



# Annual pilot overview report 2022

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| Belgium/Wallonia | Netherlands    |
| Czech Republic   | Norway         |
| Denmark          | Portugal       |
| Finland          | Slovenia       |
| France           | Spain          |
| Germany          | Sweden         |
| Greece           | United Kingdom |
| Hungary          |                |

# 1. Introduction

Core Members of the C-Roads platform are European States that agree to work together to achieve deployments that enable interoperable and seamless cross-border C-ITS services for European travellers. At the current stage, eighteen European States committed to participate with their pilot sites. The C-Roads Platform remains open for other European States as well, as long as they are willing to actively participate. Since 2019 the scope was enlarged towards urban areas. Currently more than 50 cities are starting to implement C-ITS Use Cases.



Figure 1: C-Roads overview

The annual pilot overview report gives a summary of the pilot activities performed in each participating European Member State and the participating cities. The final status of pilots which have already come to an end are described. For projects that are still running the chapters include a progress report. Additionally, the number of all installed Road Site Units based on funding by CINEA is listed per country/pilot.

## 2. The Austrian Pilot site

The C-Roads Austria pilot was built on the core elements of the European C-ITS Corridor project in Austria ([ECo-AT](#)), as defined in the Austrian C-ITS Strategy. Since 2016, a pilot area (ECo-AT Living Lab) around Vienna - based on ECo-AT specifications - had been operational and open for stakeholders in various test cycles and cross-border tests.

It was Austria's intention to replace the ECo-AT Living Lab with an operational C-ITS system within the lifetime of C-Roads Austria. In order to facilitate that, a large tender for the national rollout of a fully "hybrid" C-ITS roadside system on the whole Austrian motorway network was issued, including several hundred roadside stations and various Day-1 and future Day-2 use cases from the C-Roads catalogue. "Hybrid" means: VANET communication (ITS-G5) and IP-based communication (based both on fully harmonized C-Roads specifications) coexist to deliver the same content over different media, short-range and long-range. This tender started end of 2018, with the intention to have the first elements of this operational system, including a first batch of roadside stations, available in 2019 – just in time for planned C-Roads testing activities in 2020.

With the Delegated Regulation on C-ITS not materializing in 2019, the tender was put on hold to reassess the situation. After the formation of the [C-ITS Deployment Group](#) and its successful statement on continued deployment in late 2019, the Austrian Ministry of Transport and ASFINAG decided to continue with the tender on a new time frame – with the operational system and the first batch of roadside stations now available in 2021. This meant, however, that for mandatory C-Roads testing in 2020, additional efforts had to be made to update roadside units from the pre-existing ECo-AT Living Lab to the current level of C-Roads specifications and to have roadworks trailers equipped with C-ITS communication units. A contract for dedicated pilot installations was awarded in late 2019, with 25 ITS-G5 roadside stations around Vienna, Graz and Linz available for testing in 2020. In the same year, a framework contract for multifunctional roadworks trailers including C-ITS (ITS-G5) was established, from which 15 units were available for testing in 2020 and ready for operation in 2021.

Due to COVID-19 and resulting travel restrictions, C-Roads testing activities came to a hold in early 2020. In October of 2020, in between lockdowns, Austria was able to perform a small, but successful C-Roads cross-test on the A1 near Linz, with special COVID-19 precautions in place and support limited to virtual meetings. With the COVID-19 situation worsening after that and a second lockdown in place, Austria asked for an extension of C-Roads Austria until the end of 2021 to enable proper testing, accomplish the C-Roads milestones and fulfil the vision of an operational C-ITS rollout in Austria within C-Roads Austria.

As a result, the pilot – planned to be only available for 2020 – was extended until Q2 of 2021. The tender for national C-ITS deployment at the roadside level was concluded in October 2020 and a framework contract was awarded to Siemens Mobility Austria, which was renamed to Yunex Traffic Austria after a management carve-out mid-2021. Out of that framework, an initial contract for the delivery of the central C-ITS station and 175 ITS-G5 roadside stations was obtained, including service and operation for up to 12 years. These first 175 roadside stations were selected to be placed on the motorways around Vienna, the "west corridor" from Vienna to Linz to Salzburg (as part of the co-operative C-ITS corridor from Rotterdam via Frankfurt to Vienna), around Graz



and on several border regions, to facilitate easier cross-border testing. During 2021, these roadside stations have been deployed in several waves and have been put into (limited) operation for testing. They will either remain in that testing status or in a bilateral operational mode with Volkswagen vehicles until the requirements and the timeframe for a full operational status on the ECTL have become known (which only happened at the end of 2021) and can be implemented (which will not happen before the end of 2022). Nevertheless, these deployments have supplanted the pilot installations from Q2 / 2021 onwards for additional C-Roads test activities.

In addition to the roadside deployment of C-ITS, Austria also decided to equip ASFINAG's road operator vehicles (equipped with amber or blue lights) with C-ITS vehicle units, based on the available use cases for such vehicles in the C-Roads catalogue. A contract to equip 100 vehicles overall was awarded in late 2020 to Kapsch TrafficCom AG out of an existing framework contract, with a first batch of (prototype) vehicles ready and equipped until the end of 2021 and full deployment including operational status on the ECTL achieved not before 2023.

From 2022 onwards, the operational deployment of C-ITS in Austria at roadside, in vehicles and by using trailers has continued in C-Roads Austria 2. The roadside framework contract allows for the deployment of up to 525 roadside stations on Austria's motorway network and the aim is to add 100 additional roadside stations each year until full deployment is reached in 2025. Given an overall network length of around 2250 kilometres, the average distance between to stations would be less than 4 kilometres – with a typical communication radius of 1.5 to 2 kilometres for ITS-G5, this nearly accumulates to area-wide coverage of the whole network.

Additionally, in C-Roads Austria 2 urban use cases have been implemented in the cities of Graz, Wien and Salzburg, in order to bridge the gap between motorways and urban areas until 2023. The use cases focus on public transport services, signalized intersections as well as hazardous location notifications.

From 2022 until 2025, this should continue and even be further expanded in the scope of C-Roads Austria 3, by adding new use cases within the city of Graz and extending the implementation of C-ITS to the city of Klagenfurt.

Moreover, further cities are planning to install roadside units and on-board units to transmit C-ITS services in urban areas. For example, the city of Linz already started to conceptualize their future installations. Other Austrian cities are expected to follow in future.

## Involved partners

- ASFINAG
- Contractors:
  - Siemens Mobility Austria GmbH, now Yunex Traffic Austria GmbH
  - Kapsch TrafficCom AG
- Stadt Graz
- Land Salzburg
- Stadt Wien
- Wiener Linien
- Stadt Klagenfurt
- Land Kärnten
- Institut für Technologie und alternative Mobilität
- pdcp GmbH
- Klagenfurt Mobil GmbH

## Location

### Inter-urban



**Figure 2: Staged operational deployment of C-ITS roadside stations in Austria from 2021-2025**

The operational C-ITS rollout / C-Roads pilot in Austria covers several different areas of the motorway network:

- The motorways around Vienna, the former “Eco-AT Living Lab”, was updated to full deployment status in the first stage of deployment in 2021.
- At the same time in the first stage of 2021, the motorways from Vienna to Salzburg (including Linz), a stretch of nearly 300 km, also known as the “West Corridor” and the Austrian part of the “C-ITS Corridor” between Netherlands, Germany and Austria, thus by definition the first C-ITS deployment area, were equipped with roadside stations, as already declared in an MoU between these three countries in 2013. This initial deployment also included the motorways around Graz (a known proving region for automated driving) and several border areas, relevant for cross-border deployment and testing.
- Deployment was extended to the rest of the Austrian motorway network in 2022, with the 2022 deployment concentrating on the “Brenner” and “Tauern” transit routes, as well as filling the gaps on the West corridor.
- In 2023, the “Tauern” transit route and the Baltic-Adriatic TEN-T Corridor from Villach to Vienna will be equipped, with the 2024 deployment planned to happen mainly in Styria, on and around the A9. 2025 will fill the gaps on the rest of the Austrian motorway network, which spans around 2250 km in total. By the end of 2025, 525 roadside stations will be on the network.
- Road operator vehicles and trailers are stationed all over Austria and used operationally whenever and wherever they are needed.

