operations in case of ANPR systems is that carriers always need to obtain a permit in advance. That's why time windows are showed after the text «and authorised». The same applies for disabled people, unless in the country a centralised check of blue badges is in place (so cameras can recognize disabled users without pre-registration)

Barcelona

City/Region
Sant Just Desvern / Barcelona Metropolitan Area
Name of the UVAR scheme & Typology (PED, LEZ, LTZ, etc,)
LEZ & LTZ
Map with scheme boundaries

Entry/Exit zonal signs + road marking

Advance warning signs
No advance warning signs
Variable Message Signs
No variable message signs
Time validity of the scheme
24h day *Access only for pedestrians, neighbors, bicycles and electric vehicles.* *Urban delivery access only labor days from Monday to Saturday from 8:00 a.m. to 11:00 a.m.*
Vehicles affected / minimum standards
All motorized vehicles
Is preliminary registration needed to access the area? What about foreign vehicles?
No preliminary registration needed.
User/vehicle categories eligible for a permit or exempted
To be electric o non-emission vehicle.
Enforcement method used (e.g. manual check, cameras/ANPR, bollards, other physical elements)

Cameras
Amount of the penalty fee and road charges (also if associated to permits)
Governance & Operation *If tomorrow a city wants to put in place this UVAR typology, who has to approve/authorize the scheme? Who has responsibility for its operation and enforcement? Who takes care of signage-related aspects?*
The municipality is the one that regulates the area and the AMB is the one that collaborates in the metropolitan coordination of the measure.
Final comments *Please use this section to provide your views on aspects such as clarity/completeness/comprehension of the information provided to drivers via road signs, their intentional/unintentional behaviour (particularly from foreign vehicles) and possible ways of improving on road information provision*
The restricted area of Sant Just Desvern, even though it is called a Low Emission Zone, corresponds to a traffic limitation that has allowed the creation of a pedestrian area. *Before and after*   

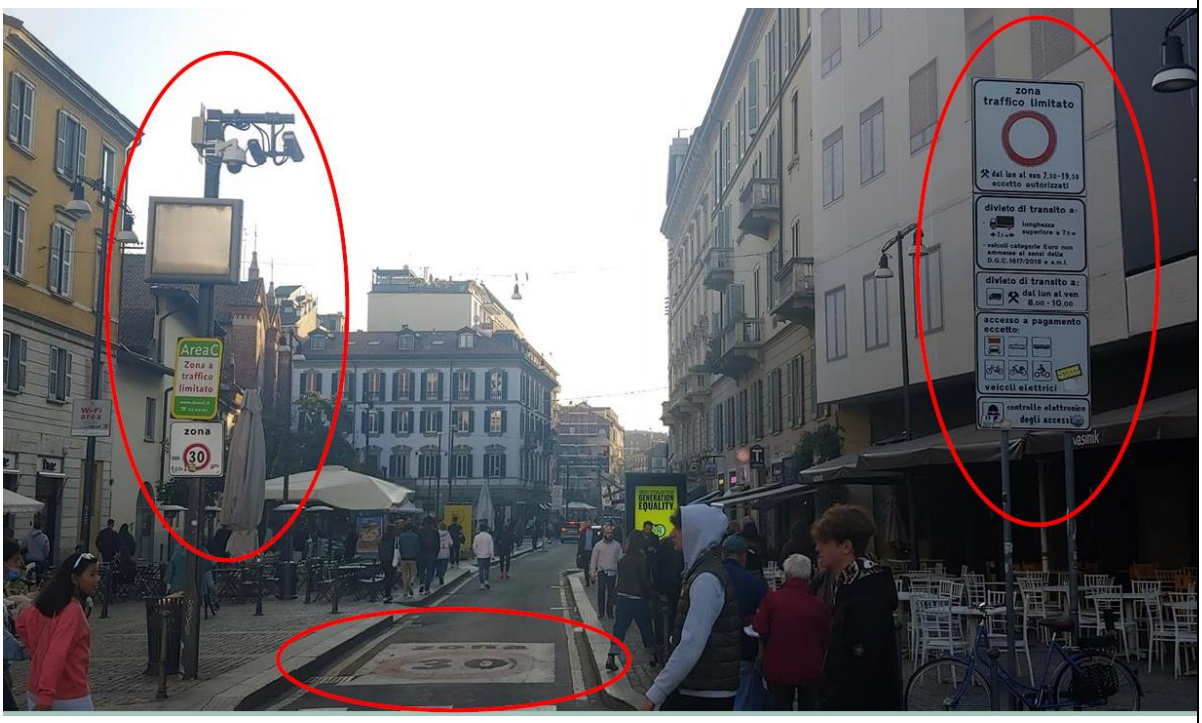
Milan & Lombardy Region

City/Region
Milano
Name of the UVAR scheme & Typology (PED, LEZ, LTZ, etc,)
Various, see below
Map with scheme boundaries
Not provided

Entry/Exit zonal signs + road marking

Area B – Low Emission Zone

Area C – Congestion Charge Zone



Limited Traffic Zone

Pedestrian Zone

Advance warning signs

Coordinates:

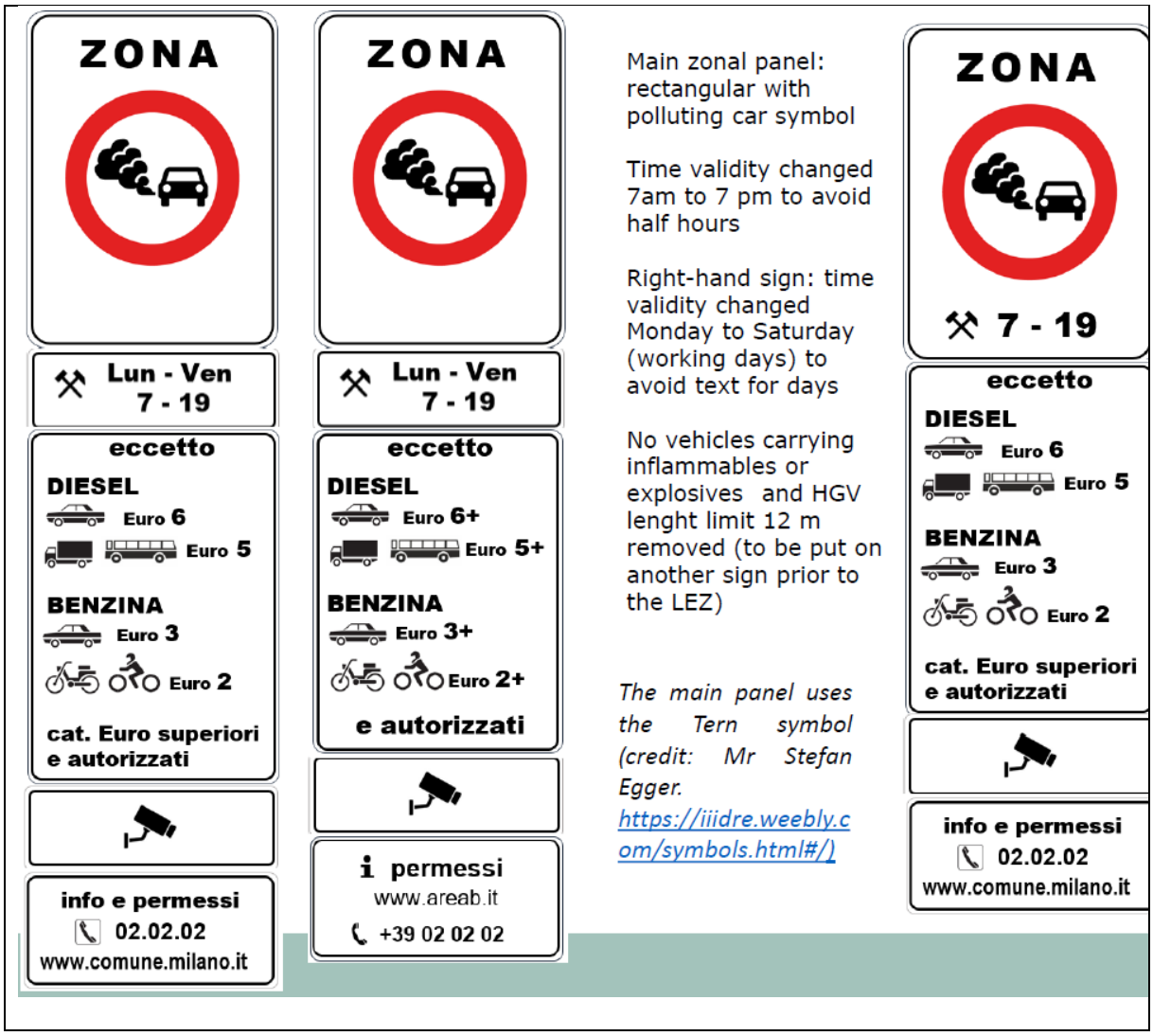
45.44702, 9.17297

45.452213, 9.169913

45.447650, 9.255845

45.449572, 9.165192
Variable Message Signs

Time validity of the scheme (Months, days and/or hours of operation) – please specify time windows for different users if any (e.g. delivery)
Different validities
Vehicles affected / minimum standards
Various
Is preliminary registration needed to access the area? What about foreign vehicles?
Yes
User/vehicle categories eligible for a permit or exempted
Enforcement method used (e.g. manual check, cameras/ANPR, bollards, other physical elements)
ANPR
Amount of the penalty fee and road charges (also if associated to permits)
Milan and Lombardy Region: complete LTZ proposals
Milan LEZ Area B


ZONA
Lun - Ven
7 - 19
eccetto
DIESEL
Euro 6
Euro 5
BENZINA
Euro 3
Euro 2
cat. Euro superiori
e autorizzati
info e permessi
02.02.02
www.comune.milano.it
ZONA
Lun - Ven
7 - 19
eccetto
DIESEL
Euro 6+
Euro 5+
BENZINA
Euro 3+
Euro 2+
e autorizzati
permessi
www.areab.it
+39 02 02 02
Main zonal panel: rectangular with polluting car symbol
Time validity changed 7am to 7 pm to avoid half hours
Right-hand sign: time validity changed Monday to Saturday (working days) to avoid text for days
No vehicles carrying inflammables or explosives and HGV lenght limit 12 m removed (to be put on another sign prior to the LEZ)
The main panel uses the Tern symbol (credit: Mr Stefan Egger.
https://iiidre.weebly.com/symbols.html#/)
ZONA
7 - 19
eccetto
DIESEL
Euro 6
Euro 5
BENZINA
Euro 3
Euro 2
cat. Euro superiori
e autorizzati
info e permessi
02.02.02
www.comune.milano.it

LEZ Lombardy

The Netherlands

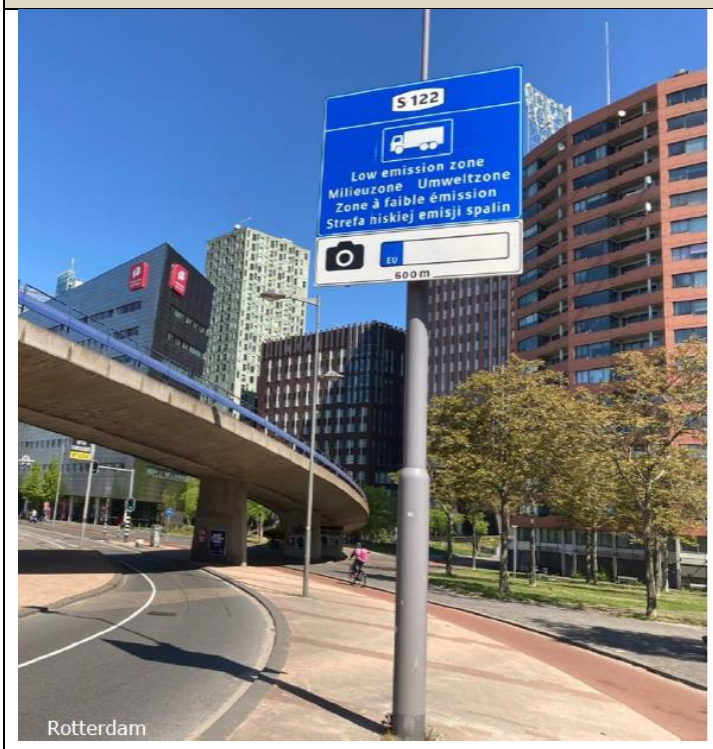
City/Region
The Hague
Name of the UVAR scheme & Typology (PED, LEZ, LTZ, etc,)
Various, see below
Map with scheme boundaries
Not provided
Entry/Exit zonal signs + road marking
Low Emission Zone

Limited Traffic Zone

Pedestrian zone

Pedestrian Priority Zone

Advance warning signs



Variable Message Signs

Not provided

Time validity of the scheme (Months, days and/or hours of operation) – please specify time windows for different users if any (e.g. delivery)

Different validities

Vehicles affected / minimum standards

Various
Is preliminary registration needed to access the area? What about foreign vehicles?
No
User/vehicle categories eligible for a permit or exempted
Enforcement method used (e.g. manual check, cameras/ANPR, bollards, other physical elements)
ANPR
Amount of the penalty fee and road charges (also if associated to permits)
The Netherlands: complete LEZ proposals

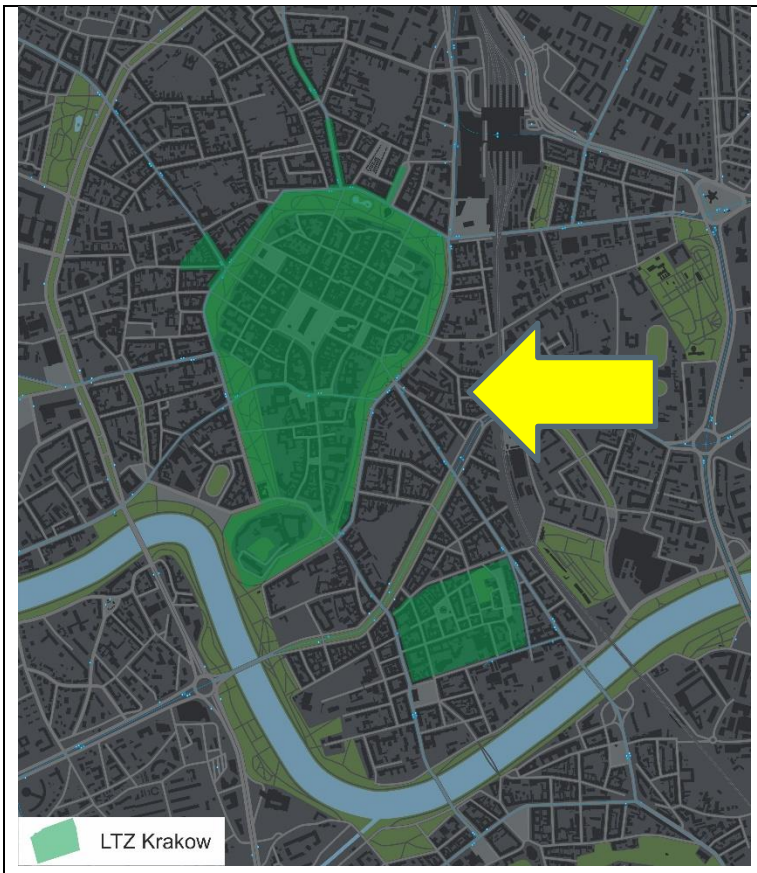

Krakow

Pedestrian Zones (PED)	Yes.
Limited Traffic Zone (LTZ)	Yes. https://urbanaccessregulations.eu/countries-mainmenu-147/poland/krakow-ltz
Low Emission Zone (LEZ)	No but there's a plan to introduce a new LEZ in the coming months

Congestion Charge Zone (CC)	No
Pedestrian Priority Zone (PPZ) such as 30 km/h Zones, Home Zones, Residential Areas, Superblocks	Yes

https://urbanaccessregulations.eu/countries-mainmenu-147/poland/krakow-cracow

City/Region
Krakow, Poland
Name of the UVAR scheme & Typology (PED, LEZ, LTZ, etc.)
Limited Traffic Zone Old Town First comprehensive project of Limited Traffic Zone was introduced in Krakow on October 1, 1988. It was the first such a solution in Poland, other Polish cities introduced them later, using the experience of Krakow. In addition to the well-known traffic and environmental reasons, the current challenge at that time was the need to protect cultural values, which raised after the Krakow Old Town in 1978 was placed on the first UNESCO list of world cultural and natural heritage. The idea of the project introduced in 1988 was the division of the city center into three zones: A for pedestrians and bicycles, vehicles for unloading between 19:00 and 10:00; zone B with limited car traffic - rules common with zone A, and in addition for vehicles of residents of zones A and B, public transport, institutions located there with a permit and hotel guests for check in; • zone C of limited and paid parking valid on weekdays from 10:00 to 18:00. The parking time was limited to 2 hours (this did not apply to subscription holders). Public transport played an important role, as an alternative for car arrival. The PT routes were corrected and the frequency of all lines serving the Old Town area was increased. Traffic organization in downtown Kraków introduced in 1988. The positive effects of the introduction of area-based traffic calming in the downtown were most clearly visible immediately after its introduction. The number of vehicles entering the Old Town area per day was reduced by nearly 70%, traffic flow on the calmed northern and western sections of the 1st ring road decreased up to 58%, on the radial streets leading to the Old Town traffic volume decreased by 10 to 25% and the noise level during rush hours has decreased by 3 to 10 dB. In the year following the introduction of changes in traffic organization, the number of injured in accidents in the traffic calming zone decreased by 43%, nitrogen dioxide concentrations in the entire downtown area decreased by 15 to 30%. Social acceptance in research carried out among drivers, car owners, both from Krakow and outside the city, showed that 24% gave up commuting to the city center by car. Over the next 30 years, the original traffic-calming design underwent further expansion with final area scope limited by the first ring road and creation of the second area in the former historical Jewish district called Kazimierz. All LTZ zone is in parallel a fully pedestrian priority area, with 20km/h speed limit.
Map with scheme boundaries



Entry/Exit zonal signs + road marking

Advance warning signs
Not present
Variable Message Signs
Not present
Time validity of the scheme (Months, days and/or hours of operation) – please specify time windows for different users if any (e.g. delivery)
Permanent Loading and unloading is allowed from 22:00 - 09:30 and 13:00 - 14:00
Vehicles affected / minimum standards
All vehicles
Is preliminary registration needed to access the area? What about foreign vehicles?
Yes, users have to register via this link https://zdmk.krakow.pl/nasze-dzialania/procedura-na-wjazd-do-stref-ograniczonego-ruchu/
User/vehicle categories eligible for a permit or exempted
- Residents (except pedestrian streets) - Deliveries 22:00 - 09:30 and 13:00 - 14:00 - Disabled - Taxi - CC,CD - Money convoy - Ambulance, Police, Municipal Service - With special permit on specific occasions - Hotel guests to unload can enter if the hotel has a parking lot
Enforcement method used (e.g. manual check, cameras/ANPR, bollards, other physical elements)
Manual
Amount of the penalty fee and road charges (also if associated to permits)
250PLN, c.a. 55EUR

Brno

City/Region
Brno, South Moravian, Czech Republic
Name of the UVAR scheme & Typology (PED, LEZ, LTZ, etc,)
PED, LTZ, residential
Map with scheme boundaries

Yellow – PED

Other colours – LTZ + 30km/h

Entry/Exit zonal signs + road marking

PED:

LTZ:

Canceled by first intersection

30km/h zone:

Advance warning signs

Not present
Variable Message Signs
Not present
Time validity of the scheme (Months, days and/or hours of operation) – please specify time windows for different users if any (e.g. delivery)
Residents and tenants 24/7 Delivery and services 6:00 - 10:30
Vehicles affected / minimum standards
Individual permission (depends on zone, weight etc.)
Is preliminary registration needed to access the area? What about foreign vehicles?
Yes
User/vehicle categories eligible for a permit or exempted
Residential, tenants, delivery, services
Enforcement method used (e.g. manual check, cameras/ANPR, bollards, other physical elements)
Cameras. City police if required
Amount of the penalty fee and road charges (also if associated to permits)
Residents: • 1st car 200Kč/year • 2nd car 8 000Kč/year • 3rd and other 12 000 Kč/year Tenants: • 1st car 4 000Kč/year • 2. auto a další auto 18 000 Kč/year
Governance & Operation *If tomorrow a city wants to put in place this UVAR typology, who has to approve/authorize the scheme? Who has responsibility for its operation and enforcement? Who takes care of signage-related aspects?*
Traffic police for emergency services.