## Urban

### Pilot Graz

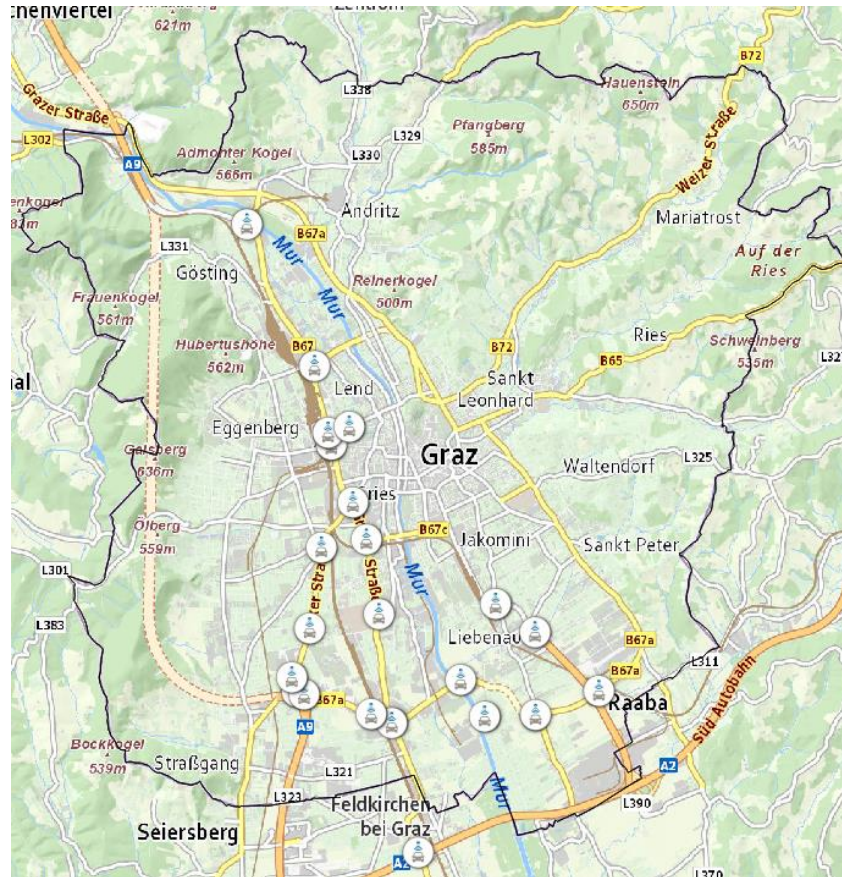


Figure 3: Map of C-ITS pilot in Graz

The two motorways A9 in the West and A2 in the South of Graz are both important connections for the city and at the same time, the city area of Graz is a common bypass in the event of incidents on one of the motorways. The most common bypass routes are the B67 and the B70, which lead directly through the city of Graz. Therefore, the first roadside station installations were located in these streets. Further actions focus on use cases and benefits for Public Transport and Vulnerable Road Users. At the same time, the city of Graz is working towards a city-wide rollout of C-ITS infrastructure.

The following actions are implemented in C-Roads Austria 2:

- Purchase of necessary equipment and necessary replacements for existing traffic light equipment (central traffic computer, etc.).
- Purchase of testing equipment to independently validate installed roadside units and to generate scenarios.
- 16 roadside units installed at signalized intersections on the above mentioned routes B67 and B70. All of those send SPAT/MAP information.

- 1 roadside unit installed at an intersection with a parallel bike lane. This location is used to test a VRU use case by detecting cyclists on the bike lane.
- 4 busses equipped with onboard units, which are used to compare the PT prioritization and test other use cases.
- 1 vehicle equipped with an onboard unit, which is used to test a RWW use case for the urban area.
- Equipment of a city tunnel with roadside units which are supposed to send out the information of the variable message signs.
- Design of an application to display messages in vehicles which are retrofitted with onboard units.

Implementations in C-Roads Austria 3 consist of:

- At least 2 new use cases:
  - One will be the signalisation of bottlenecks for busses. Besides few permanent locations for this use case, it will be investigated if a mobile version of this could possibly be used for long-term road works.
  - The other one will be a warning message that pedestrians cross the street without a pedestrian crossing at special locations.
- At least 3 new roadside stations.
- At least 5 new onboard units.
- A Broker and first hybrid tests: especially in a national context discussions need to continue which amount of brokers is feasible and desirable.

## Pilot Wien

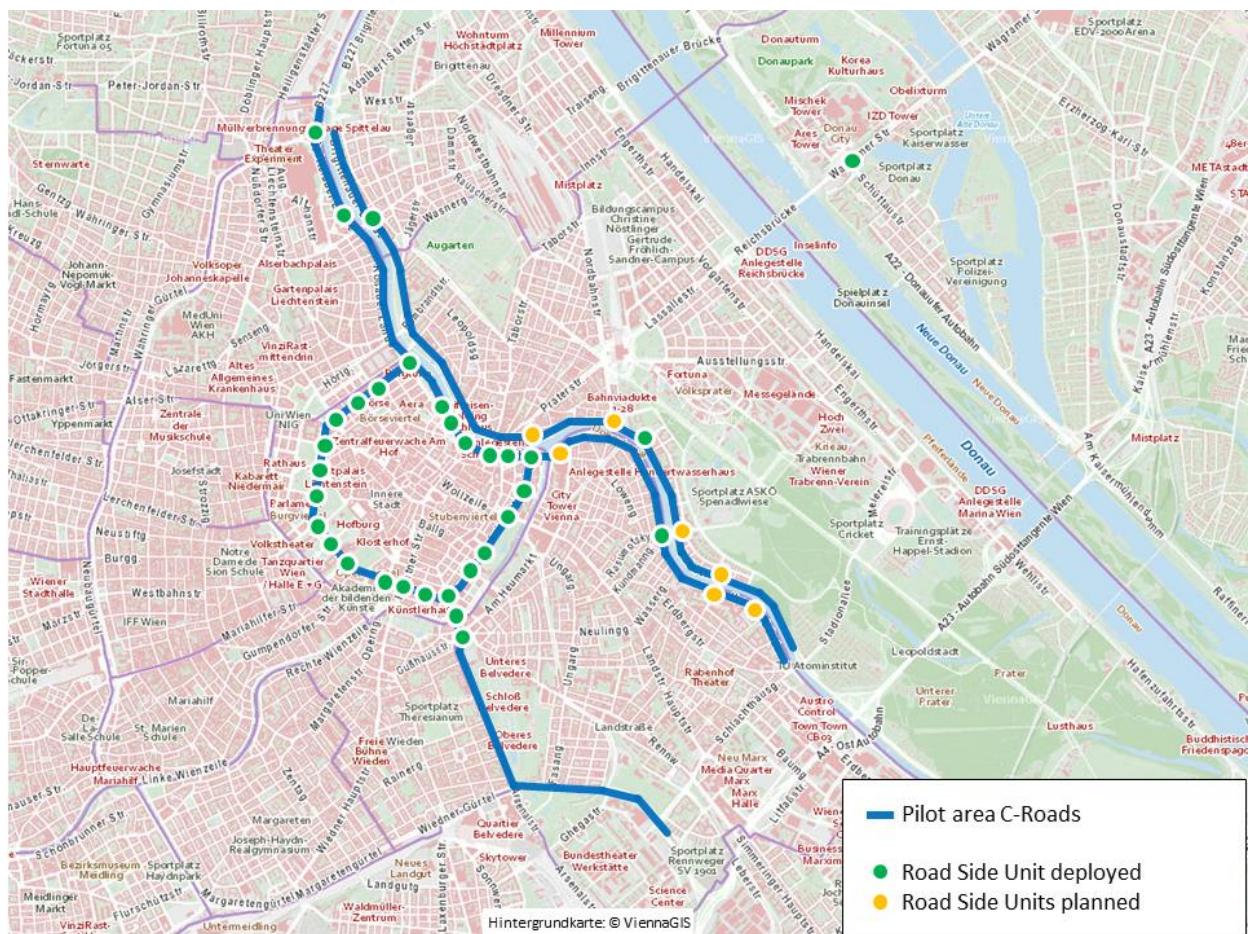


Figure 4: Map of C-ITS pilot in Vienna

The pilot site Vienna includes urban road sections from motorway intersection A23 / A4 (Knoten Prater / Knoten Landstraße) to the city center with a total length of approximately 17 km and 70 traffic lights:

- Schüttelstraße – Untere Donaustraße – Obere Donaustraße – Brigittenauer Lände
- Rossauer Lände – Franz-Josefs-Kai – Dampfschiffstraße – Weißgerber Lände – Erdberger Lände
- Landstraßer Gürtel – Prinz-Eugen-Straße
- Ringstraße

The pilot area will be gradually equipped with C-ITS infrastructure. This includes:

- Purchase of necessary equipment and necessary replacements for existing traffic light equipment.
- 40 road side units are already installed at signalized intersections across the above mentioned routes. All of those send SPAT/MAP information. More will come in the following months.

- 2 tramways equipped with onboard units, as preparation for the PT prioritization.
- 1 vehicle was equipped with an onboard unit in 2022, which is used to test several use cases for the urban area.
- 1 RSU has already PT priority and emergency vehicle priority implemented.