1.2.4. Challenges, barriers and benefits/opportunities encoutered

The level of involvement of the different public entities varied a lot depending on both time and financial constraints: due to the fact that participation was given on a voluntary basis and without any budget, some representatives were not able to follow the entire process as initially planned.

It was decided to focus more on bilateral exchange and meetings, sometimes enlarged to other participating entities from the same country, in order to discuss of the different elements, agree on possible improvements and validate reports' conclusions.

It was not possible to further explore the potential of a real life testing because in almost all countries (except for Spain and Vitoria-Gasteiz in particular) modifications of existing signs is not possible without a proper legal update or insertion in official regulations and/or guidelines.

The most relevant opportunity was the contribution to the work of the UNECE Working Group on Signs and Signals via the participation of CORTE at their meeting s as well as the presence of the WG Secretary at all UVAR Exchange stakeholder workshops.

1.2.5. Findings, recommendations and next steps

The Demo was fundamental to properly understand differences and practices among the current UVAR signs in Europe but also to focus on possible ways of improving clarity and completeness of the information to be conveyed on physical signage.

All recommendations for proper UVAR signage and proposed harmonisation of signs and panels' layout for the different UVAR typologies are included in Task 1 report.

In terms of next steps, the EC should support the adoption at EU Member State level of the polluting car symbol inside the C,2 prohibitory red roundel for Low Emission Zones, thus facilitating the recognition of the scheme and its differentiation from other UVARs namely Limited Traffic Zones.

Member State representatives could be also involved in collaborative and coordination activities (also within the Expert Group on Urban Mobility) on UVAR signage harmonisation, particularly on the use of a common layout and rules for organising text and symbols on the panels: this may led to immediate adaptations in line with the current legislation (e.g., transferred in official guidelines so that cities can properly adapt their signage) or prepare the ground for future changes of national norms such as the introduction of new signs, symbols, inscriptions or road marking.

It is important to continue to contribute to the work of the UNECE Group of Experts on Road Signs and Signals which had been mandated to assess the new signs for a possible inclusion in the 1968 Vienna Convention in a number of priority areas, including the polluting car symbol for LEZs or the symbol depicting zero emission vehicles. Other symbols might be suggested for discussion as for the ones depicting permits and charges.

Dissemination and learning opportunities, e.g., via the CIVITAS Initiative, the ELTIS platform or other demonstrative projects, should focus more on the comprehension of differencies and functioning of the different UVAR typologies and include elements such as road signs, road marking and adaptations of the road layout as well as other practical aspects of UVARs' information provision and access (info on the web, C-ITS, registration procedures, etc.) In this vein, the suggestion is to pursue and work more on UVAR design following a user-centric approach and thus covering all aspects (e.g. coexistence of different schemes, boundaries, time validities, affected categories and enforcement systems) that can influence their implementation.

1.3. UVAR VMS Demo

1.3.1. Aim of the demo

While Task 1.3 relies on the standardization and harmonisation of the information provided via Variable Message Signs and exploiting the potential of VMS for UVAR provision, Task 1.4.1, namely the VMS demonstrator, consists of the reproduction and implementation of the outcomes from the first Task in real-life. Therefore, this demonstrator aims to enable the harmonisation of the representation in VMS of selected UVARs.

1.3.2. Process and consultation activities

The process for the VMS demonstration followed the steps previously identified in the beginning of the project:

1) Selection and involvement of demonstrator cities
2) Organisation of preparatory workshops: Brainstorming and Kickstart workshop
3) Collaborative work on harmonisation of UVAR road signs
4) Beta implementation of the VMS representation

For this task to start, brainstorming on the demo phase (practical activities to be deployed) was needed. Afterward, it was necessary to select the formal involvement of targeted cities. Partners used their contacts' network and selected cities with already existing and well-placed VMS panels that could be willing to participate in the demo phase. In the end, the cities of Lisbon and Monza showed to be keen to use their panels for demonstration purposes.

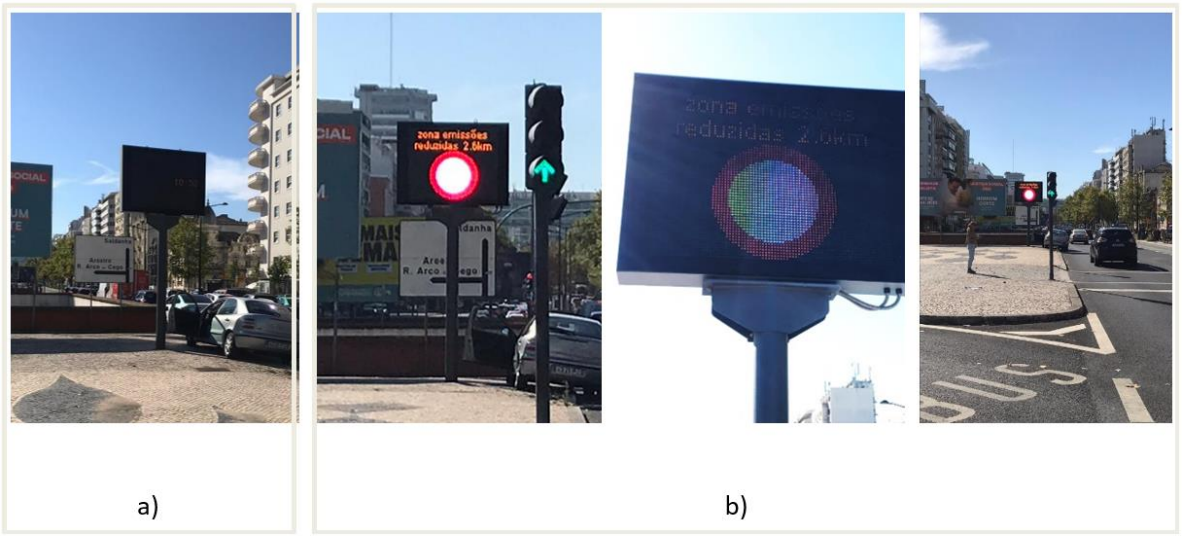
Several discussions took place with cities and organizations related to signage systems and prescription and a feedback loop was created between the UVAR Exchange consortium and the cities aiming at participating in the VMS demonstrator. The final step and activity was devoted to the practical implementation of the demo. Basically, the cities worked on their system of installed VMS panels in order to "run" the defined common harmonised messages for a specific period.

1.3.3. Demonstration actvities

Two real life demonstrations were pursued. After studying each panel and designing each message it was possible to show them in the streets of Lisbon (Portugal) and Monza (Italy) for their Low Emission Zones.

Lisbon's real-life demonstrator took place on the 12th of October 2022. The Figure below shows a collection of real photos.

Figure 1: Real photos from the VMS demo in Lisbon: a) panel without the message (showing the time); b) panel with the UVAR message (from distinct frames).



The real-life demonstrator in Monza took place on the morning of the 17th of October 2022. Figure 2 shows a real photo of the implementation.

Figure 2: Real photo from the VMS demo in Monza

1.3.4. Challenges, barriers and benefits/opportunities encoutered

One of the main challenges faced was the limitations associated with each panel's characteristics. The regulations and standards must be carefully followed, however, when it comes to recommendations, they serve only as guidelines for obtaining a result with the higher quality possible. This applies to the defined UVAR VMS messages implemented in the demo. While trying to follow the recommendations identified in Tasks 1.1, 1.2, and 1.3, it was possible to conclude that not all can be applied at the same time since there are always limitations from different kinds. For instance, the location of the panels was not perfect since they were reused instead of strategically installed for project purposes. Furthermore, the dimensions and resolution of the panel were a limitation to presenting more information (e.g., bilingual messages), a clearer sentence, or more detailed pictograms (e.g., prohibition symbol with a polluting car inside it).

On one hand, the identification of cities with already existing VMS panels was a challenge. The project did not provide any budget for installing new equipment, thus, besides looking for cities willing to

collaborate, an additional requirement was to have already an available panel. For instance, Lisbon made two panels available for the demo, but given the time of the demonstration, they were only able to provide us with one of the panels. Nevertheless, the message was designed for both. The panel's location was also a challenge since it had to be close to an UVAR entry or in a place where it would represent well an advance warning.

On the other hand, it is important to acknowledge that the use of VMS allows more flexibility than physical signage since a message can be easily changed without requiring too much effort or resources.

Besides the above mentioned limitations, the result was very successful and it was only possible due to the cities' goodwill, which have always been active in the discussions with the consortium and project's initiatives. Moreover, it is worth mentioning that no significant technical barriers were faced. The communication with the cities' responsibles for the VMS panels was very simple and our proposed messages could be shown without constraints.

1.3.5. Findings, recomendations and next steps

Overall, it was possible to consider two cities for the VMS real life demonstrator: Lisbon (Portugal) and Monza (Italy). A total of three UVAR messages were designed but only two could be exposed in real-life. The demonstration comprehended a theoretical phase where the possible messages were discussed, and a practical phase where the technical requirements were defined, and the necessary artifacts were produced.

In the end it was possible to conclude that besides having a set of recommendations to guide the process of defining a message, there is no defined recipe, and each case must be analysed carefully to achieve a harmonised and comprehensible result.

To pursue with the work that has been carried out towards harmonization of UVAR VMS, the following next steps should be considered:

- The recommendations and guidelines should be implemented in real-world scenarios. This requires collaboration between the relevant authorities, such as traffic and transport departments, and the manufacturers and suppliers of VMS panels.

- Once implemented, the UVAR messages on the VMS panels should be tested and evaluated to ensure that they are effective in communicating the intended message to drivers. This could involve monitoring driver behaviour before and after the installation of the VMS panels or conducting surveys to gather feedback from drivers. Moreover, based on the results of the testing and evaluation, the UVAR messages on the VMS panels may need to be refined or revised.

- Even with clear and effective UVAR messages on VMS panels, it is important to educate drivers about the importance of following urban vehicle access regulations. This could involve targeted outreach campaigns, such as social media ads or posters in high-traffic areas, to raise awareness and encourage compliance with UVARs.

- Finally, it is important to continue monitoring and improving the effectiveness of the UVAR messages on VMS panels over time. This could involve regularly reviewing and updating the messages to reflect changes in regulations or best practices, or conducting periodic evaluations to ensure that the messages are still effective in achieving their intended goals.

- To implement the steps above, it is crucial to establish partnerships, define clear testing protocols, allocate resources, and create education and outreach programs.

1.4. UVAR C-ITS Demo

1.4.1. Aim of the C-ITS demo

The aim of this demo was to test the use of C-ITS to send relevant UVAR information directly to vehicles for existing and upcoming C-ITS UVAR service in order to show the possibility of C-ITS as a medium for UVAR information.

C-ITS service provision is seen as a possibility to interact about active UVARs directly with single vehicles based on information provided directly from the regulating authority. Hereby the relevant UVAR information and its restrictions can be transmitted directly into the vehicle.

The overall objective of Task 1.4.2. is to demonstrate the potential of existing and upcoming C-ITS UVAR services for UVARs, as C-ITS services have the potential to interact with automated functions within vehicles directly, when transmitted as "legal valid service". Also, it is a chance to see the current status of development in this regard and challenges to overcome regarding the "European wide" implementation in the future. The demonstration will also tackle different types of "implementations" UVAR related C-ITS messages and derive some learnings for the future steps.

1.4.2. Process and consultation activities

The UVAR topic has high relevance on the level of city authorities. C-ITS is a topic that is quite new for many decision makers on the local level. Therefore, the process and consultation activities started with awareness raising on the level of the relevant decision makers.

Due to the innovative aspect of the topic, it was planned to do the Task 1.4.2. step by step: First starting off with the selection of cities interested in demonstrating UVAR relevant C-ITS services and their informal involvement. Then a kick-off workshop was organised with the aim of giving a basic insight into the possibilities of C-ITS regarding UVAR (in December 2021). After that the relevant partners started in-depth discussions with the interested cities, to plan and organise some demonstration of UVAR related C-ITS messages. These bilateral meetings took place with e.g., city of Helmond (NL), city of Vienna (AT), city of Milan (IT), city of Brno (CZ), city of Verona (IT), city of Gothenburg (SE).

The final activities include the demonstrations itself and the derivation of specific recommendations based on the C-ITS demonstrations.

Obstacles, dry run and actual demonstrations

The discussion with the cities in the second phase showed that UVAR demonstration via C-ITS is of interest for cities, but the cities are facing numerous obstacles in this regard at the moment.

One major obstacle was that many cities are missing the necessary basic C-ITS infrastructure or do not have implemented those message types relevant for the UVAR C-ITS message yet. Although the numerous exchange meetings with the cities showed that there is high interest in the next steps, only a few cities were potential candidates for a "full demonstration".

One city that had main interest in the implementation of UVAR with C-ITS was the city of Helmond (NL). Together with the city of Helmond the UVAR Exchange partners (Task leader AustriaTech) detailed a potential test plan, including all necessary requirements and steps for a demonstration of UVAR via C-ITS. The test plan was an important step to detail the necessary developments and investments regarding the actual demonstratation and implement UVAR via C-ITS in the city of Helmond. Due to the given timeframe an actual implementation was not possible during the course of the project.

However, the results are important for the city itself, but the learnings can also be used for other cities to evaluate their requirements, as the developed test plan contains the planned features, the necessary technological requirements regarding C-ITS infrastructure and explains how the actual testing of C-ITS UVAR messages can take place.

These results and outcomes are also referred below as “dry run”.

Summarizing the interaction with the cities during the consultation process within UVAR exchange it can be stated, that

- UVAR is a topic of high interest for cities.
- C-ITS is an innovation topic for some cities, but major developments in this regard are missing at the moment.
- The relevant message types for UVAR (IVI messages) are not implemented in most cities that already have C-ITS infrastructure, as their major focus is currently on SPAT-MAP messages.
- Results and learnings are important to share with cities in the future as the topic “UVAR C-ITS message” is still a highly innovative task, but with major potential for the future. However, there is the need for further awareness raising and training.

In addition to the “dry run” two full demonstrations were done within the course of UVAR Exchange project, in two different EU members states with different focus on the tested messages. In the full demonstration the sending out of UVAR related C-ITS messages was planned and demonstrated with real on-site test drives and results in form of logs and videos.

The full demonstration could be distinguished between the “free text use case” and the “traffic sign use case”. In principle UVAR messages will be sent out in form of an IVI message (see chapter 2.4.3 - Introduction to C-ITS). But even the message format provides space for different types of implementations. One possibility is to use the message type “free text” IVI message (Free text use case). Another option to is to adapt the “traffic sign use case” and use a pictogram instead of a free text. Both options need slightly different implementation. For UVAR Exchange it was decided to test both use cases for UVAR and collect learnings for both options. In Vienna/AT the free text use case was demonstrated. In Trento/IT the adaption of the traffic sign use case was tested.

Summarizing the process done in the project it can be stated that the actual “consultations” process for the C-ITS use of UVAR is higher as originally expected and cities are facing major hurdles at the moment. Having this in mind the actual awareness raising process took more resources and was more relevant than originally expected.

However, the step-by-step process made different types of implementations and learnings possible (e.g. in the dry run, in different types of demonstrations) and delivered important input for all future discussion and further implementation.

The concrete results are described below.

1.4.3. Demonstration activities

2.4.3.1. Introduction to C-ITS

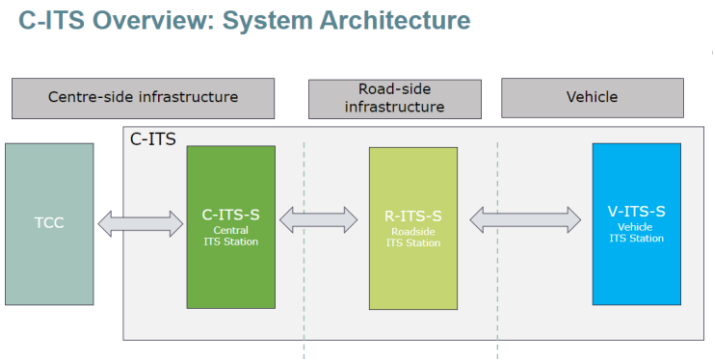
C-ITS provides various channels and possibilities to transport information directly into a vehicle and provide cooperative driving aspects. In Europe the C-Roads Platform in general specifies use cases and provides the specification for the use of C-ITS and defines message profiles used in various use cases.

From a communication technology aspect there are two ways to deliver C-ITS messages to a vehicle:

- ITS-G5

This is based on IEEE 802.11p and is used for short range communication between vehicles and infrastructure to vehicles where available and useful. The technology is proven in various pilots across Europe and is currently deployed in several countries from infrastructure providers as well as car manufacturers. This communication is based on several Roadside Units placed alongside the road (e.g., at traffic lights) and provide the connection between a traffic management centre (TMC) and vehicles (see **Error! Reference source not found.**).

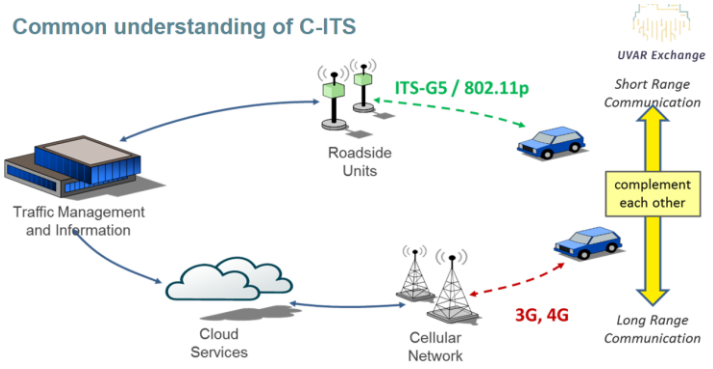
Figure 3: C-ITS System Architecture for ITS-G5



- Cellular communication (4G/5G)

A second possibility is long range communication using cellular technologies like 4G or 5G. In this case C-ITS communicates with the vehicles via an internet cloud solution.

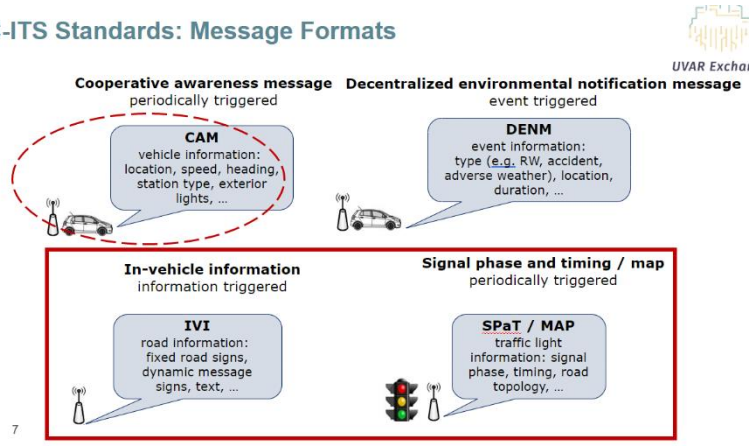
Figure 4: C-ITS Common Understanding



Both solutions as shown in **Error! Reference source not found.** are providing the same information to vehicles but over different communication technologies and provide for different purposes of information exchange a variety of possibilities.

As the information, which is exchanged varies widely - from a simple traffic event warning (like an accident warning) to more complex signaling information at intersections. All those use cases have their different needs of information and therefore need several different messages, which are specified within the C-ITS context.

Figure 5: C-ITS Message Formats



In principle it can be distinguished between four different types of messages: CAM messages (for vehicle related information like location, speed, heading), DENM messages (for information on events, including the type of event, the location and the duration), the IVI messages (for in-vehicle information related to the road like road signs, dynamic message signs, etc) and SPaT / MAP messages (used for traffic light information).

The evaluation done within UVAR Exchange project showed that the IVI message type is the most appropriate way to provide a UVAR messages, as it has the most appropriate functionalities regarding the UVAR use cases (see **Error! Reference source not found.Error! Reference source not found.**). IVI messages (In Vehicle Information Messages) are designed to provide a driver with the information ahead such speed limits or several other traffic sign or text information a driver would usually receive. In the cities usually also SPAT/MAP messages can be received, but these are not relevant for the C-ITS UVAR.