## Pilot Salzburg

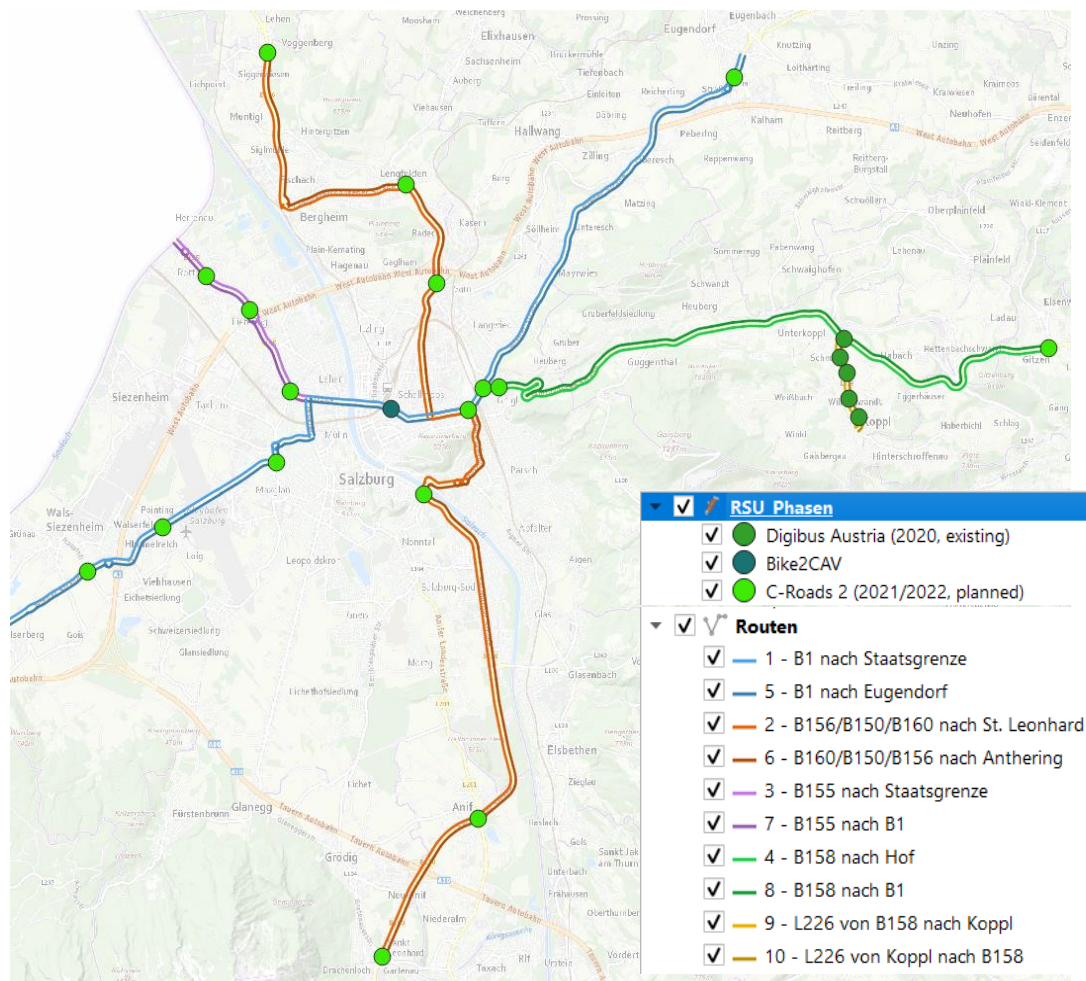


Figure 5: Existing and planned road corridors and RSU locations in and around the City of Salzburg

The Salzburg pilot aims at deploying C-ITS infrastructure on the main roads intersecting the city centre (i.e. peri-urban roads B1, B150, B155 and B156). In addition, those roads also serve as detours for the motorways which will also be equipped with ITS-G5 road side units. Hence, it is possible to create a continuous ETSI ITS-G5 infrastructure between the motorways and the peri-urban and urban road networks.

#### Planned deployment:

- For each corridor, a location was chosen that is outside the motorway. At this location, it would be possible to communicate traffic control measures in order to keep traffic away from the city centre and divert it onto the motorway during special events in the urban area (e.g. road closures). At the same time, it would also be possible to react in good time in the event of a motorway closure and, for example, to prevent traffic from driving onto the motorway. 7 locations of RSS were selected based on these considerations.
- Another location is planned for each corridor immediately after the motorway junctions, i.e. when vehicles leave the motorway and enter the city of Salzburg, they can be provided with information about the city of Salzburg at these locations. These locations are also planned so that they are located at traffic lights, if possible. 4 locations of RSS were selected based on these considerations.
- Within the city of Salzburg, the locations have been chosen to cover essential selected traffic nodes along corridors where traffic guidance is also possible. On the one hand, a shift between corridors can take place here, on the other hand, it is also possible to react with appropriate information in the event of congestion in the city centre. The locations are also almost all linked to LSAs. 6 locations of RSS were selected based on these considerations.
- The 17 RSS have been installed at the described locations by the end of Q1/2022.
- In addition to the 17 RSS from the C-Roads 2 project, 6 further RSS in the greater Salzburg area were installed (Lead project [Digibus Austria](#) - Test route Koppl, Project [Bike2CAV](#) - Test crossing Weiserstraße). These were funded in other projects with a C-ITS background and can also be used for traffic control.

## Pilot Klagenfurt

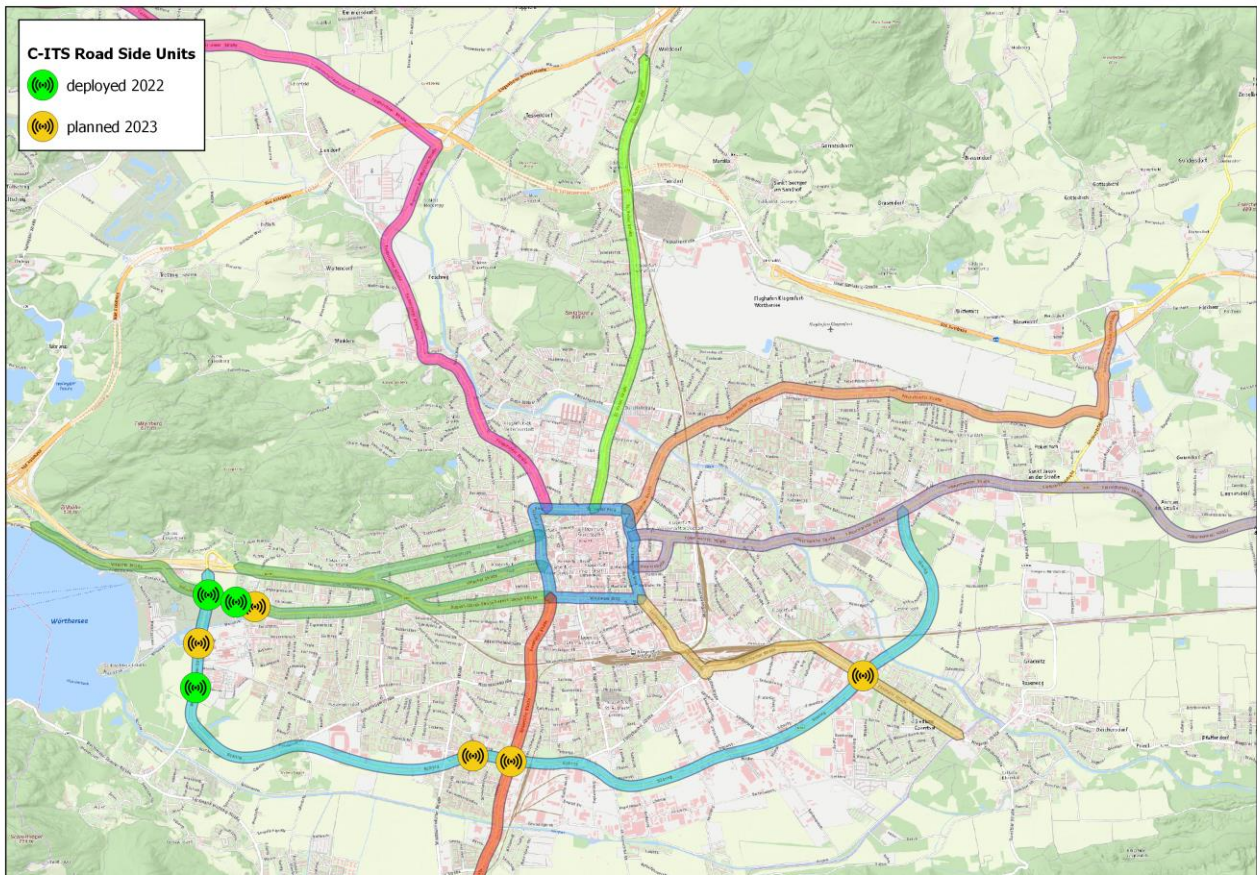


Figure 6: Map of C-ITS implementations in Klagenfurt

In Klagenfurt, traffic lights along the main access roads to the city centre will be equipped with C-ITS roadside units. In addition, the alternative route of the motorway A2, Klagenfurt's south ring (light blue line), is to be equipped with roadside units too. In total, 18 traffic lights are planned to be upgraded within the project C-Roads Austria 3. This includes the replacement of the traffic light's control unit and the modernization of the electrics, if necessary, the installation of traffic detectors to optimize traffic management and the introduction of a central management system on Klagenfurt's traffic computer to control and monitor the C-ITS stations.

The following actions are planned for 2023:

- Upgrade of another 5 traffic lights with roadside units
- Equip the entire urban transport bus fleet with C-ITS on-board units to enable prioritization at traffic lights (83 on-board units in a first step)

At the beginning of 2023, the planned manufacturer of the autonomous shuttle dropped out (Navya, France). Unfortunately, this affects the planning of the project in Klagenfurt for 2023. Alternative measures (different shuttle OEMs etc.) are already being planned and implemented.

The following actions were planned for 2023 and will now proceed in 2023 or 2024:



- Equip autonomous shuttles with C-ITS on-board units to enable autonomous driving along a corridor with 5 traffic lights
- Installation of 4 digital displays to additionally visualize the alerts coming from the autonomous shuttles via C-ITS

## Overview of progress by End of 2022

### Inter-Urban

C-ITS deployment on the Austrian core network corridors is an ongoing effort that started in the original C-Roads Austria action. When that action was extended to 2021 due to the COVID pandemic, deployment efforts remained with the original C-Roads action for 2021 and only switched to C-Roads Austria 2 in 2022. C-ITS Deployment will gradually continue until 2025 and therefore also concern C-Roads Austria 3.

ASFINAG is the first motorway operator in Europe to launch C-ITS large scale with 3 interconnected, inter-urban deployments – roadside stations, road operator vehicles and trailers. The cornerstone in these efforts is the deployment of a C-ITS Central station (C-ITS-S) and many hundred roadside ITS stations (R-ITS-S or RSU), which disseminate a variety of C-ITS messages from the harmonized C-Roads catalogue using short-range communication (ITS-G5). Each roadside station (RSU) is connected to and communicating with the central ITS station (C-ITS-S), which generates the message content based on content provided by the traffic control centre (TCC).

The roadside deployment met the forecast for 2022. 98 new roadside stations were installed and put into operation on motorways A12/A13 (30 RSUs), A4/A8/A25 (33 RSUs) and A1/A10 (35 RSUs). By the end of 2022, the total number of operational RSUs has risen to 242 RSUs. For further deployment in 2023, 122 new units were purchased, to be installed in 2023, locations were scouted, detailed and preparation work (data and energy connections, mounting points) was carried out to enable these installations.

C-ITS deployment (or rather retrofitting) in road operator vehicles, more specifically ASFINAG road-inspection, traffic management and toll enforcement vehicles also continued as planned. In 2022, 23 new vehicles were equipped, leading to a total of 26 vehicles by the end of 2022.

17 mobile warning trailers (IMIS) with C-ITS equipment have been deployed and are in active operation since, disseminating C-Roads compliant roadworks warning messages. This number has not changed in 2022, but work has continued on IMIS backend systems: this work will enable the trailers to also send other hazardous location and in-vehicle signage information in the future.

In regard to “hybrid” IP-based C-ITS interface based in C-Roads specifications, as of 2022, the complete communication functionality of the IP-based AMQP message broker has been achieved in the operational environment. C-ITS messages disseminated to roadside stations can also be published on the IP-based interface. Still missing are the parts concerning the security domain and the specific requirements to achieve access and compliance to the EU CCMS for hybrid communication, as no one had ever foreseen IP-based C-ITS communication when drafting the EU certificate and security policy.

## Urban

### Pilot Graz

In 2022, the onboard-units which were ordered in December 2020 were finally delivered. 4 of the 5 on-board-units were installed in public transport busses. With the equipment finally in place, the previously internally tested use case public transport prioritisation was put to test and compared to the existing solution. The final report on the results is available and it depicts the C-ITS use case as a reliable option to the current system.

With the good results from the comparison, the city of Graz entered into discussions with the local public transport provider on future challenges regarding the communication channel for prioritisation and possible technology solutions. The city of Graz also started discussions with the regional public transport provider to improve prioritisation of regional busses on city streets.

The visualisation tool was under development in 2022. The goal of finalizing the application in the first quarter of 2022 (as stated in the last Action Status Report) couldn't be reached due to change in the overall visualisation for better user experience. A first version of the application was presented at the end of summer 2022. Constant adaption and testing by the commissioned company continued throughout 2022.

At the beginning of 2023, the visualisation application will be tested by users of the city of Graz. The collected feedback will be used to improve the application. The final version (barring regular bug fixes and improvements) is expected to be available by mid-2023.

There are no open tasks or milestones in C-Roads Austria 2 for the city of Graz. Further C-ITS deployments are planned in C-Roads Austria 3 which is scheduled to start as early as 2023.

### Pilot Wien

By the end of 2022, around 40 RSUs have been installed in Vienna. The main use case visualises SPAT/MAP information. The next use cases are going to focus on the PT prioritization und emergency vehicle prioritization and will be implemented on 2 RSUs. An OBU which can be set as tram, emergency vehicle or normal car is used for test drives as well as quality management and therefore helps to improve the whole system. Testing with the OBU has shown the difference between the companies' work.

The signal phase and timing information for the specific tramway signals have improved significantly since 2021.

As in 2021, test drives were carried out by AustriaTech and Kapsch in 2022 to improve the whole system.

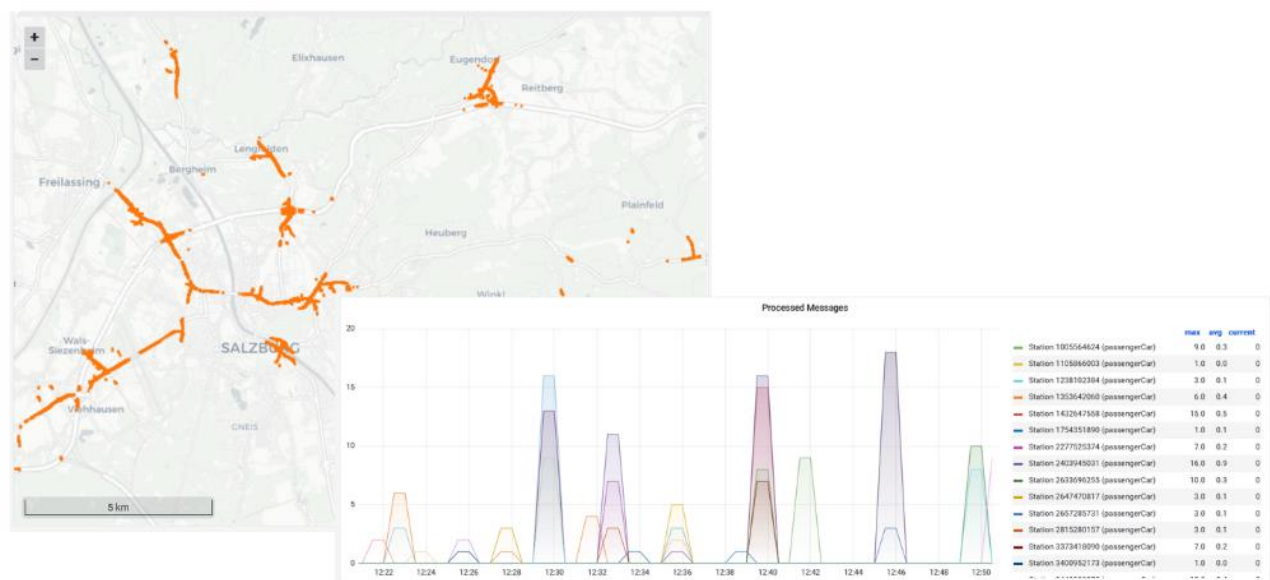
### Pilot Salzburg

In 2022, the installation of the 17 R-ITS-S in the Pilot Site Salzburg was completed by the end of February and all R-ITS-S are connected to the central C-ITS station (C-ITS-S). In addition, the monitoring of the C-ITS-S and the R-ITS-S was improved and the interface between the C-ITS-S

and the R-ITS-S was updated. From then, the C-ITS-S Salzburg and the installed 17 R-ITS-S are in continuous operation.

Subsequently, the following use cases were implemented in the Salzburg pilot site in 2022:

- RoadWorksWarning (RWW) - Road Closure (RWW-RC) and Lane Closure (RWW-LC): Implementation of the use cases incl. implementation of a connection to the national road traffic information system EVIS.AT for receiving planned and unplanned traffic events. With this step, traffic messages relevant for the city of Salzburg can be automatically taken over and sent out via the C-ITS channel.
- In-vehicle Signage (IVS) - Dynamic Speed Limit Information (IVS-DSLI) and Embedded VMS "Free Text" (IVS-EVFT): Some R-ITS-S send out stationary speed limit information (e.g. 30km/h speed limits on roads in the city centre) and free text-messages (e.g. recommendation for using Park & Ride facilities in case of overload of off-street parking facilities in the city centre).
- Signalised Intersection (SI) - Signal Phase and Timing Information (SI-SPTI) and SI-GLOSA: These use cases have been implemented for three selected intersections in the City of Salzburg. The necessary connection between the C-ITS centre and the traffic signal controller for the exchange of individual states (e.g. SPAT/MAP) was established.
- Probe Vehicle Data (PVD) - Vehicle Data Collection (VDC) and Event Data Collection (EDC): The CAMs received by R-ITS-S are forwarded to the ITS system (real-time traffic state estimation) of the Federal State of Salzburg (ITS Austria West) and used for improving traffic state estimation and traffic analyses.



**Figure 7: C-ITS-S Monitoring System of the Pilot Site Salzburg with overview of received CAM (Use Case PVD-VDC)**

The use cases implemented in 2022 were successfully tested in a national cross-site test with AustriaTech's test vehicle. Based on the recommendations from the test results, an improvement of the use cases was carried out and completed. During this cross-site test, the seamless

handover between the C-ITS infrastructure on the motorway and in the urban environment was also successfully demonstrated.

In autumn 2022, preparations for the implementation of use cases for on-board units (OBU) were started. The aim is to implement the following use cases at the Salzburg pilot site: RWW-WM, HLN-ERVI and -ERVA, HLN-PTVC and -PTVS.

Due to the late publication of the C-Roads specification "Common C-ITS Service and Use Case Definitions" version 2.0.5 and "C-ITS Message Profiles" version 2.0.5 with significant changes for the relevant use cases for OBUs, the procurement process could not be started until the end of 2022.