Although IVI messages seem to be most appropriate at the current point of view there are some restrictions that should be tackled here: C-ITS messages are developed within the sphere of motorway operation. Therefore, the messages are designed for a linear setup. Access restrictions are often related to certain “zones” or districts within the urban area. In principle IVI messages can be used as well for these zones, but the effort in preparing and coding the messages is quite high. The C-ITS UVAR demonstrations within UVAR will show the principal feasibility and give further recommendations. However, for the further implementation of UVAR within C-ITS (and other C-ITS services in the urban area) there is need for a further development of appropriate message formats that can easily be adapted to the requirements on the level of urban traffic (like the scope on zones, districts, etc) (see also chapter “recommendations”).

However, based on the current state-of-the-art IVI messages are the type of message that can actually be used for UVAR. How this looks like in implementation is shown in the following chapters.

As stated, before **the availability of C-ITS infrastructure in the pilot test sites (cities) is necessary** for the complete demonstration of UVAR related C-ITS message and in addition the possibility to send IVI messages. What the in-depth discussion with the cities showed is that the implementation of C-ITS infrastructure in the European cities is currently still a development task. Within the project UVAR Exchange an intensive exchange with numerous cities took place. With the result that many cities were challenged to set up a practical test within the time frame due to the given framework conditions on urban level. So a majority is missing the necessary basic C-ITS infrastructure to enable such a pilot demonstration and are therefore not relevant for a full demonstration. And most of those cities

contacted that are already active in the area of C-ITS have not implemented IVI messages in general yet (as their focus is on SPAT-MAP for the traffic light information currently).

That shows that using C-ITS for UVAR is definitely a topic that has a future impact but is challenging considering the current state-of-the-art developments.

This had also an impact on the planned approach, as described in the previous chapter. To handle the given restrictions it was decided to follow a two-folded approach for the demonstration phase:

- With one city a so called "dry run" was performed, which is actual the first stage of any kind of demonstration, as this means a concrete planning and definition of a pilot demonstration, the concrete pilot area and the detailed features that can be tested within in a full demo in a future step. It also lays down the concrete technical requirements.
- Within two pilot sides two different "full demonstrations" could be done, showing the actual implementation of the UVAR C-ITS message in two different ways.

Both types of demonstrations are described in the upcoming chapters.

2.4.3.2. Dry run (city of Helmond/NL)

A dry run is a typical tool used in pilot areas which are interested to test, but do not have the necessary technical minimum requirements. The dry run was breaking down the concrete features and technical requirements for a potential implementation. In regard to UVAR Exchange this does mean that it is not possible to send out specific UVAR messages over C-ITS, so the major focus was on the definition of the test and demonstration, the theoretical setup with the requirements of the specific city and a principal summary of outcomes. A dry run in this regard implicated demonstrating the potential impact for a pilot site, without the long-term investment in the infrastructure before, but having a glimpse on the necessary future developments.

Therefore, the test was done theoretically and helped the city to understand how C-ITS can inform drivers of UVARs. Due to the given framework conditions the UVAR Exchange project team put high efforts in making the dry run as detailed as possible. The outcomes were as well used as preparation for the other following "full demo pilots".

<u>Process and consultation activities</u>

As stated, before the city of Helmond is equipped with C-ITS infrastructure. Therefore the plan was to demonstrate UVAR C-ITS messages on C-ITS infrastructure already in place. Various meetings were taking place with representatives from the city and the technical implementation partner V-Tron. Unfortunately, the detailed analysis showed that it is not possible in the current environment of the city of Helmond to send or receive IVI Messages (which are the type of messages needed for the UVAR case). Also, the development in this regard is not on the current development plan of the city within the given timeframe of UVAR Exchange. However, the city of Helmond is very interested on the UVAR use case. Therefore, the consortium decided to do the necessary planning and technical concepts the UVAR C-ITS use case together with Helmond. This made the concrete specification and the estimation of the concrete efforts (in terms of time and money) for the city of Helmond possible.

<u>Demonstration activities – Detailed test plan</u>

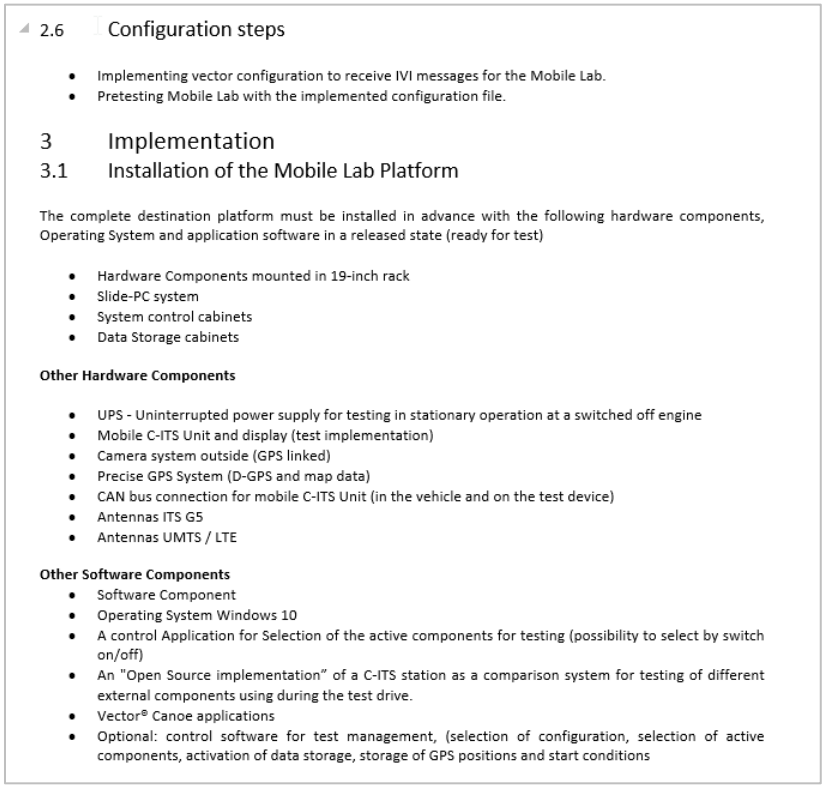
The general goal in regard to UVAR Exchange pilot demonstrations was to verify that a correct message is sent when entering or leaving the Zero Emission Zone in Helmond/NL. Low Emission Zones restrict access by the most polluting vehicles to a specific area within a city at all times.

As stated, before the use case of UVAR C-ITS messages was theoretically envisioned and planned in detail with using the existing C-ITS pilot infrastructure to provide an UVAR low emission zone warning. It was envisioned that the Mobile Lab from AustriaTech and vehicles from V-Tron would drive and collect data.

In the test plan the basic (technical) implementation requirements were defined e.g. the test verification environment, the basic software elements, the configuration of the C-ITS test system, the functional tests, the Non-functional tests and the usability testing, the test scenario and the concrete demonstration area.

The main aspects of the dry run were summarized in the "Test plan". Below some examples of the test plan are included:

Figure 6: Examples from the Test plan



2.6 Configuration steps

- Implementing vector configuration to receive IVI messages for the Mobile Lab.
- Pretesting Mobile Lab with the implemented configuration file.

3 Implementation

3.1 Installation of the Mobile Lab Platform

The complete destination platform must be installed in advance with the following hardware components, Operating System and application software in a released state (ready for test)

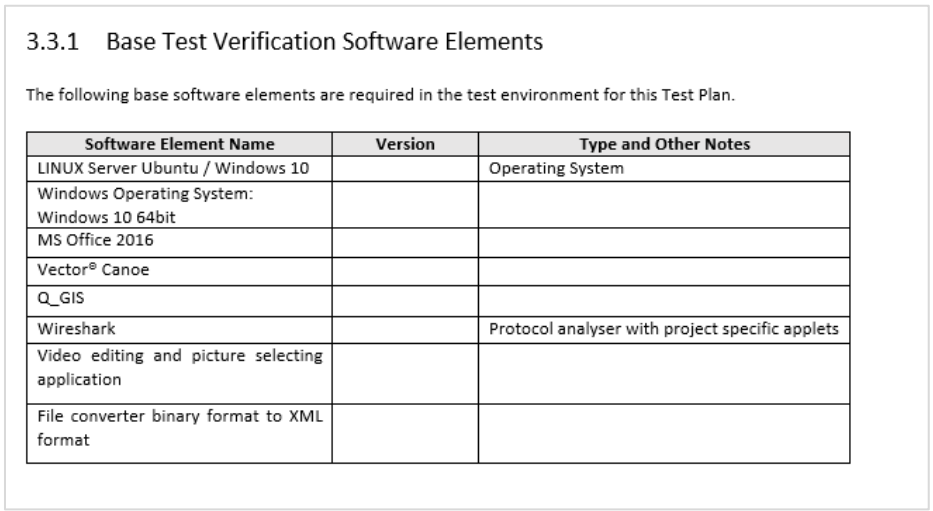
- Hardware Components mounted in 19-inch rack
- Slide-PC system
- System control cabinets
- Data Storage cabinets

Other Hardware Components

- UPS - Uninterrupted power supply for testing in stationary operation at a switched off engine
- Mobile C-ITS Unit and display (test implementation)
- Camera system outside (GPS linked)
- Precise GPS System (D-GPS and map data)
- CAN bus connection for mobile C-ITS Unit (in the vehicle and on the test device)
- Antennas ITS G5
- Antennas UMTS / LTE

Other Software Components

- Software Component
- Operating System Windows 10
- A control Application for Selection of the active components for testing (possibility to select by switch on/off)
- An "Open Source implementation" of a C-ITS station as a comparison system for testing of different external components using during the test drive.
- Vector® Canoe applications
- Optional: control software for test management, (selection of configuration, selection of active components, activation of data storage, storage of GPS positions and start conditions



3.3.1 Base Test Verification Software Elements

The following base software elements are required in the test environment for this Test Plan.

Software Element Name	Version	Type and Other Notes
LINUX Server Ubuntu / Windows 10		Operating System
Windows Operating System: Windows 10 64bit		
MS Office 2016		
Vector® Canoe		
Q_GIS		
Wireshark		Protocol analyser with project specific applets
Video editing and picture selecting application		
File converter binary format to XML format		

3.4 Configuration of C-ITS Test System

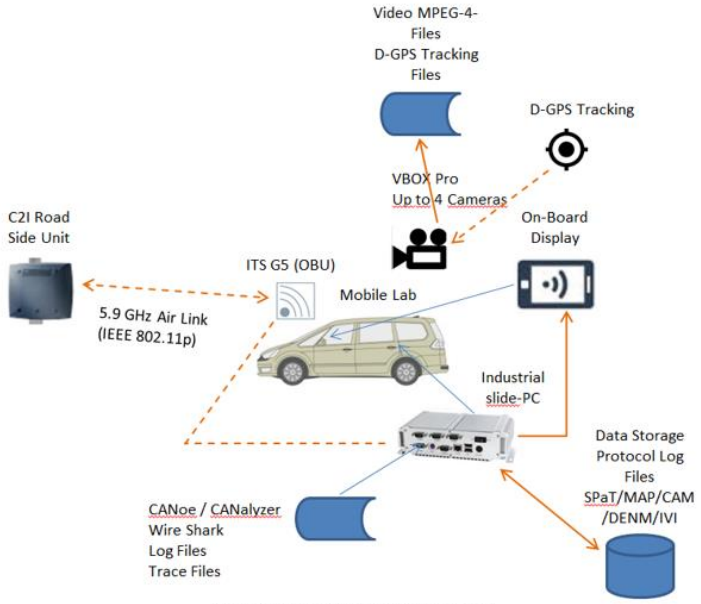


Figure 2: Configuration of C-ITS Test System

Possible test configurations depending on particular Test Scenario are listed below:

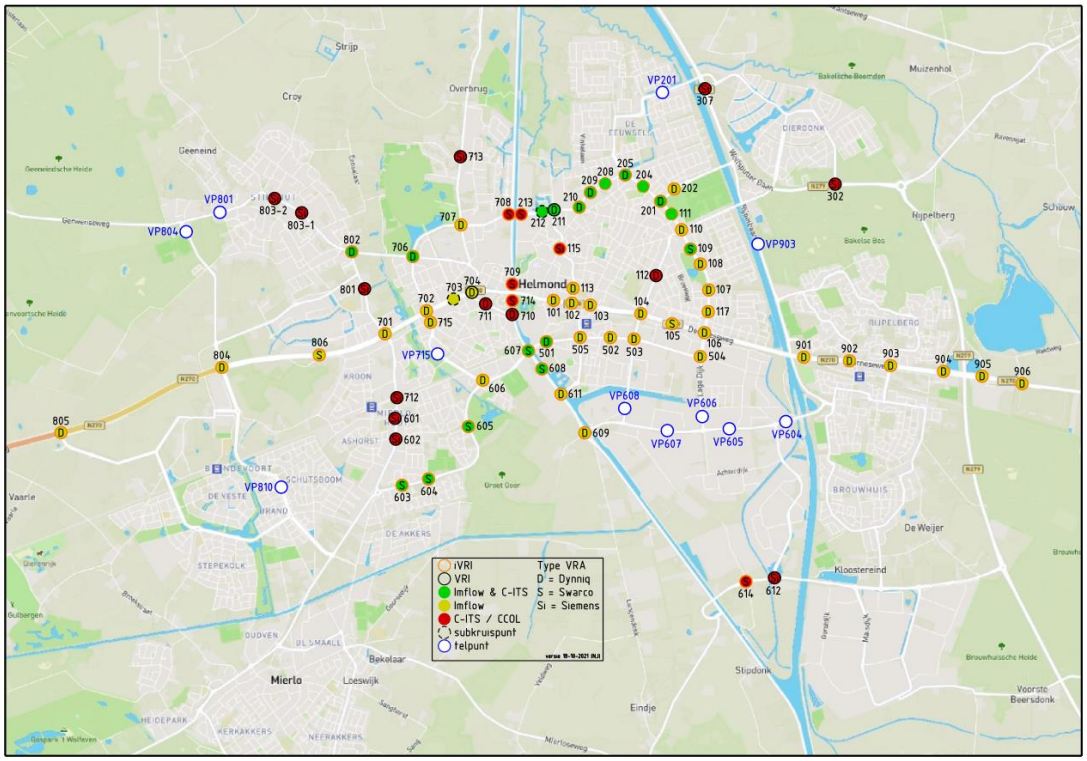
3.4.2 Configuration

C-ITS Test configuration of IVIM: "Zero Emission Zone"

Configuration Identifier: IVIM "Zero Emission Zone"
HW Component
slide-PC system
System Control cabinets
Data Storage cabinets
UPS - Uninterrupted power supply for testing in stationary operation at the switched off engine
Mobile C-ITS UNIT and display (test implementation)
Camera system outside (GPS linked)
Camera system inside (GPS linked)
Precise GPS System (D-GPS and map data)
CAN bus connection for mobile C-ITS Unit (in the vehicle and on the test device)
Antennas ITS G5
Antennas UMTS / LTE
SW Component
Operating System: Windows 10
A control Application for the Selection of active components for testing (possibility to select with the switch on/off)
An "Open Source implementation" of a C-ITS station as a comparison system for the testing of different external components in use during the test drive.
Vector® Canoe applications
Optional: control software for the managing of the tests, (selection of configuration, selection of active components, activation of data storage, storage of GPS positions and start conditions

Table 8: Configuration C-ITS Test configuration of IVIM: "Zero Emission Zone"

Figure 7: Helmond C-ITS Pilot area



Challenges, barriers and benefits/opportunities encountered

The most important next step for the city of Helmond is the development of the IVI message type for the city. As there is already C-ITS infrastructure the necessary investments have only to focus on the upgrade of the existing systems. In this case the UVAR messages can also be used as part of the C-ITS management of the city and existing processes can be used.

Findings and recommendations of this demo

C-ITS messages on the infrastructure side as well as on the vehicle side is especially for the IVI messages and in urban areas in general are not fully developed yet, like in the city of Helmond and need further development, tests and investment. So cities, like the city of Helmond need to investigate how IVI messages can be used and technically be created for its specific requirements.

In this regard dedicated awareness raising activities and maybe some “learning and training” activities specifically focused on cities will be the most appropriate next steps. Distinguishing between cities with C-ITS infrastructure and follow-up cities without any type of C-ITS infrastructure is recommended. The bilateral meetings and workshops done within UVAR Exchange were a first step. However, based on the learning and outcomes of the full demonstration more and more specific training activities should be done in the future (see also chapter “findings and recommendations”).

2.4.3.3. Full demonstration of C-ITS UVAR – Vienna/AT

Aim of this demo

The aim of the test was to verify that the correct message is sent when entering or leaving the Zero Emission Zone in Vienna. Low Emission Zones restrict access by the most polluting vehicles to a specific area within a city at all times. In Vienna, this zone exists on Franz-Josefs-Kai, where the test drive was also carried out. Furthermore, the C-Roads specified C-ITS Free Text Use Case was used to provide the information to vehicles.

Process and consultation activities

AustriaTech get in contact with the city to define the concrete options for a pilot demonstration. The city agreed to test the UVAR message on their C-Roads test pilot. Based on that agreement AustriaTech and the city of Vienna got in touch with C-ITS operator Yunex Traffic. The necessary adaptions for sending out the C-ITS UVAR messages based on the "free text use case" were done.

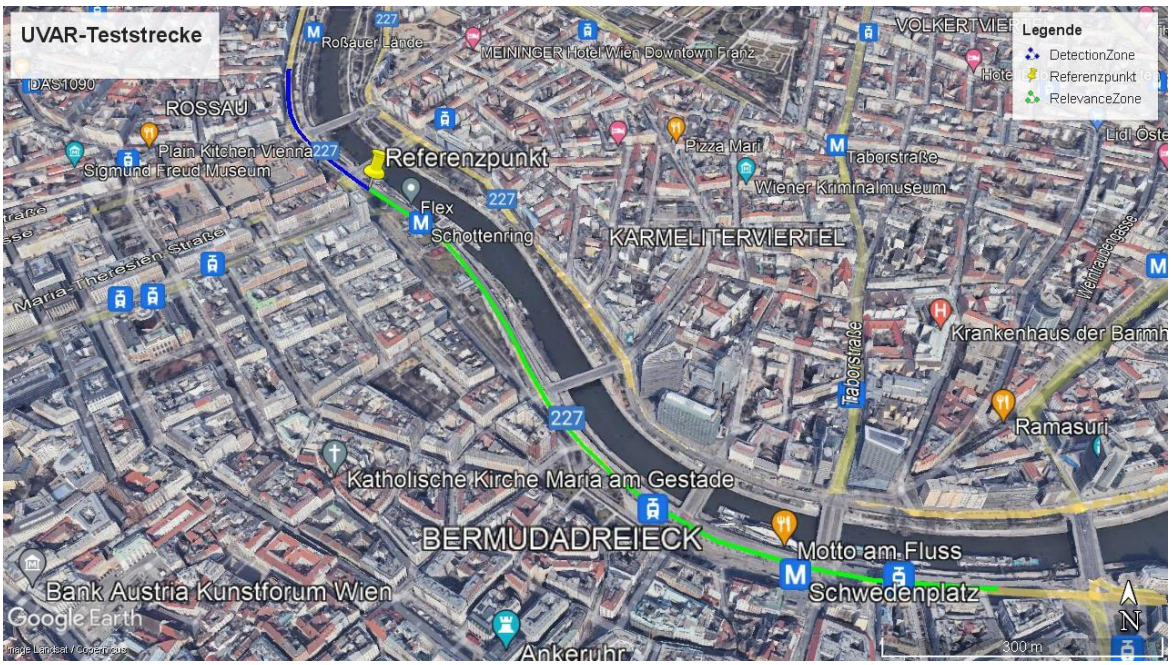
Demonstration activities

The demonstration activities took place in Vienna in September 2022.

In Vienna, the Franz-Josefs-Kai was used as planned for the demonstration. The message was sent out by an ITS-G5 roadside unit at the intersection Maria-Theresien-Straße/Franz-Josefs-Kai (**Error! Reference source not found.**, Yellow Pin).

In **Error! Reference source not found.** the message geolocation is also visible with its Relevance Zone (green) and Detection Zone (blue). The Relevance Zone is the area where the message is valid while the Detection is for vehicles to recognise the direction of the message and provide warning to the driver to adapt to the information. In an UVAR context this would mean that the driver would need to switch, if possible, into a Low Emission state of his vehicle or avoid entering the zone.