In a final step, a concept for the SI-TLP use case for public transport vehicles was developed with the involvement of the City of Salzburg as the operator of the traffic signal control system and traffic management centre (TMC).

In 2023, the necessary OBUs for the above-mentioned use cases will be procured and installed in the relevant vehicles, implemented, and tested. Two OBUs will be installed in winter service vehicles, three OBUs in emergency service vehicles and five OBUs in public transport buses.

In addition, it is planned to use the remaining budget to procure approximately 8 R-ITS-S for the application cases RWW-RC, -LC; IVS-EVFT; PVD-VDC and -EDC at entry corridors into the city of Salzburg. All R-ITS-S will be connected to locations with traffic cameras.

Concerning Day 1.5 use cases, "Park & Ride Information" and "Off Street Parking Information" will be tested via in-vehicle signage – embedded free text message. Also recommendations for "Networked and Cooperative Navigation in and out of the City" will be tested via IVI free text messages.

## **Pilot Klagenfurt**

The following implementations have been realised so far in Klagenfurt:

- Installation of 3 roadside units at traffic lights, transmitting SPAT/MAP information
- detection of VRU at one traffic light's crossing and transmitting DENM information

## **Installed RSUs based on funding by CINEA**

### **Inter-Urban**

All together 243 RSUs, 26 on-board units (OBUs) in road operator vehicles and 17 trailer units have been installed so far, a total of 286 C-ITS installations on the inter-urban road network in Austria. 525 RSUs and 200 OBUs are planned until end of 2025, while the number of trailer units will be stable at 17-20 units.

### **Urban**

All together 79 RSUs have been installed so far, and 35 are planned for installation in the upcoming years in urban areas.

### 3. The Belgium (Flanders) Pilot site

#### C-Roads Flemish Pilot (2016-2021)

The main objective of the C-Roads Flemish pilot was to operate and assess the deployment of a cloud based ‘virtual infrastructure’ for the effective deployment of C- ITS services connecting road users with the Traffic Management Centre (TMC) while allowing the TMC to directly interact with the end users. The pilot shall also bring an opportunity to upgrade Traffic Information Services and Traffic Management Services as offered today.

At the test site existing cellular based 3G-4G/LTE mobile communication networks were used in combination with the HERE Location Cloud and the local Traffic Management Centre, which allowed a group of test drivers to receive and potentially update selected Safety Related Traffic Information (SRTI) using low latency data exchange, in line with the European Commission Delegated Regulation (EU) No 886/2013 and the recommendations in the final report (phase I) of the EU C-ITS platform.

#### Involved partners

- Flemish Department of Mobility
- HERE
- ITS.be
- Tractebel Engineering

#### Location



Figure 8: Location of the Belgium (Flanders) pilot site

The pilot covered all motorways part of the core network in Flanders, including R001, E313, E17/ E19, E34 and E40 that are part of TEN-T corridors. For evaluation purposes, emphasis was given to the E313/ E34 segments.

## Final status by End of 2021

The C-Roads Flemish pilot ended on 30<sup>th</sup> June 2021. The only activities were:

- A virtual demonstration of the pilot (with recordings made during trips) on 17th June 2021.
- The evaluation of the pilot.

The main objective of the C- Roads Flemish pilot was to operate and assess the deployment of a cloud based 'virtual infrastructure' for an effective deployment of C-ITS services connecting road users with the Traffic Management Centre (TMC).

The ambition of the consortium was to build a close to production solution which can scale in space and numbers of users to keep vehicles and their drivers alert by depicting the road ahead and providing alerts on time. Test drives were executed at the beginning by members of the C-Roads Belgium/Flanders project and in a later stage having a more mature application available by friendly test users. Functional evaluations indicated some issues regarding dynamic speed limits and due to not achieving the quality standard for the application it was decided not to provide this information. Other information were provided well in the application.

The pandemic and its influence on test and pilot user recruitment on the one side and actual piloting on the other side was difficult. Starting with the ambition of getting 1000 users on-boarded for the pilot it became difficult in situations where people mostly work from home. In addition with the impact of the pandemic on traffic, significantly less safety critical situations took place as well. By working with a recruitment agency the project consortium tried to mitigate the risk of having significantly less pilot users. Those activities provided around 630 users that completed the whole trajectory.

Road works warnings and traffic jam alert were found the most relevant. For this question it has to be taken into account that the other warnings were shown less to the drivers or were never shown to them. The drivers were asked if the C-ITS information had any impact on their driving. When they entered road work warnings, 1 out of 2 drivers changed their driving. The service was found very useful for the drivers (91%) although they were not that satisfied with the service performance (56%).

Although the service was generally rated positive only 9% are willing to pay for this service. 73% state they will not pay for this service. This is very important to know for future models regarding C-ITS implementation. 45% of the respondents would recommend the service to others. This is important to know when further implementation actions are constructed.

## Antwerp – Helmond Pilot Site

C-Roads Antwerp-Helmond started in 2022 and has the ambition to integrate Cooperative Intelligent transport systems (C-ITS) with advanced driving assisting systems (ADAS, especially intelligent speed assistance (ISA)), urban vehicle access regulations (UVAR) and (urban) mobility services (buffering of trucks, prioritization and multi-modal information). The combination of these services should lead to better road-safety and liveability.

The coverage of the 4G solution will be made available on the whole pilot site (city of Antwerp, Helmond, Ring-Road, highway (see map)). One spot near the city of Antwerp will be equipped with the RSU and ANPR regarding the UVAR use-case.

The duration of every pilot on the three sites will be six months, spread in time. The pilot in Antwerp and on the indicated sections of the TEN-T road network will start simultaneously (Nov 23). The Pilot in Helmond will start later (Jan 24), partly overlapping. There are 3 main use cases:

### 1. C-ITS and ADAS

Main focus will be on Intelligent Speed Assistance (ISA). ISA is a system that helps drivers maintain the legal speed limit. It was tested in many countries with beneficial outcomes on speed reduction, livability, and traffic safety. C-ITS services that will be combined with ISA are:

- Road work warnings
- In vehicle Signage (dynamic speed information)
- Other Hazardous Locations Notification
- Traffic Light Manoeuvres Road and Lane Topology (if applicable)
- Traffic Jam ahead (testing on highways)
- Rail-road crossings

This service will be available on all pilot sites and available for private drivers and truck drivers. The vehicles will be equipped with an OBU system to provide the combined ISA and C-ITS services. ISA will be a half-open system to prevent the driver of speeding.

### 2. C-ITS and UVAR

More and more cities have urban vehicle access Regulations (UVARs) which are used to improve the livability within urban areas. The C-ITS service will be extended with user specific information when entering UVAR zone. Specific use cases are:

- Temporarily Speed restriction near school areas
- Access regulation for truck drivers depending on time and place (time-slots, access restrictions,...)
- Speed restriction for micro mobility users depending on time and place (active users)
- Cut-through traffic warnings

This service will be made available and tested in the urban area of Helmond and Antwerp. The information will be provided by the use of an OBU or smartphone application to the drivers.

### 3. C-ITS and (urban) mobility services

Within the Antwerp region a lot of works are planned on the ring-road within the next 10 to 15 years. This will have a large impact on local, national and international traffic in the region, near and in the city. Specific use cases are:

- Truck traffic buffering by providing specific information to avoid traffic jams.
- Traffic light prioritization for different active mobility users and trucks
- P+R information for drivers on the highway.
- Traffic Management Portal to monitor & analyse KPI's for (i)VRIs

This service will be made available and tested in Antwerp and on the indicated sections of the TEN-T road network. Traffic Light prioritization will be made available in Helmond. Information will be made available for truck and private drivers.

## Involved partners

- Tractebel Engineering (private)
- City of Antwerp
- City of Helmond
- Lantis/BAM
- Yunex
- Be-Mobile
- V-Tron
- Transport & Mobility Leuven
- PXL Hogeschool

## Location

This project will pilot a cooperative ITS solution enabling safety-related traffic information services for different type users: private car drivers, truck drivers and active mobility users. The pilot sites are city of Antwerp, city of Helmond and sections of the TEN-T road network (Ring Road Antwerp R01 and links to A12, E19, E313; E34 connecting Antwerp with the Netherlands).



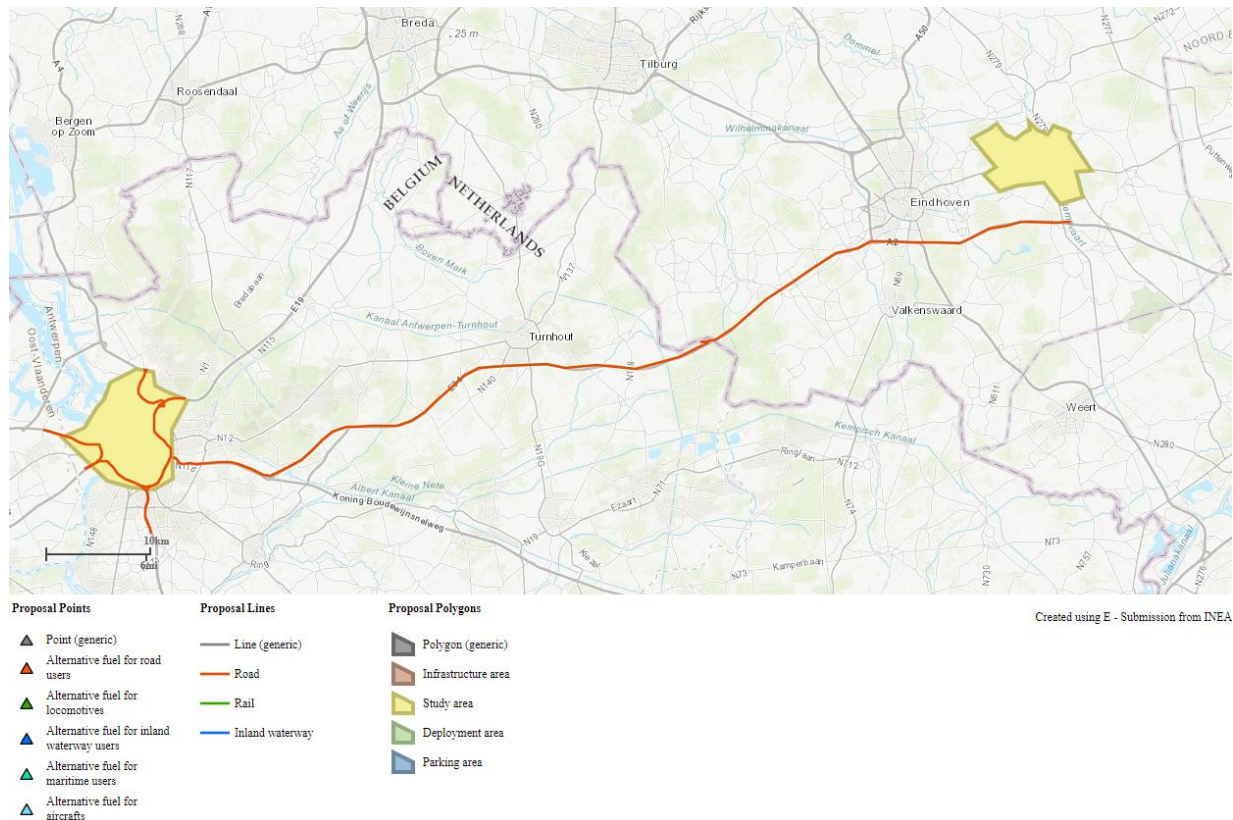


Figure 9: Location of the Antwerp – Helmond Pilot Site

## Overview of progress by End of 2022

At this stage the project was in start-up (started in November 2022).

## Installed RSUs based on funding by CINEA

No RSUs have been installed so far.

## 4. The Belgium (Wallonia) Pilot site (2017-2021)

In Belgium-Wallonia, a C-ITS pilot has been carried out from mid-2017 to end 2021. The cellular based service, which has been implemented in collaboration with service provider Coyote, continues to be operated and will be developed in order to cover more use cases.

The implementation and the development of C-ITS is part of an extensive ITS strategy deployed by SOFICO from 2017 onward to renovate and increase ITS systems along its highway and road network. A new traffic management centre has been recently equipped with a new traffic management system. Wallonia wishes to modernize its traffic management based on the newest technologies through different interfaces for data collection, data management and road user information.

### Involved partners

- Partners C-Roads Wallonia   
- (1) RSU  
- (2) 4G 

### Location

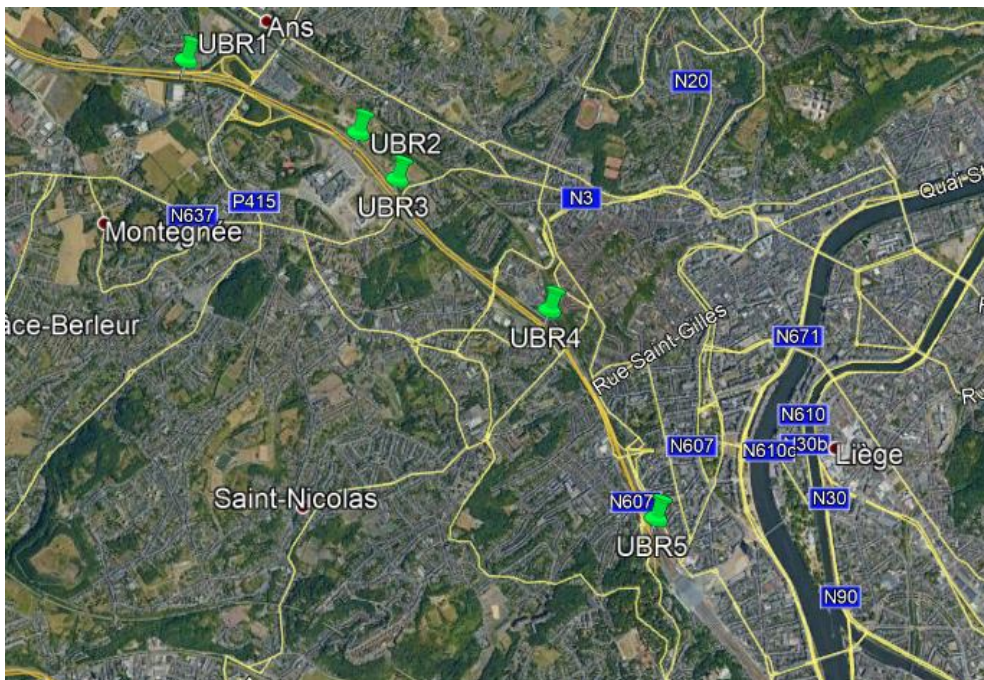


Figure 10: Localisation of the RSUs near Liège (Background: Google Maps)

- ITS - G5 technology: 5 RSU's have been installed on the A602 junction as well as a C-ITS messages server.
- Cellular communication (4G) technology: The pilot was deployed along approximately 427 km of Walloon motorways via the Coyote community.

## Final status by end of 2021

In the phase 1, Wallonia has participated in the testing and implementing of harmonised and interoperable C-ITS services. Through a Partnership in between SOFICO, Tractebel and ITS Belgium, **two projects** for C-ITS use cases deployment have been implemented on part of the Wallonia highway network.

- For the first one, the focus has been placed on the ITS - G5 technology: 6 RSUs have been installed on the A602 junction as well as a C-ITS messages server. The A602 junction hosts important traffic volumes and features major security issues since it consists in an urban environment highway featuring a succession of tunnels and bridges through the city of Liège.
- For the part based on cellular communication (4G) technology, after having considered the development of a specific own application, it has been decided to work with Coyote, a service provider already active on the Belgian market. The pilot has been deployed along approximately 427 km of Walloon motorways via the Coyote community.

Wallonia has currently no new project in the frame of C-Roads phase 2.

## Installed RSUs based on funding by CINEA

All together 6 RSUs have been installed.

## 5. The Czech Pilot site

Czech Republic has, in accordance to the project proposal, defined implementation and pilot testing of hybrid C-ITS services in six phases (further reported as DT – Deployment & Tests) split based on their geographical location and responsible implementation bodies.

### Involved partners

The project coordinator is the Ministry of Transport of the Czech Republic. Following project partners are responsible for the realization of this project:

- Deployment of C-ITS services via ITS G5
  - Road and motorway Directorate (RSD) of the Czech Republic
  - City of Brno (via. Brněnské komunikace)
  - Správa železnic, state organization (SŽDC)
  - City of Ostrava and Plzeň (via. their public transport companies)
  - AŽD Praha
- Deployment of hybrid C-ITS system based on ITS G5 and current LTE technologies
  - O2
  - INTENS Corporation
  - T-Mobile
  - Škoda Auto
- Deployment of new cellular technologies (LTE-V)
  - T-Mobile
- Evaluation and Assessment of implemented systems:
  - Czech Technical University in Prague, Faculty of Transportation Sciences (CTU)

### Location

The C-Roads Czech Republic pilot sites are located on:

- the Rhine-Danube Core Network Corridor, from Rozvadov at the Czech/German border to Praha
- the Orient-East Med Core Network Corridor, section Praha – Brno

- the urban nodes Plzeň, Brno and Ostrava. Plzeň and Ostrava are situated on the Rhine-Danube Core Network Corridor. Ostrava and Brno are situated on the Baltic-Adriatic Core Network Corridor.
- In case of railway level crossings in Pardubice region and In Ústí n. L. region

The deployment of C-ITS system and services was carried out on the following parts of the Czech road network split into individual DT's:

- **DT1 Brno agglomeration** covers the southern sector of the city of Brno, in particular the following roads / motorways:
  - Part of motorway D1 in the length of 30 km between km 180 and km 210
  - Part of motorway D2
- **DT2 Brno city**, this pilot took place on the 1<sup>st</sup> class radial roads connecting the city centre and outer ring road of Brno (motorway D1), as well as on the southern part of the Brno inner ring road. This deployment stage was closely coordinated with DT1 in order to supplement highway RSUs with RSUs on the major city roads and to provide early notification about highway situation. Because road classification doesn't always correspond with streets importance for city traffic, some intersections on lower class roads were also chosen to be equipped with RSU. For example, intersections on Vídeňská and Jihlavská streets.