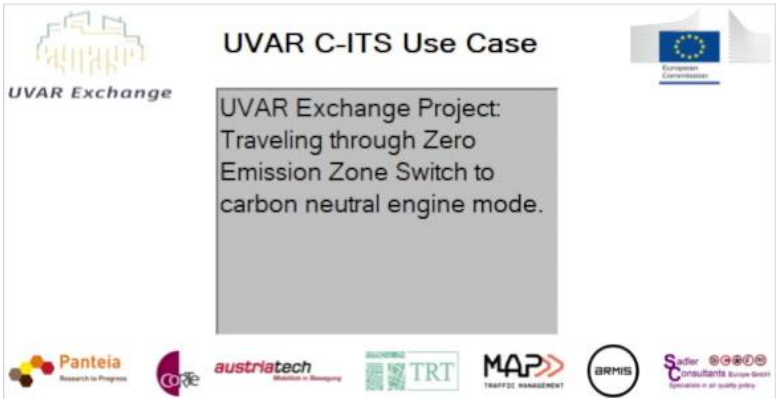
Figure 8: Test drive shown on map



The data was collected in the Mobile Lab Vehicle from AustriaTech and collected data logs and displayed the message on its user interface. Afterwards, the verification process of the gained results (trace files, recorded videos etc.) was started.

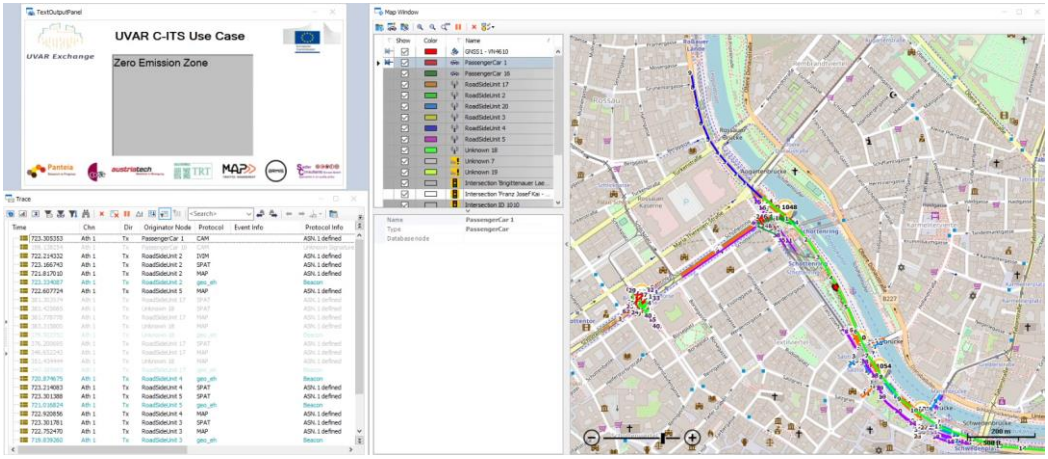
In the first drive, the message was correctly sent out and displayed in the Mobile Lab as seen in **Error! Reference source not found.**. With the message text "UVAR Exchange Project: Traveling through Zero Emission Zone Switch to carbon neutral engine mode."

Figure 9: Long version of UVAR message



In the second drive, the message was changed to contain the text "Zero Emission Zone", which was also sent out correctly and displayed as can be seen in **Error! Reference source not found.**.

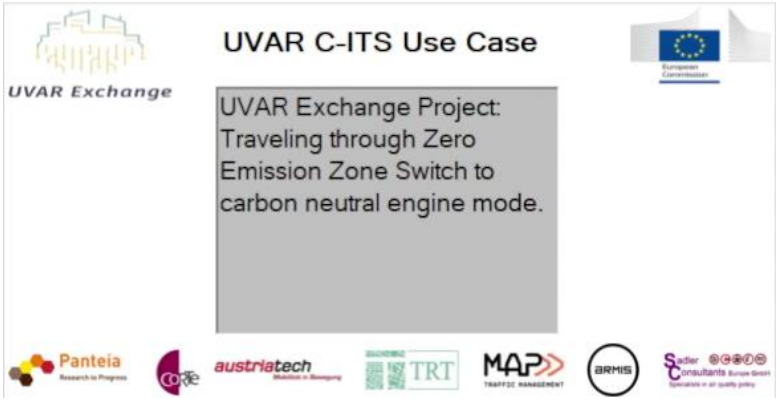
Figure 10: Interface of testing tool with short UVAR message displayed



<u>Challenges, barriers and benefits/opportunities encountered</u>

The first version of the message "UVAR Exchange Project: Traveling through Zero Emission Zone Switch to carbon neutral engine mode." was too long to be displayed in the car and would have introduced safety issues as it would have been difficult to detect and react to such a long message and not be distracted by it (see **Error! Reference source not found.**).

Figure 11: Long version of UVAR message



Therefore, the message was shortened to “Zero Emission Zone”, which makes it easier and faster to understand and the driver can respond accordingly (see **Error! Reference source not found.**).

Figure 12: Short version of UVAR message

Furthermore, it was noticed that IVI are not completely useful in the UVAR case as the message heavily relies on linear routes and cannot be used easily for whole areas like districts.

<u>Findings and recommendations of this demo</u>

The C-ITS messages was shortened and displayed the whole time, while the vehicle is within an UVAR zone and not only along the border of the zone. This removes the need for the driver to comprehend rather complex information within a few seconds, which would be the case with using variable text panels, or traffic signs. With shorter messages that are displayed the whole time while driving within the zone, it makes it easier for the driver to understand and respond to the message.

2.4.3.4 Full demonstration of C-ITS UVAR – Trento/IT

Aim of this demo

The aim of the test was to verify that a correct message can be sent out as an early warning for a Zero Emission Zone in Trento on the motorway leading into the city. Low Emission Zones restrict access by the most polluting vehicles to a specific area within a city at all times. In Trento a test was conducted together with A22 (Autostrada del Brennero). For this demonstration, the C-Roads specified C-ITS Traffic Sign Use Case was used to provide the information to vehicles. In this case a specific pictogram is displayed to inform the user on the Low Emission zone. This has the advantage that the user does not need to "read" long texts and therefore the reaction time is expected to be shorter.

Process and consultation activities

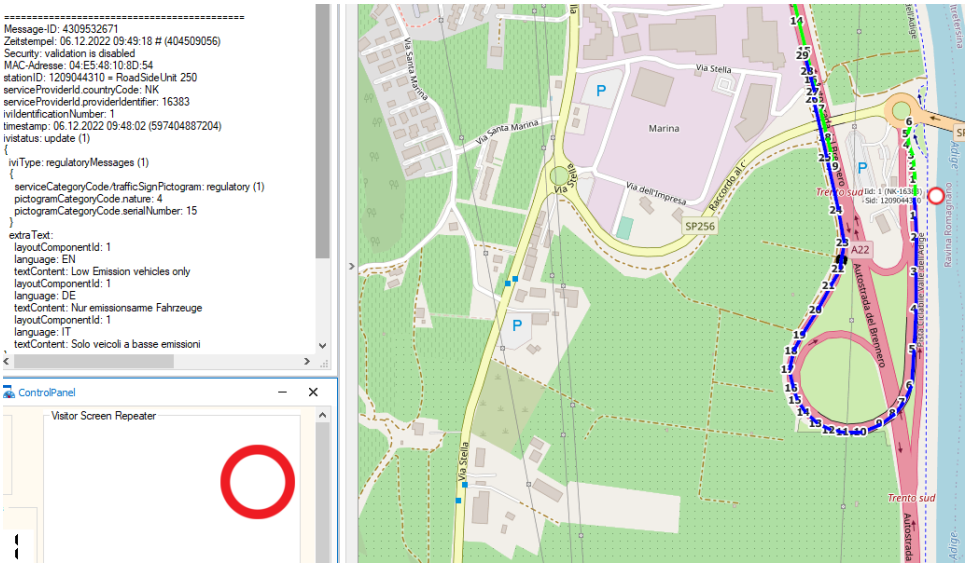
As the traffic sign use case (IVIM) is not implemented in many cities, AustriaTech decided to get in touch with the motorway provider of the A22 (Autostrada del Brennero). They agreed to update their systems and implement in a way that UVAR Exchange could also test this special use case with a motorway operator and its lanes into a city (interface between city and motorway).

Demonstration activities

The demonstration took place on 5th and 6th December 2022 in Trento.

The use of an IVI Message with the traffic sign was tested on the motorway on the way into the city (interface between city and motorway). This allowed not only to test the message type, but also to test early warning of UVARs for drivers who are already provided information of the UVAR when entering a city.

Figure 13: Overview Trento C-ITS Message



The C-ITS Message was sent out at the motorway intersection Trento Sud and informed incoming drivers of the Low Emission Zone. Figure 11 shows the map on the right, where the trace of the message can be seen in blue and green. On the left side is the content of the message with the corresponding traffic sign.

The test drive route was from Trento Nord to Trento Sud and the message was received via ITS G5.

Challenges, barriers and benefits/opportunities encountered

The advantages of the UVAR message on the highway are, on the one hand, that drivers are warned at an early stage to the city and, on the other hand, that the IVI message itself is much easier to prepare than in an urban area. The information provided with a traffic sign that is supplemented with text can be more easily understood than information provided only as text. For the driver, the traffic sign already provides some understanding of the meaning of the information and the additional text only needs to provide more information about the UVAR.

The communication between the city and the motorway operator was not part of this test but should be part of future deployment discussion. This is important to ensure that correct information is sent out to drivers, especially in complex UVAR scenarios.

The effort to send messages proved to be quite straightforward, as several highway operators such as the A22 already have experience with C-ITS and send IVI messages, e.g., about speed limits, on their network.

Findings and recommendations of this demo

The use of the "traffic sign use case" (which means to adapt the IVI message that is actually designed to provide information about a certain traffic sign) can easily be adapted to the UVAR use case, showing the specified traffic sign relevant. However, there is the need of the availability of specific sign/pictogram for UVAR in standardised format.

The provision of UVAR information already at the interface between city and motorway has several advantages. Motorway operators are already experiences with the implementation of C-ITS messages and a majority has all relevant message types implemented. So, the UVAR use case as tested and suggested can quite easily be implemented. The early information of the driver on the upcoming UVAR has also some positive effect on the traffic regulation in cities and urban areas.

Having in mind the necessary developments for urban C-ITS in the upcoming years the linkage of UVAR messages to the interfaces from highways to the urban areas seems to be a manageable first step implementation for the UVAR C-ITS.

1.4.4. Findings, recommendations and next steps

Major learnings from the C-ITS demonstrations within the UVAR Exchange project is that C-ITS in the urban area is still a major innovation task.

The topic of C-ITS has been driven mainly by motorway operators so far. For a few years cities start to raise interest in the usage of C-ITS for urban traffic management. However, the deployment of C-ITS related infrastructure in urban areas, is currently a work in progress. UVAR Exchange project also showed even more that many cities are not aware of the topic of C-ITS at all, and specifically not related to UVAR.

Looking towards the future of C-ITS for UVAR a bundle of measures needs to be implemented, considering the triangle of **cities**, **vehicles**, (legal) **framework** and **standardisation**.

On the level of the cities there is the need to raise awareness for C-ITS as a tool for innovative, demand-based traffic management in the urban areas that enables the implementation of policy measures including e.g., the reduction of the environmental impact. The major learnings show that specific

awareness raising measure on the possibilities of C-ITS (connected with urban use cases like UVAR) are necessary to make the first steps towards the C-ITS implementation in cities. C-ITS enables more demand-based and dynamic urban traffic management, e.g., adaptions based on environmental criteria, including a proper and timely information to the travellers. C-ITS shows significant support to achieve lower emission drive systems by increased traffic efficiency. Evaluations already show the positive impact regarding emission savings through improved traffic flow, leading also to reduce air pollution. Having in mind the current challenges cities are facing in this regard the use of C-ITS should be one part of the bundle.

For those cities that are already active in the C-ITS domain the topic of UVAR and C-ITS (and the potential implementation) is still new. The results of the UVAR Exchange project can be used as a starting point for more dissemination and awareness raising for the UVAR use case in those cities that are already active in this area. The demonstration of the two different C-ITS use cases (free text vs. traffic sign) also allows the consortium to come up with first insights on the potential implementation and the estimated effort for the implementation (depending on the actual status of C-ITS deployment).

On the side of the automotive industry there is the need for a stronger commitment towards the use of C-ITS as part of their user service, as this is part of the full picture for making urban C-ITS services, as for (dynamic) UVARs reality. As the automotive actors are the ones who will contribute to the wide uptake of C-ITS services by the adoption of the necessary equipment in the cars and hence contributing to the uptake of the respective services, it is important to tackle them as well in the future activities.

In addition, the third important column on (legal) framework and standardisation aspects is of equal importance.

As we have seen from in the previous chapters the C-ITS message types currently available are in principle appropriate for the UVAR message but need high effort for the implementation of urban areas, as it is not appropriate for the implementation within “zones” or “districts”. So, this is not the final solution for long-term deployment on the urban level. Therefore, it is recommended that the relevance of urban C-ITS is emphasized within the major C-ITS platforms like the C-Roads platform WG 4 on urban C-ITS harmonisation to develop and standardize C-ITS message types appropriate for the cities’ needs (e.g., for UVAR specific cases). The results of UVAR Exchange can be used as a first input to the discussion. But there is a need for further developments in these areas to make a wide-spread deployment of urban C-ITS services and C-ITS for UVAR possible.

Regarding the UVAR specific use case the need for a harmonised “UVAR sign”/pictogram should be emphasized again. Here international standardisation and harmonisation activities are important (see also the results of Task 1.1.).

For ensuring a mid- to long-term shift towards dynamic, flexible, more efficient urban traffic management (e.g. making use of dynamic UVARs) the legal framework must be adapted accordingly. In the future the legal bindingness of C-ITS messages e.g., for UVAR is a crucial aspect to make the steps towards the innovative urban traffic management of the future.

Finally, it is recommended to start with the topic of UVAR immediately so local authorities will also learn by the already existing pilots. Therefore, it is recommended to start with those areas which need less adaption to make C-ITS for UVAR already reality: It is recommended to start implementing UVAR via C-ITS on the interfaces between the motorway and the urban areas. As the C-ITS deployment on the motorways is already quite advanced this can be easily implemented. The early information of the driver can also be expected to have a positive impact on the traffic management. In this regard it is recommended to identify those areas with high potential for this implementation and start with trials

and first long-term demonstrations. This could also foster the deployment of UVAR via C-ITS in the future, direct in the city area.

Looking at the next steps for the dry-run and the pilots it has to be stated that for the C-ITS UVAR demonstrations the focus was on the technical feasibility and the learnings, which are now directly transformed into findings and recommendations for the next steps. For the dry run in Helmond the further local C-ITS implementation and especially an appropriate message type will be a key for the further next steps. The pilot demonstrations in Vienna and Trento mainly focused on the different technical use cases, therefore the demonstration in Trento is still usable, but not in operation. In Vienna the developed message type is still in use, but also exploited for raising awareness for other types of C-ITS use cases. But as mentioned, in this regard, the proof-of-concept and the learnings as input for the next steps were in the focus.

So having the long-term vision in mind this topic has to be tackled step by step. Looking at the next steps the following could be recommended, specifically looking at the cities:

- For those cities already active in C-ITS it is important to raise the awareness for the topic of UVAR in relation to C-ITS. Therefore, it is recommended to organise a workshop or dedicated sessions for those cities. Already existing cooperation platforms and networks (e.g. in cooperation with the C-Roads Plattform working group on urban C-ITS) could be a good starting point to start of the discussion, also in regard to the legal framework. As C-Roads is as well in close collaboration with the car-industry (via the Car-2-Car Communication Platform), an awareness raising would be as well achieved with the vehicle manufactures. In these dedicated sessions the focus will be on the concrete learnings concerning impact, large-scale feasibility and implementation, including standardisation, C-ITS service specifications and development needs.
- To raise the awareness for cities not familiar with the topic of C-ITS it makes sense to spread the know-how using as well the existing specific networks. This could be done either with dedicated sessions and presentations within the frame of city networks like POLIS, but also national events tackling stakeholders from the local and regional governments (like national cities associations, etc.) in each country are an appropriate entry point for the topic. The focus here will be more on raising awareness for UVAR measures in general, but also for the potential of C-ITS. As e.g. POLIS has a collaboration agreement with the C-Roads Platform, as well here a further push can be given via the Urban C-ITS working group of C-Roads.
- Looking at the recommendations coming from the demonstration in Italy it should be emphasized again that at the interfaces between highways and urban areas already “entry points” exist, that are appropriate for small pilots (making use of the know-how on C-ITS existing at the motorway operators). This handover of C-ITS related messages between different operators (e.g city operators and motorway operators) has already been managed and demonstrated by C-Roads. So having in mind the necessary developments for urban C-ITS in the upcoming years the linkage of UVAR messages to the interfaces from highways to the urban areas seems to be a manageable first step implementation for the UVAR C-ITS. Again, the key element is to have UVARs reflected in the standardisation as well as the C-ITS service specifications.

Tackling the aspects relate to the legal (framework) and standardisation the following next steps can be recommended:

- The C-Roads Platform WG 4 on urban C-ITS harmonisation should include the topic into their agenda to specify the concrete needs for the use case of UVARs. In addition, C-Roads WG 2 on technical aspects need to focus on UVAR-C-ITS-standard needs and to harmonise specifications for C-ITS messages including the harmonisation with the Car-2-Car Communication Consortium. However, it is clear that the developed message type should serve more than one use case and should be appropriate for the various UVAR types. The results of UVAR Exchange can be used as a first input to the discussion and further harmonisation.
- Regarding the UVAR specific use case the need for a harmonised "UVAR sign"/pictogram should be emphasized again. Here international standardisation and harmonisation activities are important (see also the results of Task 1.1.). This is not a core coming from the C-ITS demonstration, but will be an important aspect in the further development, especially when it comes to the driver information services.

It is important to state again that the further developments in the C-ITS sector are the main driver here. UVARs are one of the future urban C-ITS use cases. The next steps at this stage and from the aspect of UVAR Exchange is to raise the awareness on the potential and the concrete development needs among cities, OEMs and the C-ITS implementation community to take the next steps.

Summarizing it can be stated that C-ITS will be an important future component for UVAR in specific and efficient urban traffic management in general. There is a strong need to set specific measures that will create the relevant framework conditions and raise the awareness and commitment for the topic. Meanwhile it is important to start with the first demonstrations with pilot sites that have the appropriate framework conditions to "keep rolling". UVAR Exchange already delivered a valuable basis for these first pilots.

2. DEMONSTRATION ACTIVITIES ON CROSS BORDER DATA EXCHANGE

2.1. Aim of the demo

The cross-border data exchange demonstrators aimed to test and showcase the organisational and technical aspects of the UVAR enforcement processes and support the identification of current barriers and potential solutions while implementing and operating a cross-border data exchange solution. The approach targets at:

- "Learning by doing", means continuing to capture insights and lessons while testing the solutions in different local contexts and identifying practical shortcomings and challenges.
- "Showcase and record" the use and the benefits of the solutions and how they support and add value to cross-border data exchange.
- Enrich the recommendations with practical aspects to overcome encountered challenges during hands-on experiences

The demonstrations were intended to be performed in several different European cities to capture the different national and local characteristics of the enforcement process.

The demonstrations were done within the legal framework in place for the specific city and country. When this was not possible a test environment with simulated test data was used to demonstrate the technical possibility of data exchange between EU Member States.

The results provided the basis for developing recommendations for the wide implementation of cross-border solutions. At the same time, the demonstrations also aimed to raise awareness among Member States, and national and local stakeholders and contribute to the promotion of potential cross-border solutions.