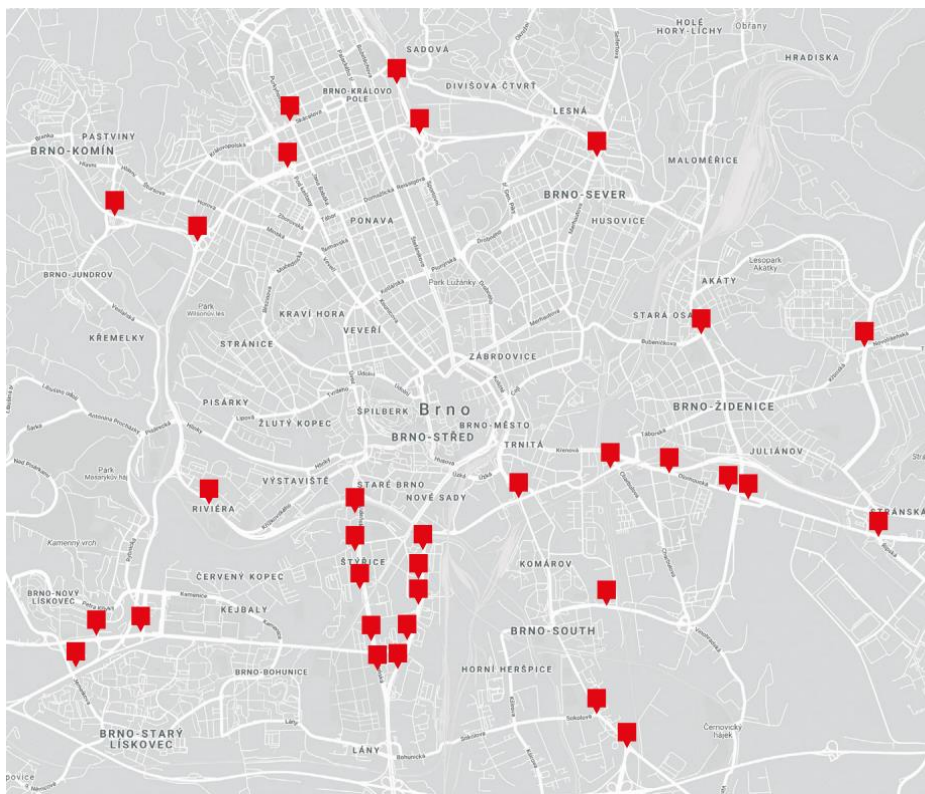


Figure 11: Deployment in Brno

- **DT3 – Motorways D1, D5, D11 and I/52 / D52** C-ITS equipment and services were deployed on the D1 motorway between Prague and Brno, D5 motorway between Prague and Rozvadov (German border), on the D11 motorway between Prague and Hradec Králové, and on the D52/I52 connection road between Brno and the Austrian border. Total length amounts to more than 360 km. This pilot site includes both cross-border locations – on the D5 motorway with Germany, and on the D52/I52 motorway/road with Austria.
  - Motorway D1 (E50/E65) between Prague and Brno, where ITS-G5 technology was deployed around the Brno agglomeration and cellular technology is being used for C-ITS services coverage on the remaining part of the motorway.
  - Motorway D5 (E50) between Prague and the German border, where ITS-G5 technology was deployed on the section between Prague and Plzeň (km 6 – km 90) and around the German border. The cellular technology was used for C-ITS services coverage on remaining part of the motorway.
  - Motorway D11 (E67) between Prague and Hradec Králové (km 0 – km 90), where ITS-G5 technology covered the whole motorway section and cellular technology was used as a secondary communication tool for C-ITS service provision.
  - Combined motorway D52 and 1<sup>st</sup> class road I52 (E461) from Brno to the Austrian border was covered by cellular technology to provide C-ITS services.
- **DT4 – Public transport deployment in cities of Plzen and Ostrava** was implemented in existing city streets/roads and intersections with tram rail infrastructure. Suitable junctions equipped with traffic lights were selected for public transport priority use case as well as “dangerous” locations for passengers or critical collision points between public and individual transports were identified for deployment of safety related applications.
- **DT5 – Railway crossing pilot** - Správa železnic (Railway network operator - SŽDC) together with project partner AŽD were responsible for ITS G5 deployment, and LTE-based services are being offered by mobile phone operators O2 and T-Mobile. C-ITS services are being offered via hybrid ITS G5 / LTE system and the pilot is deployed on 4 level railway crossings equipped with protection systems with level crossing signals, where two were equipped with barriers and further two without barriers.
- **DT6 – Cross border testing** - because of the unstable pandemic situation, a virtual session replaced physical cross-border and international field testing. For virtual testing, Czech Republic partners chose as the pilot site the city of Brno and surrounding motorway D1, and additionally the pilot site of a railway level crossing. The chosen pilot sites fully represented the sample of use cases and implementations suitable for testing. Cross-testing with other C-Roads Platform members on their pilot sites was also part of this activity. All C-Roads Platform partners were invited to the testing.

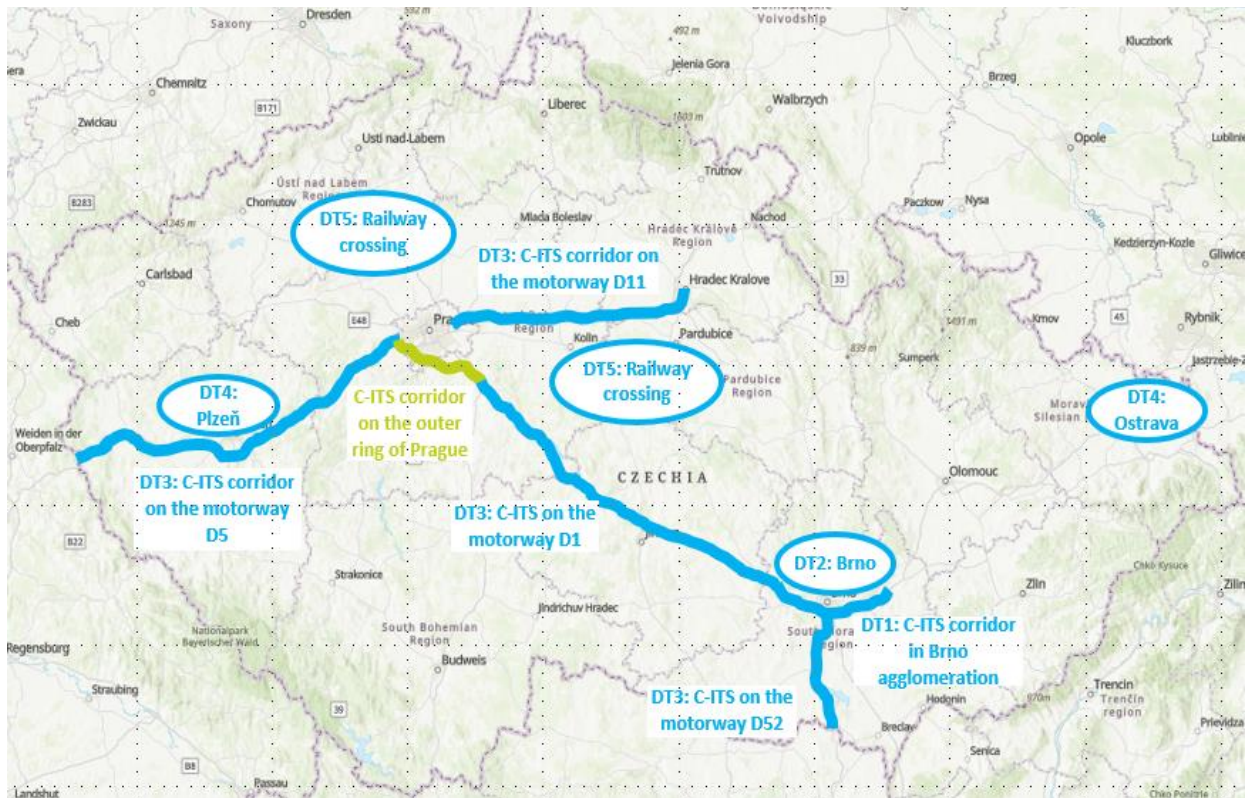


Figure 12: Location of the Czech pilot site

## Overview of progress by End of 2022

The C-Roads project was completed in the Czech Republic on 31 December 2021. This does not mean, of course, that C-ITS deployment works were stopped. Based on the authorisation of the Ministry of Transport of the Czech Republic for operating the C-ITS central elements the Roads and Motorways Directorate ensures that they can operate continuously since September 2021. From that time, the operation of the C-ITS Central Elements at the sites built under the C-Roads project is assured.

From January 2022 other entities (municipalities, vehicle manufacturers, transport and railway undertakings, infrastructure managers, road and rail operators and other stakeholders) are gradually joining to the C-ITS ecosystem. The C-ITS central elements have been linked to the European central components to ensure the exchange of C-ITS messages in a European environment. Therefore, the beginning of 2022 is considered as the start of C-ITS live operation in the Czech Republic. During 2022, the Directorate of Roads and Motorways has also started the next phase of deployment of C-ITS systems and plans to extend the coverage of C-ITS services on motorways in the TEN-T network.

## Installed RSUs based on funding by CINEA

All together 115 RSUs have been installed so far based on funding by CINEA in the context of C-Roads projects.

## 6. The Danish Pilot site

Denmark does not have its own national pilot and consequently not a separate pilot budget.