2.2. Process and consultation activities

To identify and engage with potential demonstration locations, a range of stakeholders was consulted through bilateral meetings and project workshops, such as:

- City/Enforcement authorities
- Ministry level authorities
- Data Exchange solution providers – EUCARIS, IN Groupe[2], Vehicle Manufacturers, DG GROW (IMI team), and Tachograph Manufacturers.
- Vehicle Registration Authorities through EREG
- European Associations – EREG, IRU, ACEA, POLIS
- European Commission – DG MOVE

The initial consultation allowed us to identify a preliminary list of cities that was willing to collaborate in the demonstration activities. These include:

- Aachen (Germany)
- Antwerp (Belgium)
- Barcelona (Spain)
- Brussels (Belgium)
- Rotterdam (The Netherlands)
- Verona (Italy)

For each of these cities and countries the demonstration activities followed the following stepwise approach:

1. Preliminary meetings

As preparation for the demonstrations, preliminary meetings were held with representatives of different cities in Europe. During these preliminary meetings, the goals for the UVAR Exchange project and the demonstrations were explained, initial ideas were discussed, and all the relevant stakeholders that are needed to perform a demonstration were identified. During these meetings, the current situation of enforcement done by the city was mapped and possible missing technical, legal and organisational steps for cross-border enforcement were identified. The possibility of demonstrating cross-border data exchange was discussed to showcase the benefits of solutions and show how they add value to cross-border data exchange. By demonstrating a solution in different local contexts, practical shortcomings or challenges can be identified.

2. Dry run phase

[2] Specialist in identity and secure digital services, partner of the French government, ingroupe.com

For the Dry run phase of the demonstrations, a test plan description (STP) was developed in which, for each city, the necessary steps to be taken for a successful demonstration have been described. As the next step, a walk-through dry run was prepared for each city, for which use case and test scenarios (STD) were developed.

During the dry run meetings, the local enforcement steps were discussed with the city and the solution providers. Where applicable also national agencies were involved in the process. A review of the main preconditions and requirements of using one of the identified solutions was performed. Based on this review actions needed to implement the solution in the future were formulated, including the ones necessary for a real-life demonstration.

3. Real-life demonstrations

Based on the findings during the dry runs, real-life demonstrations were planned and developed, including a walk-through of all the test steps and scenarios. These demonstrations were recorded in video and test results were reported.

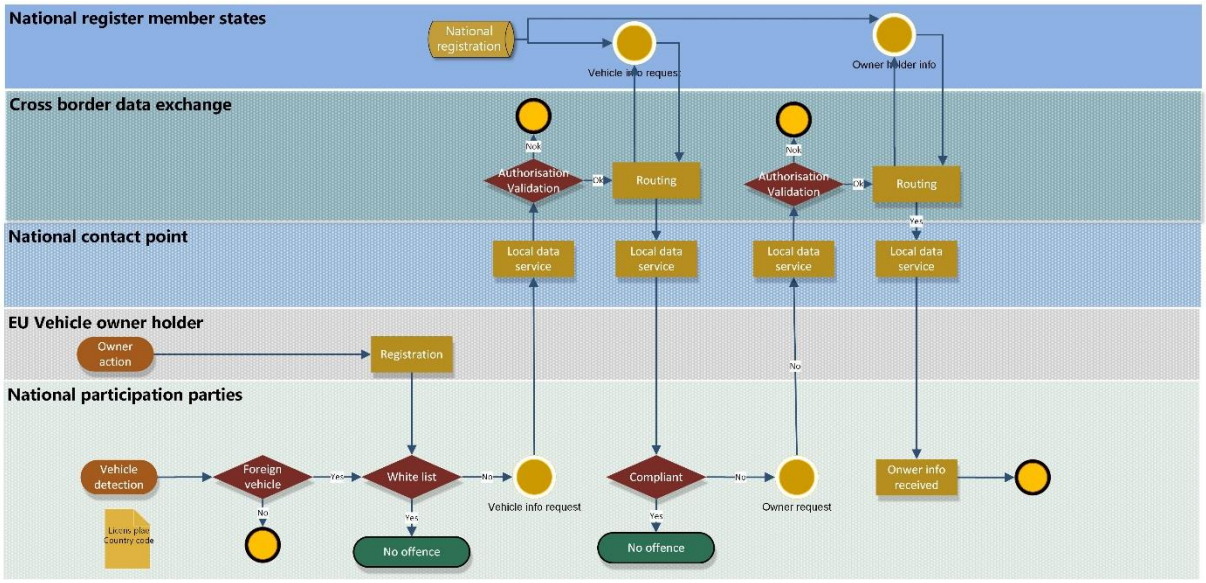
2.3. Interviews with solution providers

With the solution providers, EUCARIS and IN Groupe intensive talks were held to deep dive into the possible solutions to support the enforcement of UVARs.

EUCARIS

From the start of the project, talks were held with EUCARIS to understand the solution EUCARIS can provide for cross-border data exchange and in what way EUCARIS can support the demonstrations organised with cities and necessary stakeholders like vehicle registration agencies and the different ministries involved in cross-border data exchange and enforcement. The EUCARIS approach is that every country organises its application where public authorities within the country can connect and access is granted thru the national contact point of EUCARIS. **Error! Reference source not found.** shows the general workflow for enquiries regarding UVARs/LEZ.

Figure 14: LEZ enforcement process EUCARIS implementation



For the exchange of (non-sensitive) vehicle technical data and vehicle, owner-holder data EUCARIS prepared the following messages sets :

- EUCARIS XML Message Specification Non-Sensitive Vehicle Data [V2.06, 04-10-2022]
- EUCARIS-XML-Message-Specification-Vehicle-Owner-Holder-sVHOH [V9.01, 22-06-2021]

IN Groupe

IN Groupe is a key player in identity and trust solutions. Its shares are owned by the French State and they are empowered by the State to take care of several technical implementations linked to EU and national obligations (for example the issuing of personalised tachograph cards in commercial road transport). IN Groupe was also responsible for the implementation of COVID pass solution in France. The solution allows the issuance of certificates that can be controlled by the police forces inside the country or at border control points. It is also made available to the port/airport infrastructure operators or airlines for integration into their equipment to facilitate control of passenger flow. During meetings, IN Groupe explained the concept of UVAR verifiable credentials using a European Trusted Repository ledger hosting UVAR-VC issuing authorities' public keys and Applicable dynamic rules. Based on this concept IN Groupe created a user story using the 'UVARwallet' integrated solution. This is demonstrated by a disabled French driver wanting to access Brussels LEZ.

2.4. Challenges, barriers and benefits/opportunities encountered

The main general challenge encountered in the process was to identify cities willing and available to engage in the demonstration process. This also entailed major time costly activities not only in the identification of the right organisations in the cities and member states but also in the identification and engagement of the responsible or necessary person(s) to participate in the project demonstrations.

The main general barriers encountered and stated by cities and organisations were:

- Lack of legal framework for participating in cross-border data exchange
- Lack of available processes and systems to allow this cross-border exchange
- Lack of capacity (time resources) to support the necessary research and developments

The main opportunities encountered were the existence of solutions (almost) ready to apply to the UVAR cross-border use case, like EUCARIS and IN Groupe.

2.5. Aachen (Germany)

2.5.1. Aim of this demo

The proposed demo aimed to test and showcase organisational and technical aspects of the UVAR enforcement processes and support the identification of current barriers and potential solutions while implementing and operating EUCARIS as a cross-border data exchange solution.

2.5.2. Process and consultation activities

Preliminary meetings with:

- Representative of the city of Aachen - Division leader of the department 'Fachbereich Sicherheit und Ordnung' of Aachen
- Representative of KBA the German Federal Motor Transport Authority

2.5.3. Demonstration activities

Preliminary meetings led to the development of a high-level scheme for the UVAR enforcement process in the city of Aachen.

2.5.4. Challenges, barriers and benefits/opportunities encountered

Demonstrations in the City of Aachen were not feasible as KBA required an EU legal basis to cooperate further for “Dry run demonstration” and “Real life demonstration” steps.

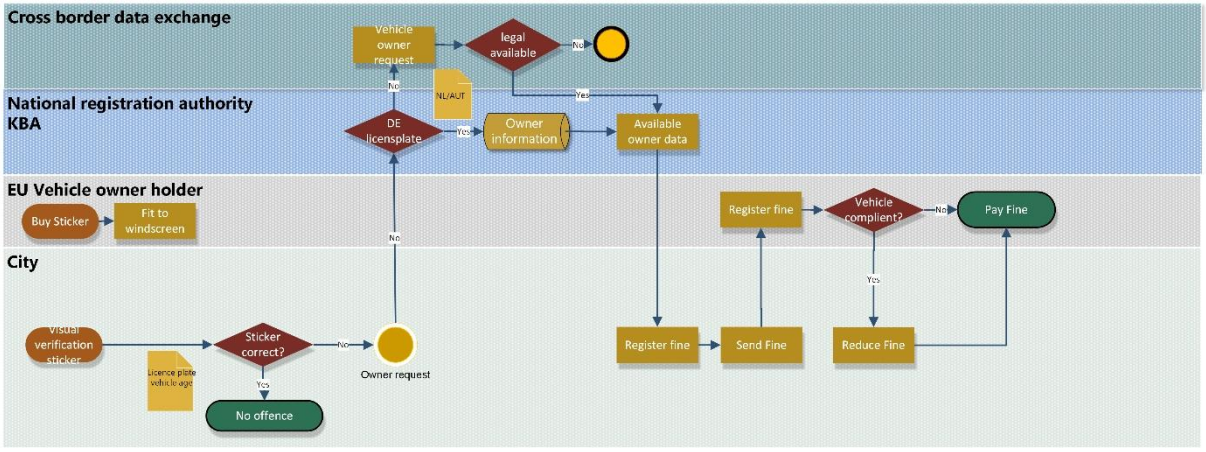
2.5.5. Findings,recommendations and next steps

Current foreign vehicle enforcement practice:

- Main contact: division leader of the department ‘Fachbereich Sicherheit und Ordnung’of Aachen
- LEZ is based on the national framework. **A vehicle needs to meet German sticker standards.** The enforcement is done based on street manual/visual *vehicle detection and compliance assessment* by 100 city officers. If a LEZ sticker is on an “older” vehicle the officer will use **expert judgment** to assess a *possible* violation.
- When a foreign vehicle owner-holder wants to register for a sticker he/she must register at the local Strassenverkehrsambt which will forward the registration information to the KBA which is the central register for Germany.
- When a vehicle has no sticker, the license plate is registered and processed by the city system for sending a fine. After receiving the fine the vehicle owner holder can present proof that the vehicle is compliant and the fine will be reduced to 35 euros for administrative costs.
- **For registering and processing offences** the **city uses “Winowig” (https://www.owig.de/referenzen) a software solution used in hundreds of cities in Germany**. The solution organises all the steps for retrieving vehicle owner-holder data and preparing and sending fines. The system also couples with the KBA in Flensburg. **During the night a bulk license plates request is done and all possible owner-holder data is retrieved**. This is also done for foreign vehicles although it only retrieves the countries where it's legally possible.
- There is a bilateral agreement for the exchange of owner data with the Netherlands and Austria.
- Approximately 1.8 million Euros on UVAR fines are issued per year by the city. Half of the violations are related to vehicles registered in Belgium.

Error! Reference source not found. below shows the enforcement process of the city of Aachen.

Figure 15: LEZ enforcement process city of Aachen



Electric Vehicles

In Germany, based on the Electic Mobility Act (EmoG – Elektromobilitätsgesetz) cities can create incentives for electric vehicle drivers like free parking or special lanes. To allow identification of electric vehicles the letter E is added to the license plates, see **Error! Reference source not found.** below. Of the European countries, 13 have special signage for electric vehicles plus UK, Ukraine and Switzerland. The member states have either (11) number plates or (2) stickers to identify these vehicles. Countries distinguish one or the other way the license plates of Electric/Hydrogen/PHEV using special series,

additions (like Germany), a different background (e.g. Poland), different colours of letters (Austria), different colours combined with two reserved starting letters (Latvia) or a green strip (flash) on the left-hand side of the number plate for zero-emission vehicles (United Kingdom).

Figure 16: Number plate electric vehicles Germany (source adac.de) and UK (source www.gov.uk)

2.6. Antwerp

2.6.1. Aim of this demo

The proposed demo aimed to test and showcase organisational and technical aspects of the UVAR enforcement processes and support the identification of current barriers and potential solutions while implementing and operating EUCARIS as a cross-border data exchange solution.

2.6.2. Process and consultation activities

Preliminary meetings and dry run meetings:

- Representatives of the city of Antwerp:
  - Environmental department
  - Fiscal department
  - IT department
- Representatives of the Flemish Environmental Agency
- Representatives of the Flemish Digital Agency
- Representatives of the Flemish Department of Mobility and Public Works
- Representatives of the Federal Public Service Mobility and Transport

2.6.3. Demonstration activities

Preliminary meetings led to the development of the high-level scheme of the UVAR enforcement process in the city of Antwerp.

"Dry run demonstration" sessions aiming to apply EUCARIS solution to the following LEZ enforcement use cases: French and Dutch owner-holder and vehicle technical data exchanged via the "DIV-EUCARIS service", under the bilateral agreement between Belgium with France and the Netherlands.

"Real life demonstration"

- *Participants:* City of Antwerp, DIV, FOD, Digitaal Vlaanderen, EUCARIS
- *User stories:* Foreign vehicle non-registered entering Antwerp
- *EUCARIS solution:* Full functional implementation of the connection to the Belgium EUCARIS NCP[3], DIV

[3] National Contact Point of EUCARIS

- *Systems in place:*
  - City Antwerp ANPR monitoring and enforcement systems
  - 'MAGDA' connection between Antwerp and DIV
  - EUCARIS digital service
- *Steps were taken to perform the real-life demo*
  - Workshops (online) sessions supported the development of "Use cases" and "Enforcement process flowchart" detailed descriptions based on "Dry run demonstration" results
  - Digitaal Vlaanderen facilitated the EUCARIS integration thru MAGDA service in the City of Antwerp
- *Showcase and record*
  - Video recording for showcasing was not feasible during the project period

2.6.4. Challenges, barriers and benefits/opportunities encountered

Main challenges/ barriers encountered:

- Identifying and engaging with the right persons and departments mandate and necessary to support the proposed demo
- Lack of capacity (time resources) by some stakeholders to support the necessary research and developments

Main opportunities/benefits:

- Raised awareness and motivation between the different organisations for implementing the proposed solution
- A fully ready technical implementation of the services for Cities to enable cross-border data exchange for UVARs (vehicle technical data and owner-holder data)

2.6.5. Findings,recommendations and next steps

LEZ UVAR is based on a Flanders region and city regulation. A vehicle needs to meet the Antwerp standards and a mandatory (free of charge) registration for non-Belgium vehicles. Only Dutch vehicles do not have to register because of the open technical data feed of the RDW. A "day pass" can be bought 8 times a year or one can pay for temporary access for a longer period to the LEZ if your vehicle does not meet the emission requirement of the LEZ. Registration can be done until the day after entering the LEZ. The UVAR is monitored with ANPR cameras and on-street by officers.

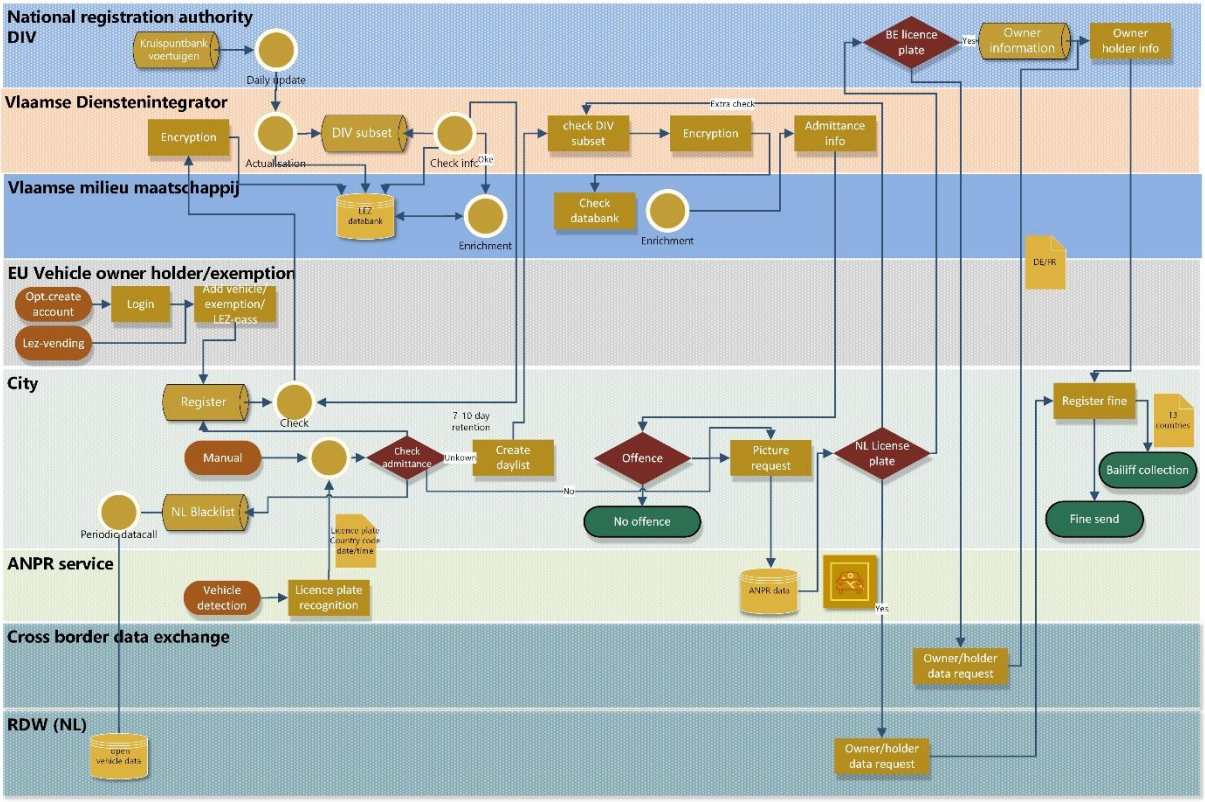
The vehicle compliance check for both Belgium and Dutch vehicles is done through cooperation between the city, the region and federal organizations. The city sends daily bulk requests for license plates from its system to the Vlaamse Milieumaatschappij (VMM). The automatic check is done by Vlaamse Dienstintegrator and uses the Federal Belgium Vehicle registration database managed by the DIV. The vehicle technical details of Dutch vehicles are collected via the RDW vehicle open data API.

For vehicle owner-holder information there are bilateral agreements with Germany and Luxembourg. Also, with France and The Netherlands on a federal level (DIV).

The fine issuing is done (and collected) by the city fiscal services after receiving the vehicle owner-holder data from the regional VMM. For 13 countries, the fine collection goes via a bailiff with a mandate of the city of Antwerp.

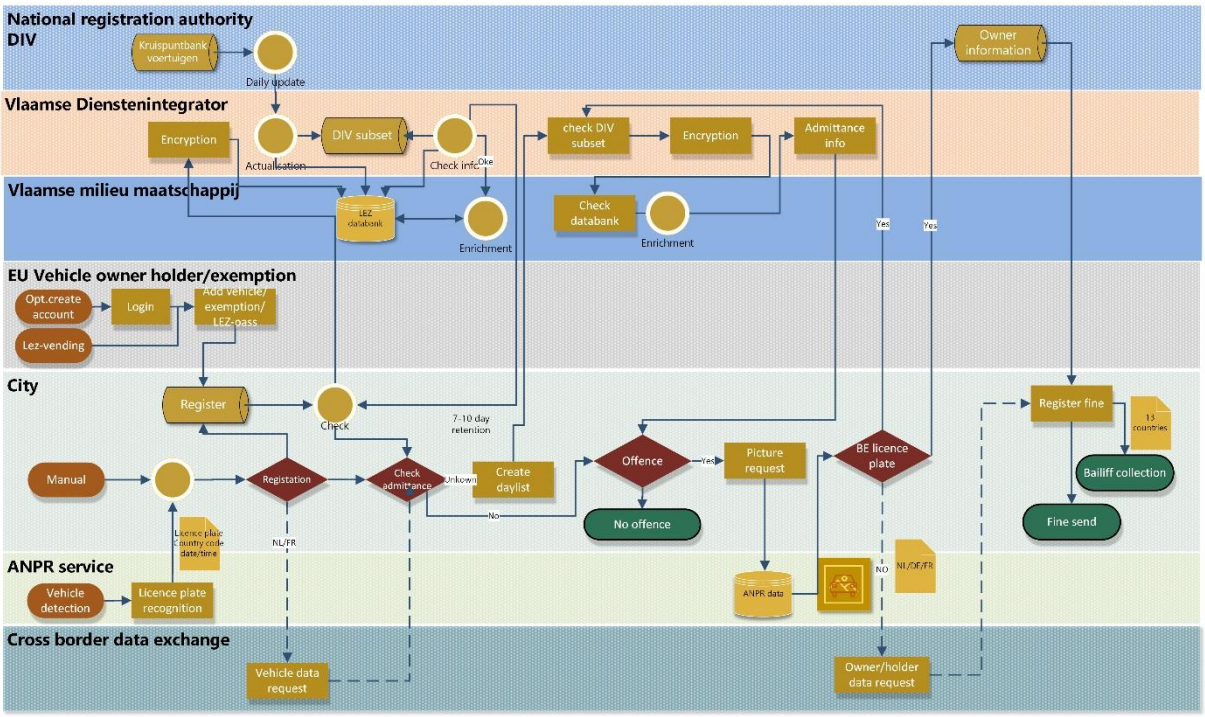
Error! Reference source not found. below shows the enforcement process of the city of Antwerp as it was in place before implementation of the EUCARIS connection.

Figure 17: LEZ enforcement process city of Antwerp



The bilateral political declaration of the Benelux countries enables data exchange of technical vehicle data between the countries. . For the 'Lage-emissiezone' the euro class of Dutch and possibly French vehicles now can be checked thru the EUCARIS connection towards the RDW and SIV. **Error! Reference source not found.** shows the setup of the new enforcement process of the city of Antwerp.

Figure 18: New LEZ enforcement process city of Antwerp



The connection from the city of Antwerp (and other cities in Flanders to EUCARIS has been set up through the MAGDA network, a closed coupled network of the governments in Flanders. A new Rest service 'Crossborder Registrations' is available via MAGDA (Via BOSA, via FOD Mobiliteit via EUCARIS) by which vehicle technical data and owner-holder data can be retrieved for foreign vehicles (where the legal framework is in place). When fully operational the pre registration of Dutch and French vehicles is no longer necessary. To do so talks were organised with all parties involved (VMM, Antwerpen, Gent, and Digitaal Vlaanderen).

Next to this on the federal level talks are conducted to lower the tariffs for inhabitants of the LEZs that are entitled to receive financial compensation (Verhoogde Tegemoetkoming, VT. Next to that, people that have a parking permit (e.g. disabled) have a right to free registration of their vehicle. At the moment these processes are complex and not all citizens are aware of this. Flanders wants to simplify these processes for the citizens by using business rules when inhabitants register for financial compensation or a disabled permit.

Also, Flandres started working on remote sensing and road checks to detect LEZ violations. A study will be started with the goal of enrolling the telemetric system in 2023 and fully functional in 2024.

2.7. Barcelona

2.7.1. Aim of this demo

The proposed demo aimed to test and showcase organisational and technical aspects of the UVAR enforcement processes and support the identification of current barriers and potential solutions while implementing and operating EUCARIS as a cross-border data exchange solution.

2.7.2. Process and consultation activities

Preliminary meetings and dry run meetings:

- Representatives of the Metropolitan area of Barcelona:
  - Mobility department
  - IT department
- Representatives of the Spanish Ministry of Interior, DGT
  - EU liaison
  - IT department
  - Fiscal department

2.7.3. Demonstration activities

Preliminary meetings led to the development of a high-level scheme of the UVAR enforcement process in the city of Barcelona

"Dry run demonstration" sessions aiming to apply EUCARIS solution to the following LEZ enforcement use cases: French and or Dutch holder owner and vehicle technical (simulated) data exchanged via the "EUCARIS test environment", due to lack of legal basis for use of real EUCARIS available data.

"Real life demonstrations"

- *Participants: Area Metropolitana de Barcelona (AMB), DGT IT department, DGT EUCARIS NCP*
- *User stories: Foreign vehicle (Dutch and French) non-registered entering Barcelona*
- *EUCARIS solution*
  - Existing and accessible to AMB via ASTEC: Spanish Webservice supporting data exchange between DGT and local organisations (like local police or city departments)
- *Systems in place:*
  - AMB ANPR monitoring and enforcement systems (simulated data)
  - ASTEC connection between AMB and DGT
  - EUCARIS Spanish NCP
- *Steps were taken to perform the real-life demo*
  - "Use cases" and "Enforcement process flowchart" detailed descriptions based on "Dry run demonstration" results
  - System integration workshop between DGT and AMB to discuss and agree on the integration of EUCARIS in AMB monitoring systems
  - Collection of simulated data from foreign vehicles non-registered in Spain> not in Barcelona white list
  - Simulated steps by AMB LEZ enforcement services (manual) to input simulated data in ASTEC /EUCARIS Webservice
- *Showcase and record*
  - Video recording for showcasing was not feasible during the project period due to delays in the integration of EUCARIS in AMB monitoring systems

2.7.4. Challenges, barriers and benefits/opportunities encountered

Main challenges/ barriers encountered:

- Identifying and engaging with the right persons and departments mandate and necessary to support the proposed demo
- Lack of legal framework for cross-border data exchange (this also demotivates the urgency for the demo)

- Lack of available processes and systems in the city to allow the use of EUCARIS for cross-border exchange
- Lack of capacity (time resources) by some stakeholders to support the necessary research and developments

Main opportunities/benefits:

- Raised awareness and motivation between the different organisations for implementing the proposed solution
- Setting up the technical connection to the EUCARIS NCP was suggested but implemented within the time frame of this project

2.7.5. Findings,recommendations and next steps

To enter LEZ in Barcelona a vehicle needs to meet Spanish national standards and to have a sticker (Distintivo Ambiental) provided by the Ministry of Interior organization Dirección General de Tráfico (DGT). Based on the vehicle data, DGT categorises all vehicles into the sticker classification. This dataset of licence plates and sticker categories is weekly retrieved by Barcelona from DGT national database and the LEZ local database of vehicles is actualised with this information. Vehicle owners can print the stickers if they want but they are not obliged to.

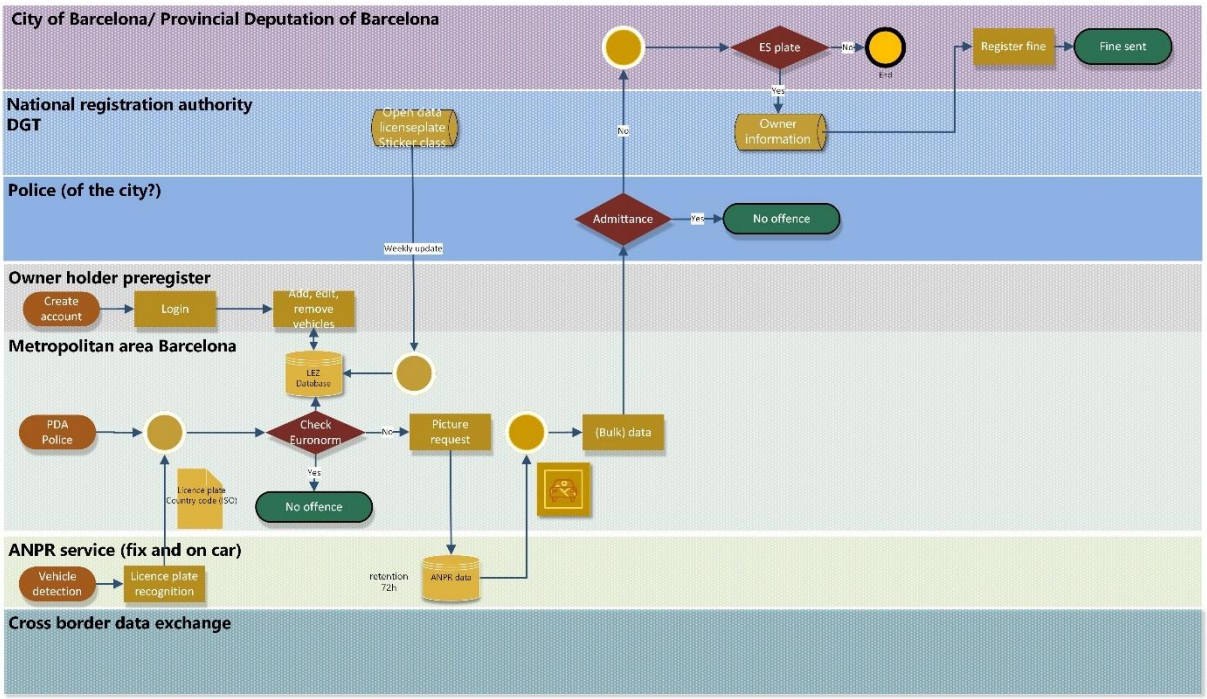
Foreign vehicle owners need to pre-register through the city website where the vehicle owner/holder makes an individual profile and provides vehicle characteristics and a copy of the vehicle technical information This is currently verified manually by a city service. Vehicle registration costs 7 euros and is applicable indefinitely. Owner-holder contact information is also needed to be able to inform in case of tightening the LEZ regulation. The owner holder can always log in to their profile to add or change the vehicle or personal information. Registered data can be shared (user consent) with national DGT but is not done yet. If a vehicle is not compliant with LEZ regulation there is an option to buy a max of 10 daily passes per year.

The LEZ is enforced by automatic vehicle detection with Automatic NumberPlate Recognition (ANPR) system, managed at a regional level. Most license plates can be matched with the country of origin, but some license plates are difficult to match e.g., from Belgium or Morocco.

When a vehicle is not compliant nor registered, the (stored) ANPR picture is sent to the city police department where the offence took place. The local police will manually control the offence (check the license plate with the vehicle and owner registration). The fine issuing and collection are done by the provincial fiscal department “Deputation de Barcelona”, except Barcelona city who has its fiscal services. A fine collection for foreign vehicles is not processed as there is no legal basis for it.

Error! Reference source not found. below shows the enforcement process of the city of Barcelona.

Figure 19: LEZ enforcement process city of Barcelona



In meetings with AMB and DGT, a set up of demonstrations has been discussed using the same setup of network connections that is already available between the Metropolitan area of Barcelona and the DGT NCP for EUCARIS to demonstrate with a test setup at EUCARIS de technical feasibility of data exchange thru the EUCAIRS solution. At the moment this report is written these preparations are taking place. To showcase the solution and show the EUCARIS Web service in the test environment created for Barcelona the functionality can be showcased. **Error! Reference source not found.** and **Error! Reference source not found.** show the interface retrieving technical data from a French EV and technical and owner/holder data from a Dutch Euro 3 vehicle.

Figure 20: EUCARIS webservice technical test data EV

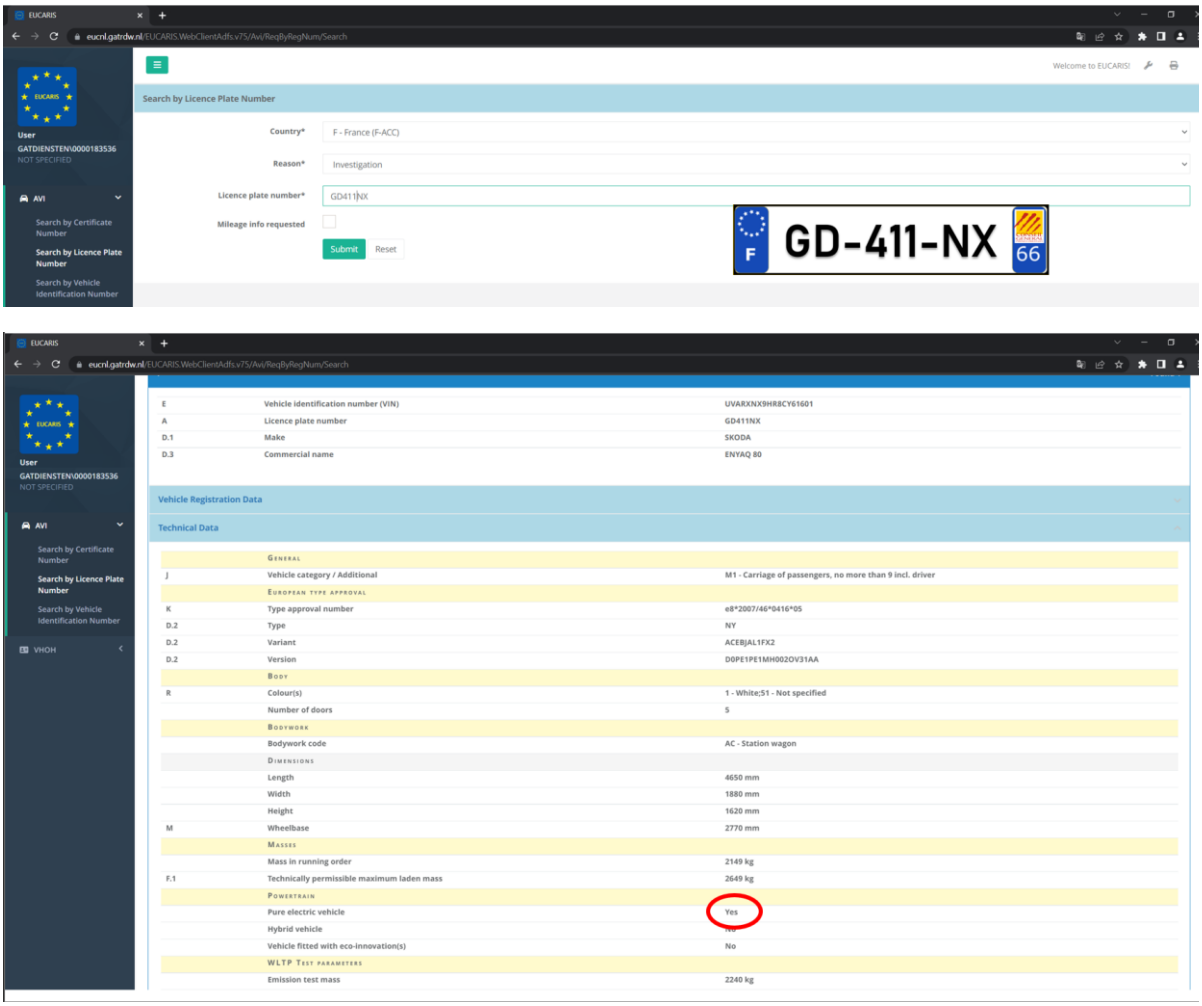
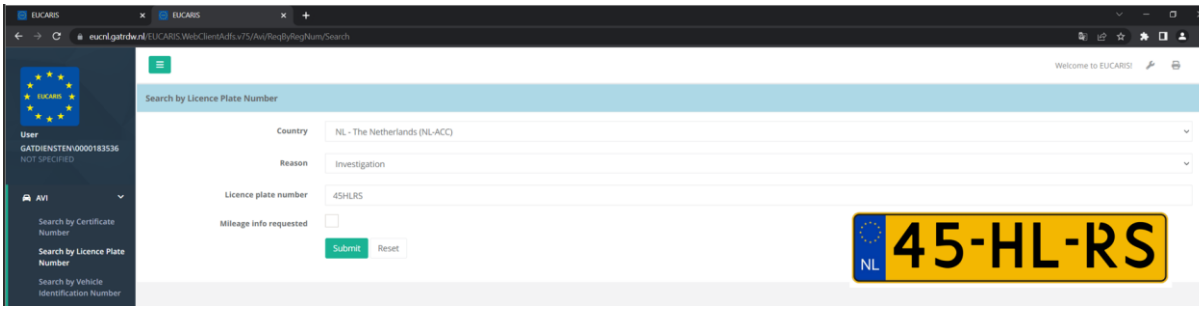
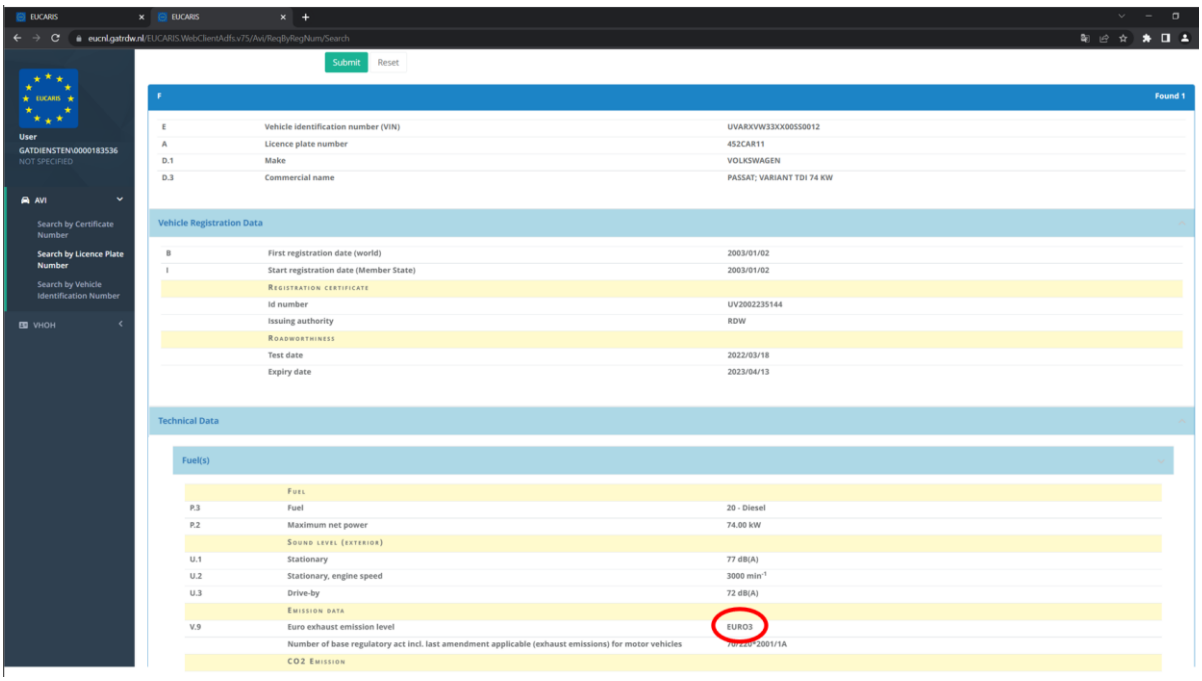
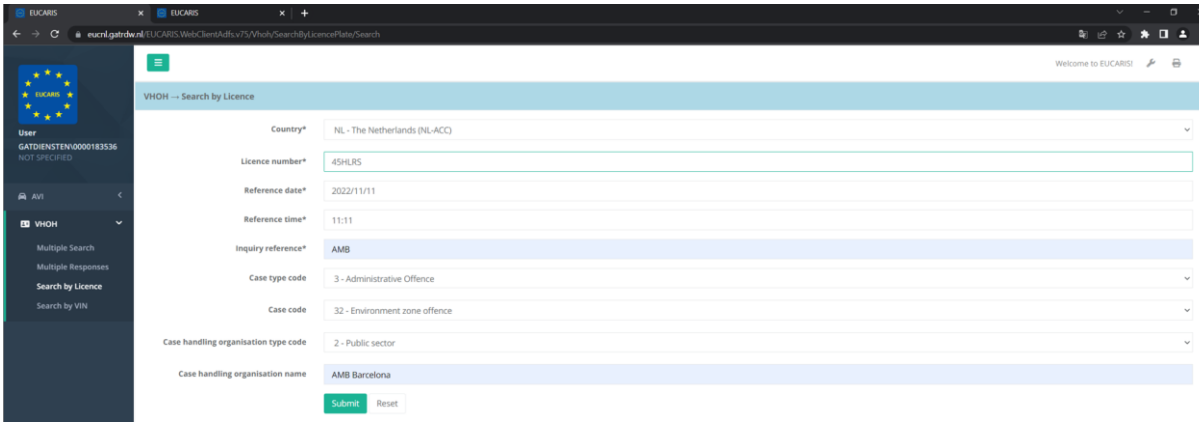
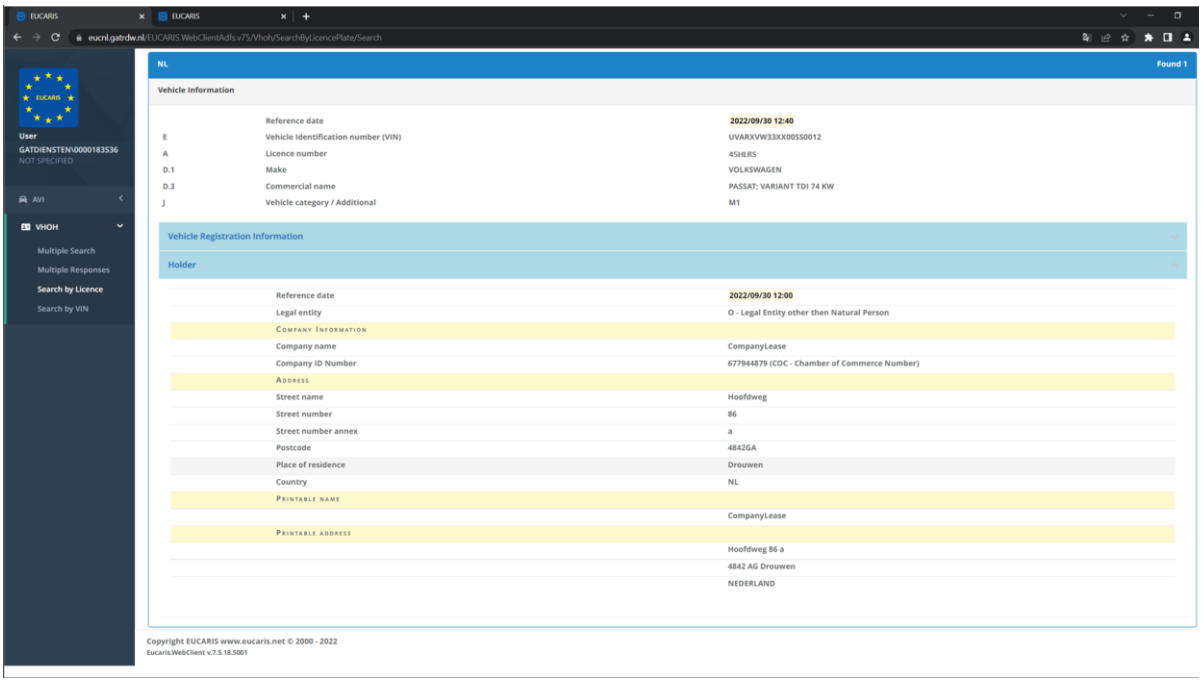


Figure 21: EUCARIS Webservice technical and holder test data Euro 3 vehicle



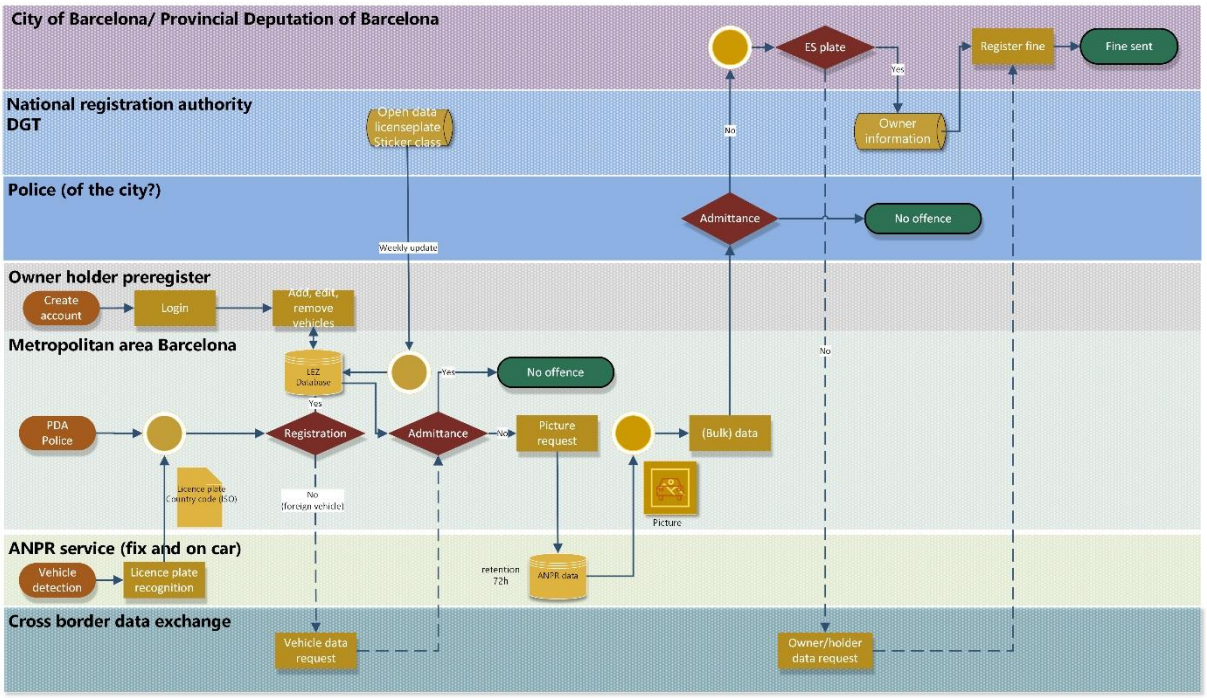






When legally possible the enforcement of cross-border data will probably look like the scheme in **Error! Reference source not found.**.

Figure 22: Future LEZ enforcement process Barcelona region



2.8. Brussels

2.8.1. Aim of this demo

The proposed demo aimed to test and showcase organisational and technical aspects of the UVAR enforcement processes and support the identification of current barriers and potential solutions while implementing and operating IN Groupe UVARWallet or EUCARIS service as a cross-border data exchange solution.

2.8.2. Process and consultation activities

Preliminary meetings and dry run meetings:

- Representatives of the city of Brussels:
  - Environmental department
  - Mobility department
  - Fiscal department
  - IT department
- Representatives of the Vias Institute
- Representatives of IN Groupe
- Representatives of the Federal Public Service Mobility and Transport

2.8.3. Demonstration activities

Preliminary meetings led to the development of a high-level scheme for the UVAR enforcement process in the city of Brussels.

"Dry run demonstration" sessions aiming to apply IN Groupe UVARWallet solution to the following LEZ enforcement use cases:

- Simulated use case French disabled person visiting Brussels with a non-compliant French vehicle
- Simulated use case of a mobile compliance check by an Enforcement officer in Brussels

"Real life demonstration"

- *Participants: IN Groupe*
- *User stories: French driver (French) registering to enable entering Brussels*
- *Owner/Holder centric solution*
  - *Systems in place:*
    - IN Groupe demo environment
    - UVARbox data schemes
    - Demo walk-through prepared by IN Groupe
- *Steps were taken to perform the real-life demo*
  - "Use cases" and "Enforcement process flowchart" detailed descriptions based on "Dry run demonstration" results
  - UVAR wallet "storyboards" and mock-up development by IN Groupe supported by UVAR Exchange
  - Simulated steps for UVARwallet LEZ enforcement services (manual) to input simulated data in the Webservice
- *Showcase and record*
  - Video recording of UVARWallet "solution walkthrough" and "user stories"

2.8.4. Challenges, barriers and benefits/opportunities encountered

Main challenges/ barriers encountered:

- Identifying and engaging with the right persons and departments mandate and necessary to support the proposed demo
- Lack of available processes and systems to allow the use of EUCARIS for cross-border data exchange
- Lack of capacity (time resources) by some stakeholders to support the necessary research and developments

Main opportunities/benefits:

- Raised awareness and motivation between the different organisations for implementing the proposed solution.

2.8.5. Findings,recommendations and next steps

Bruxelles capital Region has a LEZ UVAR in place where pre-registration is obligatory for foreign vehicles except for Dutch vehicles. At the moment only 3% of foreign vehicles have been registered. When a violation is registered a manual check is obligatory to be performed.

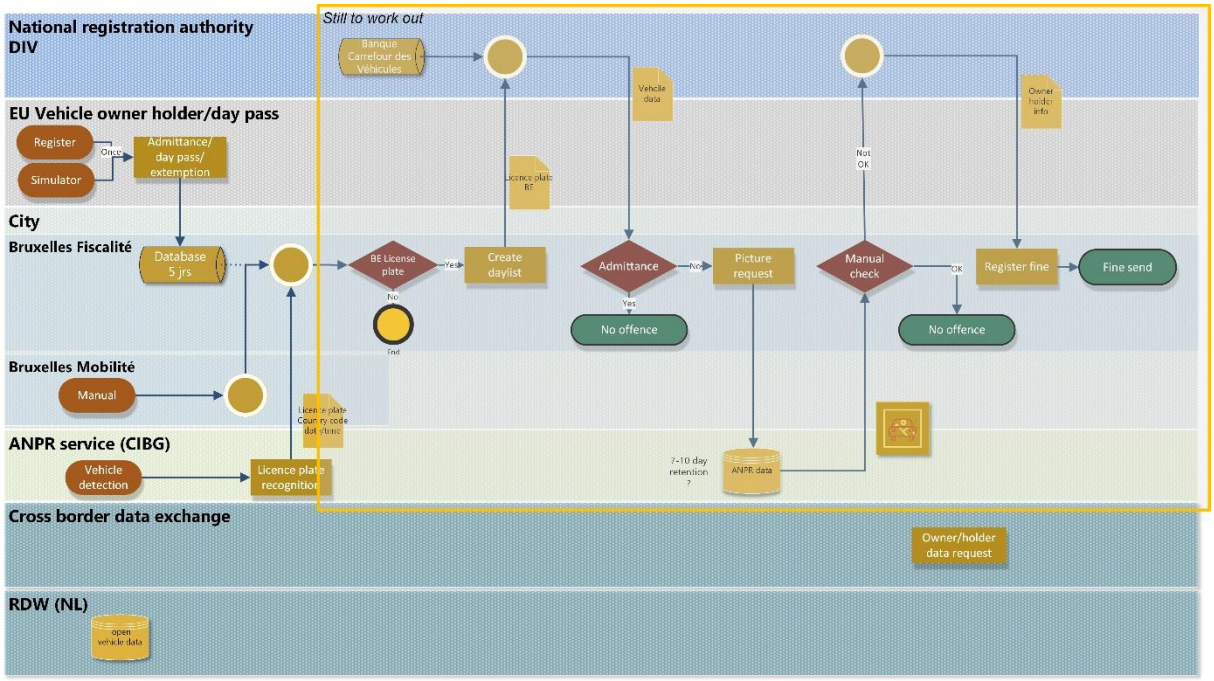
The LEZ enforcement is currently done through vehicle detection with ANPR system maintained by CIRB (Brussel IT department). Bruxelles Mobilité is currently developing a system to enable checking vehicles also with mobile control officers. This will be applied not only to LEZ but also to monitor other traffic regulations.

The vehicle compliance check for both Belgium and Dutch vehicles is done through cooperation between the city, the region and federal organizations. For Belgium, vehicles check is done directly with the Federal DIV. With the French and Dutch, there is a legal basis in place to exchange owner-holder information. Due to political reasons, this is not done at the moment. Bruxelles Fiscalité processes the collection of owner-holder data from Federal DIV[4] and issues the fines related to the violations of the LEZ regulations. The fine for not registered is 150 euros and if not compliant it is 350 euros.

Error! Reference source not found. below shows the first draft of the enforcement process of the city of Brussels.

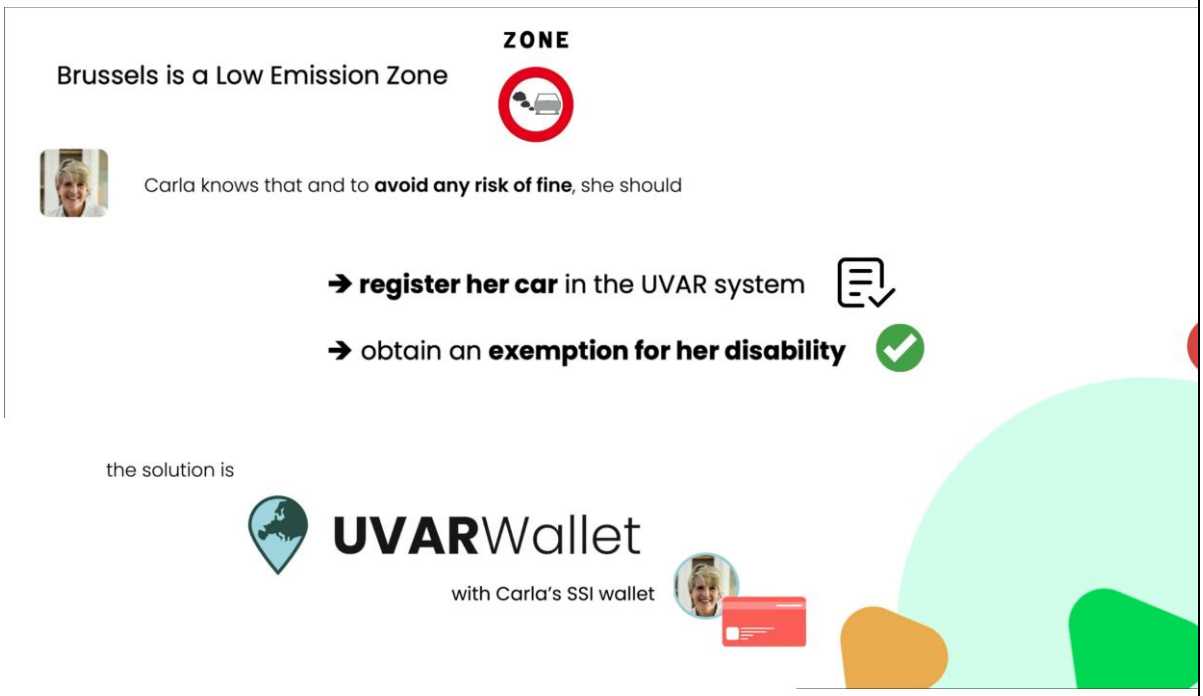
[4] Vehicle registration organisation in Belgium

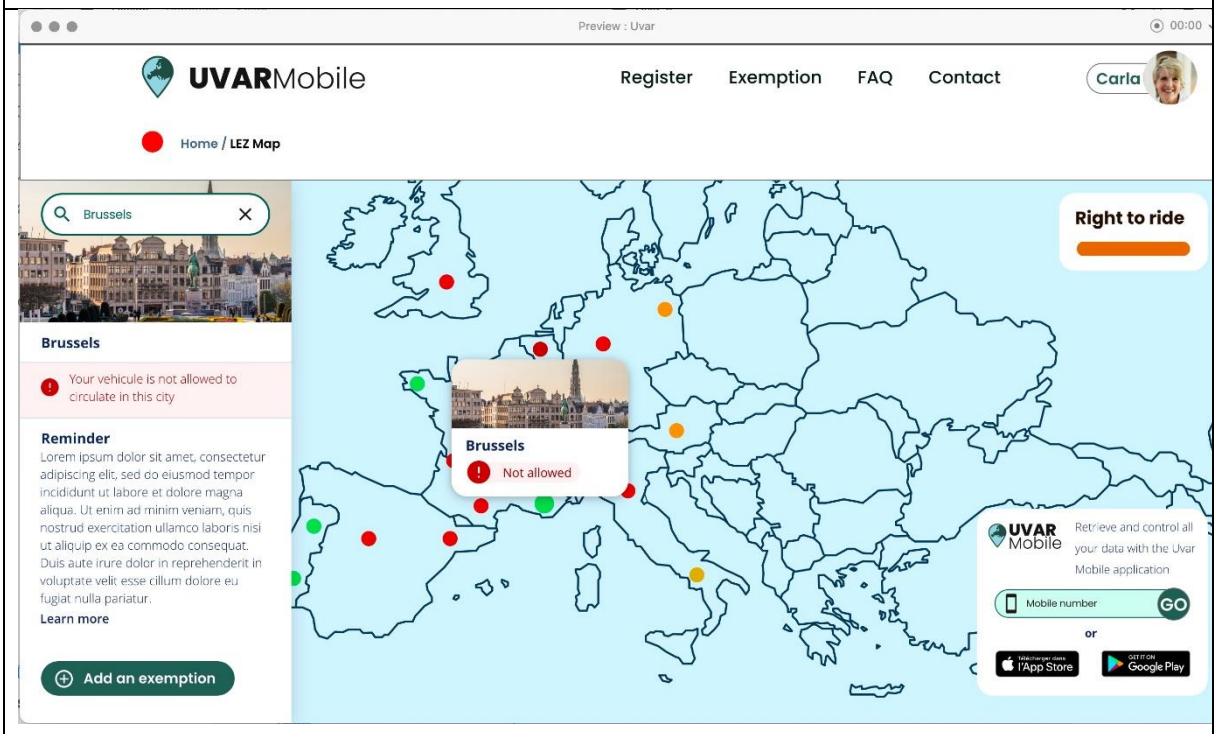
Figure 23: EZ enforcement process city of Brussels



The In Groupe demonstrated the concept of an integrated solution for UVARs where the vehicle owner/holder registers the car and any exemptions relevant in the UVARWallet enabling access to all European cities at once when compliant with the local UVAR rules. **Error! Reference source not found.** shows in short the sequence of the solution. The recorded showcase can be found at this link.

Figure 24: Driver-centric solution, Carla enabling admittance for UVARs thru registration of exemption





2.9. Rotterdam

2.9.1. Aim of this demo

The proposed demo aimed to test and showcase organisational and technical aspects of the UVAR enforcement processes and support the identification of current barriers and potential solutions while implementing and operating EUCARIS as a cross-border data exchange solution.

2.9.2. Process and consultation activities

Preliminary meetings and dry run meetings:

- Representatives of the city of Rotterdam:
  - Environmental department
  - Mobility department
  - IT department
- Representatives of the Dutch Ministry of Infrastructure and Water management
- Representatives of RDW, the Dutch Vehicle and Driver Registration Agency
- Representatives of the Dutch National Central Judicial Collection Agency (CJIB)

2.9.3. Demonstration activities

Preliminary meetings led to the development of a high-level scheme of the UVAR enforcement process in the city of Rotterdam.

"Dry run demonstration" sessions aiming to apply EUCARIS solution to the following LEZ enforcement use cases: Belgium vehicle owner-holder and vehicle technical data via the RDW under the bilateral agreement with Belgium.

"Real Life Demonstrations"

- *Participants:* City of Rotterdam, RDW, CJIB, EUCARIS
- *User stories:* Foreign lorry vehicle non-registered entering Maasvlakte
- *EUCARIS solution:* Full functional implementation of the connection to the Dutch EUCARIS NCP[5], RDW
- *Systems in place:*
  - City Rotterdam ANPR monitoring and enforcement systems at Maasvlakte (simulated data)
  - 'Diginetwerk' connection between Rotterdam and RDW
  - CJIB transaction Module
  - EUCARIS digital service
- *Steps were taken to perform the real-life demo*
  - "Use cases" and "Enforcement process flowchart" detailed descriptions based on "Dry run demonstration" results
  - DIGINET integration in the City of Rotterdam Monitoring and enforcement systems
  - EUCARIS integration in the City of Rotterdam Monitoring and enforcement systems
  - Collection of simulated data from foreign vehicles non-registered in Rotterdam> not in "white list"
  - Simulated steps by the city of Rotterdam enforcement services (manual) to input simulated data in the CJIB transaction module"
- *Showcase and record*
  - All user stories steps were video recorded for further (after the project) showcasing activities via www.uvarbox.eu website

[5] National Contact Point of EUCARIS

2.9.4. Challenges, barriers and benefits/opportunities encountered

Main challenges/ barriers encountered:

- Identifying and engaging with the right persons and departments mandate and necessary to support the proposed demo
- Lack of available processes and systems to allow the use of EUCARIS for cross-border exchange
- Lack of capacity (time resources) by some stakeholders to support the necessary research and developments

Main opportunities/benefits:

- Raised awareness and motivation between the different organisations for implementing the proposed solution.

2.9.5. Findings,recommendations and next steps

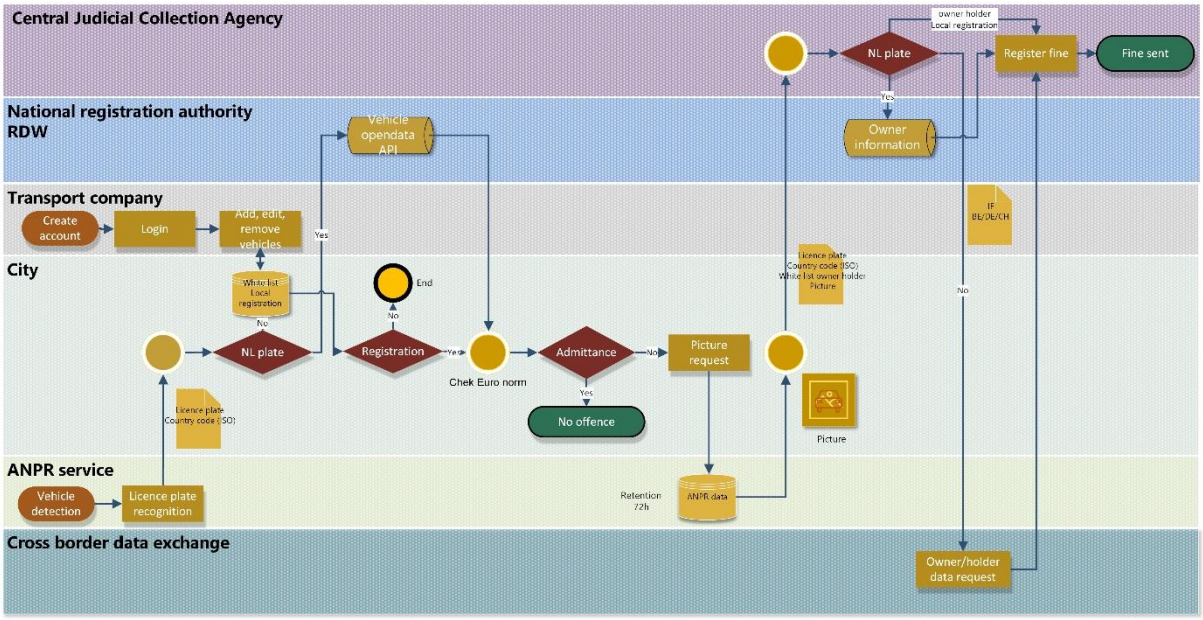
The municipality of Rotterdam manages a LEZ in the city centre of Rotterdam and the LEZ in the "Maasvlakte" harbour area/access. For the Maasvlakte there is a mandatory (free) registration for all foreign vehicle trucks (>3.5T), where vehicle registration and owner-holder information is required. Day exemptions are available for €22,70.

LEZ enforcement is done with both ANPR-system and mobile traffic control officers.

The vehicle compliance check is done locally by the city based on the local registration database and the Dutch RDW open data feed on vehicle technical data. Non-compliant vehicles license plates or holder-owner information is passed to the National Central Judicial Collection Agency (CJIB) which will issue and collect the fines both for national and foreign vehicles where this is legally allowed.

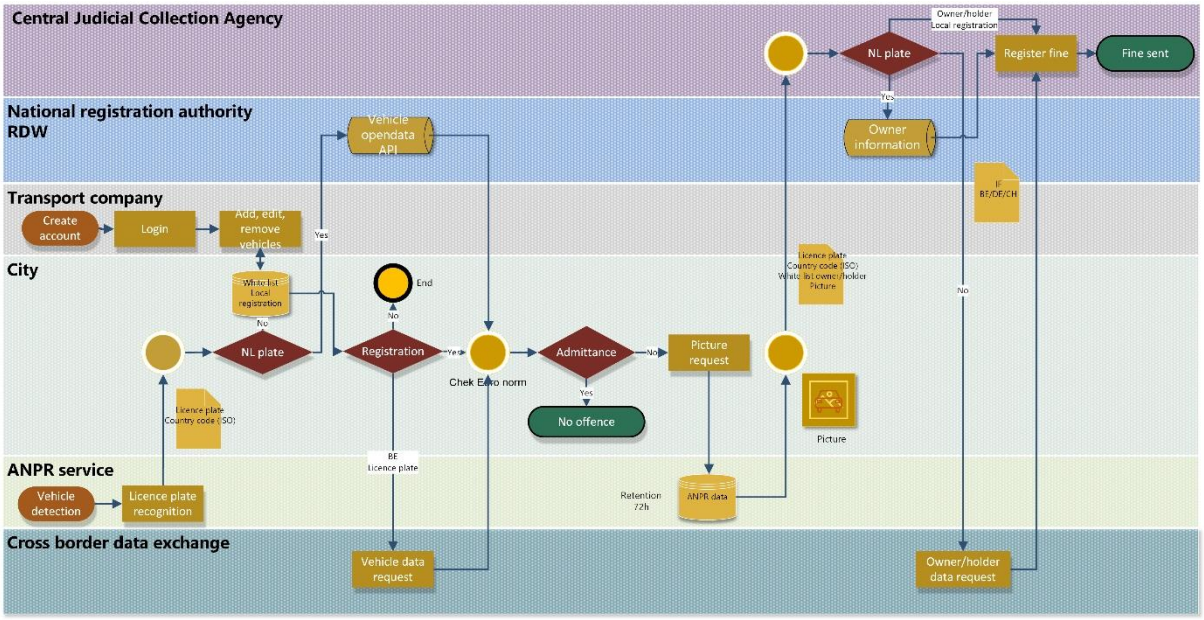
Error! Reference source not found. below shows the first draft of the enforcement process of the city of Rotterdam.

Figure 25: LEZ enforcement process city of Rotterdam



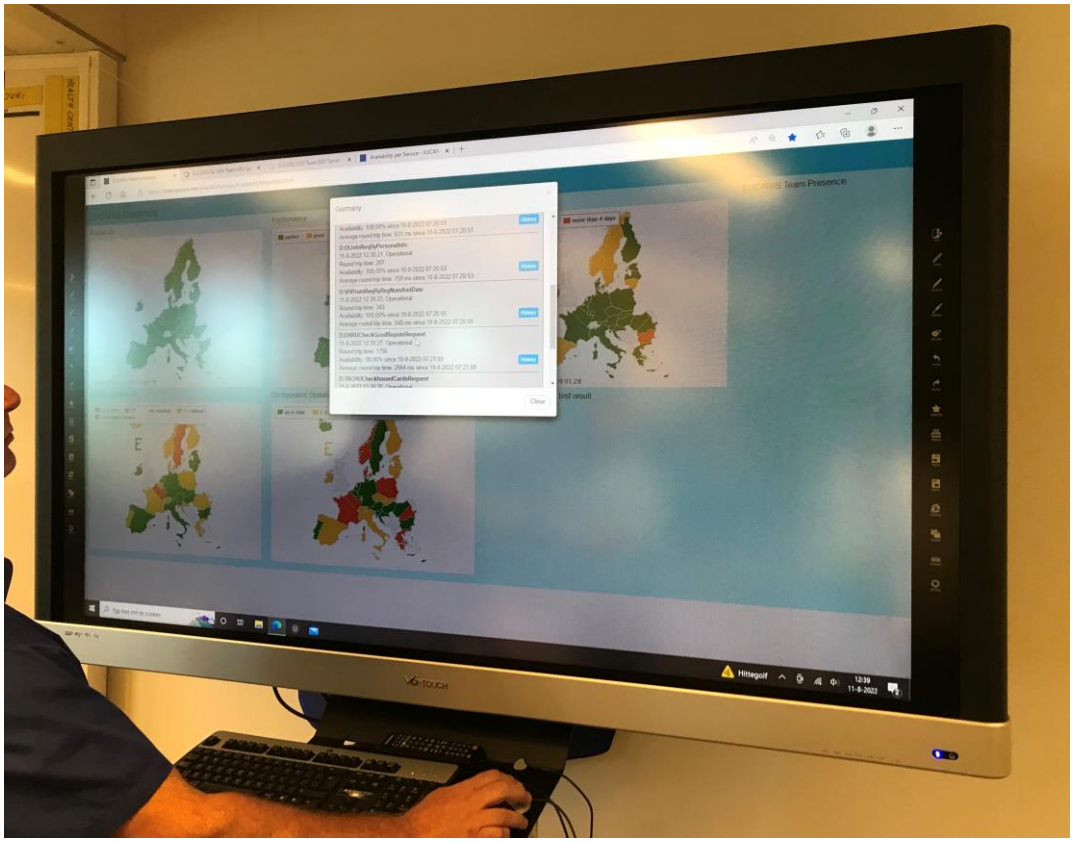
The bilateral political declaration of the Benelux countries enables data exchange of technical vehicle data between the countries. For the 'milieuzone Maasvlakte' the euro class of Belgian vehicles can be checked thru the EUCARIS connection towards de DIV. **Error! Reference source not found.** shows the setup of the new enforcement process of the city of Rotterdam.

Figure 26: New LEZ enforcement process city of Rotterdam



The connection from the city of Rotterdam to EUCARIS has been set up thru Diginetwerk, a closed coupled network of the governments in the Netherlands. The connection from EUCARIS towards the DIV has yet to be performed. For the demonstration, simulated data is used to clarify the enforcement process. For the demonstration, a storyboard has been created and discussed with the participants. The final video can be found with this link. **Error! Reference source not found.** shows the monitoring dashboard of all the connections of EUCARIS to the different countries.

Figure 27: The EUCARIS monitoring dashboard



2.10. Verona

2.10.1. Aim of this demo

The proposed demo aimed to test and showcase organisational and technical aspects of the UVAR enforcement processes and support the identification of current barriers and potential solutions while implementing and operating EUCARIS as a cross-border data exchange solution.

2.10.2. Process and consultation activities

Preliminary meetings and dry run meetings:

- Representatives of the city of Verona:
  - Mobility department
  - Police department
- Representatives of the Italian Ministry of Transport

2.10.3. Demonstration activities

Preliminary meetings led to the development of a high-level scheme of the UVAR enforcement process in the city of Verona.

"Dry run demonstration" sessions aiming to apply EUCARIS solution to the following LEZ enforcement use cases: Dutch, Belgium and German vehicle owner-holder data via the EUCARIS under the CBE agreement; Demonstration of the use cases facilitated by the Italian Ministry of Transport portal http://ilportaledellautomobilista.it/

"Real life Demonstrations"

- *Participants:* City of Verona, Verona local Police
- *User stories:* Foreign vehicle (Dutch, French and German) non-registered entering Verona
- EUCARIS solution
    - Existing and accessible to Verona police via InfoWeb: Italian Webservice supporting data exchange between the ministry of infratsructura and transport and local organisations (like local police or city departments)
- *Systems in place:*
    - City of Verona ANPR monitoring and enforcement systems (simulated data)
    - InfoWeb connection between Verona and the Ministry of Infra and transportation
    - EUCARIS Italian NCP
- *Steps were taken to perform the real-life demo*
    - "Use cases"and "Enforcement process flowchart" detailed descriptions based on "Dry run demonstration" results
    - Collection of simulated data from foreign vehicles non-registred in Verona> not in the white list
    - Simulated steps by Verona local police enforcement services (manual) to input simulate data in InfoWeb module
- *Showcase and record*
    - Video recording for showcasing was not feasible during the project period

2.10.4. Challenges, barriers and benefits/opportunities encountered

Main challenges/ barriers encountered:

- Identifying and engaging with the right persons and departments mandate and necessary to support the proposed demo
- Lack of capacity (time resources) by some stakeholders to support the necessary research and developments

Main opportunities/benefits:

- Raised awareness and motivation between the different organisations for implementing the proposed solution.

2.10.5. Findings,recommendations and next steps

The city of Verona has a Limited Traffic Zone (LTZ) UVAR in place, restricting access to the city centre on pre-defined periods and days of the week. Vehicles with specific travel purposes or driver's conditions can apply for occasional or permanent authorization.

The LTZ enforcement is done with an ANPR system to detect and identify the vehicles.

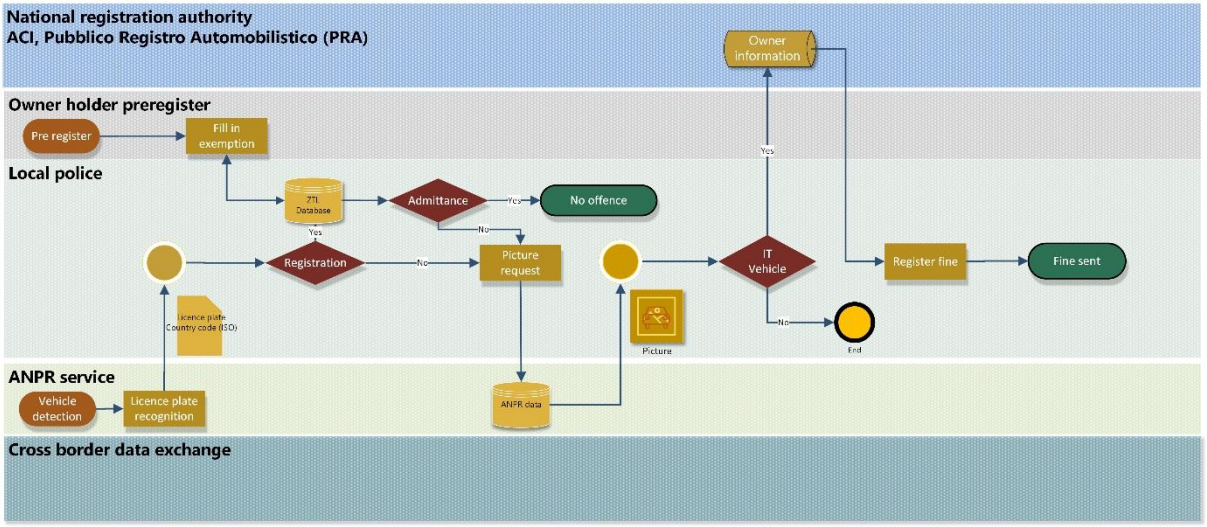
The vehicle compliance check is done locally by comparing the license plate with the registered vehicle database. Non-compliant vehicle license plates are sent to the national vehicle registry for collection of holder information to the municipal police to process and send the corresponding fine. Foreign vehicle license plates are sent to the Italian EUCARIS National Contact Point, the Ministry of Sustainable Infrastructure and Mobility, to collect owner-holder information under the EU CBE regulation.

The Ministry of Sustainable Infrastructure and Mobility provides access to domestic and foreign vehicle owner-holder information via a web service platform provided available to all local authorities. To gain

access and be able to collect domestic information, local authorities need to pay a yearly fee and a fee per single request.

Error! Reference source not found. below shows the first draft of the enforcement process of the city of Verona.

Figure 28: LTZ enforcement process city of Verona



In the historic centre of Verona, a Limited Traffic Zone (Zona a Traffico Limitato) is in place.
The Verona local police as access to several EUCARIS services to retrieve technical vehicle information and owner/holder data based on several treaties and bilaterals between European countries. A demonstration of retrieving vehicle information was executed see **Error! Reference source not found.** and **Error! Reference source not found.**

Figure 29: Infoweb vehicle technical information request

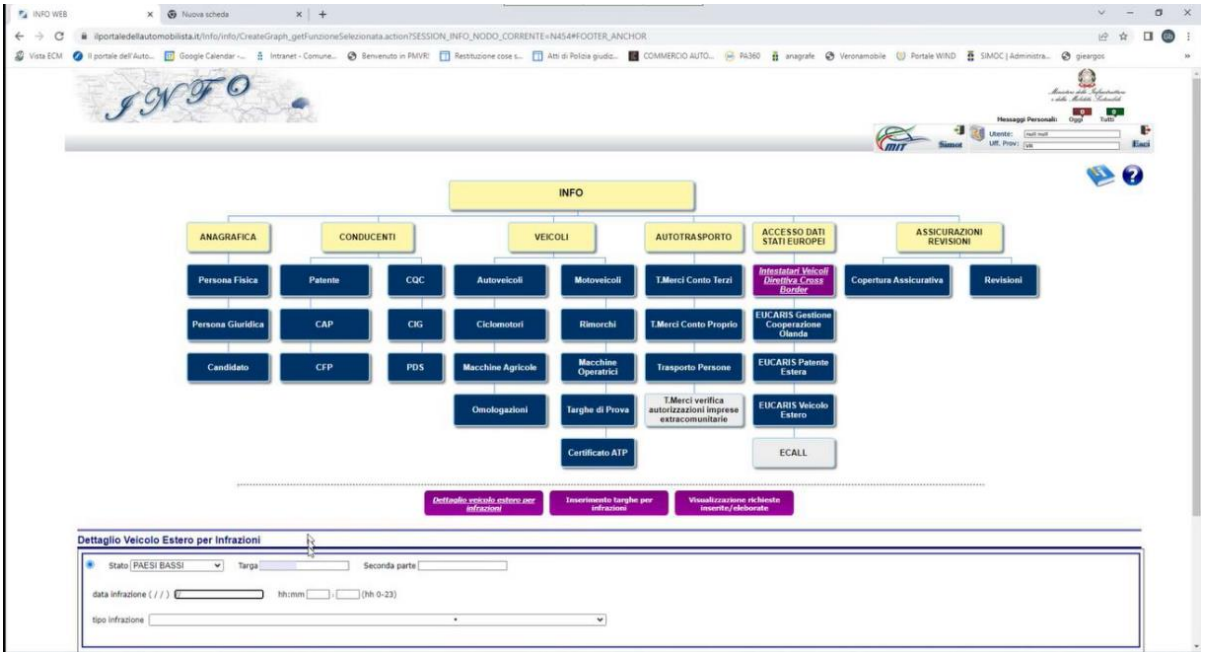
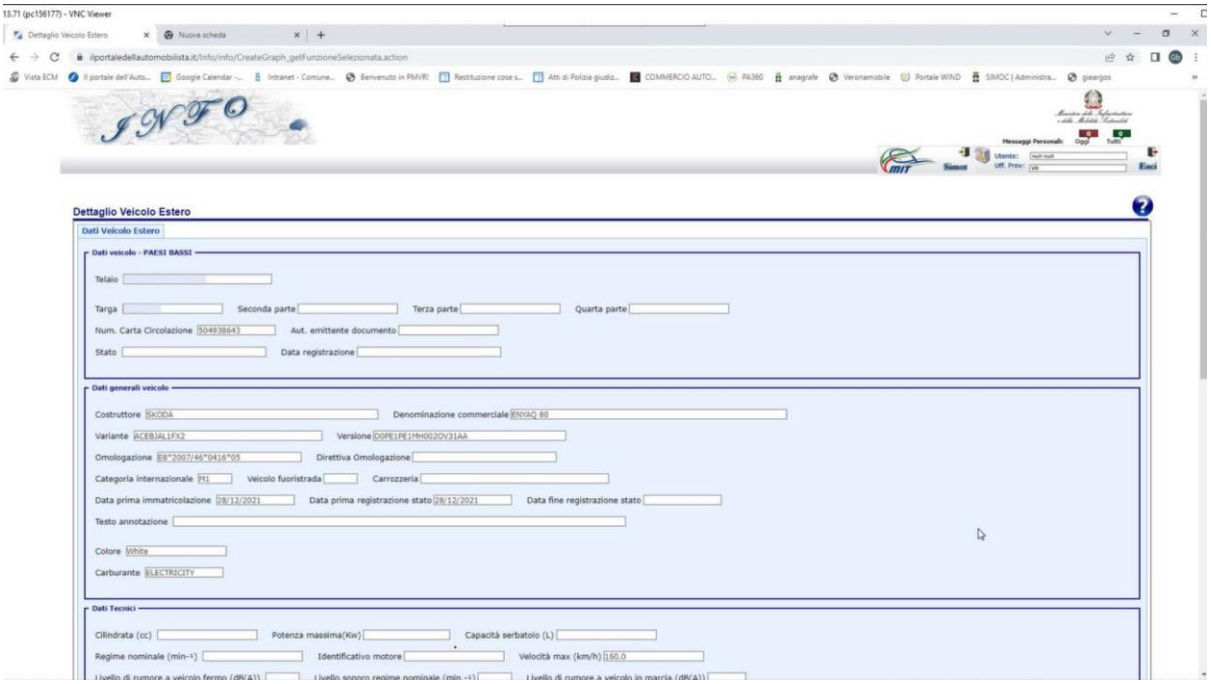


Figure 30: Infoweb vehicle technical information result



This demonstration shows that technical the exchange of data is already possible within different legal frameworks, but the EU-wide legislation yet is missing to do so. **Error! Reference source not found.** shows the possible future enforcement procedure of Verona.

Figure 31: Future LTZ enforcement process Verona