Denmark is part of NordicWay 3 (2020-2023) but is the only country without its own national pilot. It was cleared before signing the C-Roads platform agreement that it was okay for Denmark to become a C-Roads member due to the participation in NordicWay 2 horizontal activities at the time, despite Denmark not having a national pilot.

Denmark is contributing within the NordicWay 3 horizontal activities, such as interoperability issues, data sharing, communication, dissemination and tests – including testing on the Danish road network.

The main objectives of the NordicWay actions are to deploy pilot studies in order to further develop interoperable Day-1 and Day-1.5 C-ITS services and support infrastructure readiness for connected and automated driving in Denmark, Finland, Norway and Sweden.

NordicWay 3 project (2019-2023):

- Demonstrates as a large-scale pilot the feasibility of Day 1 and Day 1.5 services using hybrid communication solutions, which are fully based on European and global standards. NordicWay3 will deploy coordinated pilots on Cooperative, Connected and Automated Mobility in urban areas, interfaces between urban and interurban areas and motorway sections.
- Contribute to the harmonisation and interoperability of the C-ITS services in Europe by ensuring that the architecture, systems and services that are put in place are interoperable, in line with European developments and developed in close cooperation with industrial partners
- Supports the development and implementation of C-ITS services, adapted to the conditions, urban and interurban environments in the Nordic countries.
- Further elaborates and expands the business models and eco-systems required for large scale implementation of services as well as sharing of the required data.

The results of NordicWay 3, as well as of the previous NordicWay projects, can be viewed in the [www.nordicway.net](http://www.nordicway.net) webpage.

NordicWay 3 continues to harmonise and build European C-Roads specifications for hybrid communication. The NordicWay 3 project aims to close gaps regarding C-ITS messages and security in new pilots taking place between 2022 and 2023. The goal is to take part and verify cross border tests with other pilots in European countries who have implemented the C-Roads hybrid communication specification.

### Involved partners

The Danish Road Directorate



## Location

Danish state road network, which means that all larger roads in Denmark are included.

## Overview of progress by End of 2022

Danish Road Directorate contributed through the NordicWay 3 projects to the C-Roads TF2 Service Harmonisation as well as communication and dissemination activities.

## Installed RSUs based on funding by CINEA

No RSUs have been installed so far, and none are planned for installation in the upcoming years.

## 7. The Finnish Pilot site

The Finnish pilot is part of the NordicWay 3 project (2020-2023) pilots running in the Nordic countries Denmark, Finland, Norway and Sweden. The main objectives of the NordicWay actions are to deploy pilot studies in order to further develop interoperable Day-1 and Day-1.5 C-ITS services and support infrastructure readiness for connected and automated driving in Denmark, Finland, Norway and Sweden.

NordicWay 3 project (2019-2023):

- Demonstrates as a large-scale pilot the feasibility of Day 1 and Day 1.5 services using hybrid communication solutions, which are fully based on European and global standards. NordicWay3 will deploy coordinated pilots on Cooperative, Connected and Automated Mobility in urban areas, interfaces between urban and interurban areas and motorway sections.
- Contribute to the harmonisation and interoperability of the C-ITS services in Europe by ensuring that the architecture, systems and services that are put in place are interoperable, in line with European developments and developed in close cooperation with industrial partners
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### Finnish national pilots

In 2022 a pilot was started and several prestudies performed. The pilot is located in the city of Tampere, and collects data from different traffic light providers and different controller models in C-Roads compliant format to a central Tampere node. In 2023, an Interchange will be deployed, which will connect the Tampere node to the other NordicWay ecosystems and make the data accessible to other C-Roads member states.

A study was initiated to assess the roles of the different authorities when deploying C-ITS messages, according to European Commission and C-Roads specifications.

## Involvement partners

- The following partners are involved:
  - Traficom,
  - Vayla, Finnish Transport Infrastructure Agency
  - Fintraffic
  - City of Tampere
- consultants performing the work:
  - VTT Technical Research Centre of Finland Ltd
  - Traficon
  - Ramboll Finland LTD
  - Varala Engineering
- industrial partners involved in the Tampere pilot:
  - Nodeon
  - Swarco
  - Dynniq
  - Normivalaistus Oy

## Location

The traffic light pilot will take place in the city of Tampere. The other pre-studies relate to the national road network.

## Overview of progress by End of 2022

In Tampere, data from different traffic controller models from the various traffic light controller providers in the city are made available as SPAT/MAP data to the Tampere Node. In total 20 signalised intersections provide real-time data to the Tampere Node.

## Installed RSUs based on funding by CINEA

No RSUs have been installed so far, and no ITS-G5 RSUs are planned for installation in the upcoming years.

## 8. The French Pilot site

France contributes to the C-Roads Platform through three projects: InterCor, C-Roads France (C-Roads 1) and InDiD (C-Roads 2). They all build on the results of SCOOP@F, which was the first pre-deployment C-ITS project in France.

C-Roads France was a pilot project whose objective was to develop and experiment innovative road C-ITS solutions. C-Roads France pushed for the early adoption of flexible, interoperable and scalable C-ITS solutions, anticipating the commercialisation of equipped vehicles.

Following SCOOP@F, C-Roads France developed 2 types of new end-user services: services in the urban environment and at the urban/interurban interface, and traffic information services increasing comfort on transit stretches. The Action aimed to reach a seamless continuity of services at the urban/interurban interface. It provided enhanced and extended test fields including strategic sections of the TEN-T Core Network, key bottlenecks, black spots and interfaces with urban nodes, to reach a critical mass. The action was supported by 2 car manufacturers to maximise interoperability with the infrastructure and ensure future roll-out of vehicles.

InDiD project, is part of the continuity of the activities carried out within the framework of the SCOOP, InterCor and C-Roads projects, with a scope extended to urban and autonomous vehicles. Based on the studies and results obtained, the objective is to define new services for users and operators, the development and implementation of technical solutions to meet them, and their deployment on a large scale in various operating environments.

The project is based on a strong consortium, bringing together a number of stakeholders from industry, mobility and the digital sector. Coordinated by the Ministry in charge of Transport, it has more than 20 partners, including local authorities (the City of Paris, the Metropolis of Aix-Marseille and the Department of Isère), interdepartmental road directorates, motorway companies and their representatives, academic partners and companies.

The withdrawal of two partners METRO and the SMTC in 2020 led a new organisation of the pilot sites in 2022. The project partners validated the integration of new partners: Bordeaux Metropole, the European Collectivity of Alsace (CEA), the Eurometropolis of Strasbourg (EMS) and Mairie d'Aix-en-Provence (Aix-en-Provence). Bordeaux metropolis was integrated into the South-West pilot site, Aix-en-Provence to the Mediterranean pilot site, and a new "East" pilot site was created. This new pilot site integrates the partners European Community of Alsace and Eurometropolis of Strasbourg (EMS).

## Involvement partners

### InDiD

|  |  |
|--|--|
| Road operators                                 | <b>Ministry -public road operators</b> <ul style="list-style-type: none"> <li>• Interdepartmental Directorate of Eastern Roads, DIRE (deconcentrated state service)</li> <li>• Interdepartmental Directorate of Mediterranean Roads (deconcentrated state service)</li> <li>• Interdepartmental Directorate of Ile-de-France Roads (deconcentrated state service)</li> <li>• Interdepartmental Directorate of South west Roads (deconcentrated state service)</li> </ul>   |
| Road operators                                 | <ul style="list-style-type: none"> <li>• Interdepartmental Directorate of Centre-East Roads (deconcentrated state service)</li> <li>• Interdepartmental Directorate of north Roads (deconcentrated state service)</li> <li>• Interdepartmental Directorate of Atlantic Roads (deconcentrated state service)</li> </ul> <b>Concessions companies and provider of road transport services</b> <ul style="list-style-type: none"> <li>• ASFA: The Association of French Motorway Companies</li> <li>• APRR:</li> <li>• Société des autoroutes du Nord et de l'Est de la France SANEF: French freeway concession company</li> <li>Vinci Autoroutes: French freeway concession company</li> </ul> |
| Cities / Public Entities                       | <ul style="list-style-type: none"> <li>• City of Paris Aix-Marseille-Provence Metropole</li> <li>• Département de l'Isère</li> <li>• Bordeaux Metropole</li> <li>• European Collectivity of Alsace (CEA)</li> <li>• Eurometropolis of Strasbourg (EMS)</li> </ul>  |
| Research institutes / Universities             | <ul style="list-style-type: none"> <li>• CEREMA</li> <li>• Université Gustave Eiffel</li> <li>• Université Clermont Auvergne</li> <li>• Université de Reims Champagne-Ardennes</li> <li>• Bordeaux INP</li> <li>• Institut Mines-Télécom</li> <li>• Université Polytechnique Hauts de France</li> <li>• Eurecom</li> </ul>   |
| Security experts                               | <ul style="list-style-type: none"> <li>• IDNomic</li> </ul>  |
| Mobility Labs / Geography experts              | <ul style="list-style-type: none"> <li>• Institut Vedecom</li> <li>• Le LAB</li> <li>• IGN</li> </ul>  |
| Solution providers: C-ITS / Mobility / DIGITAL | <ul style="list-style-type: none"> <li>• Valeo</li> <li>• TomTom</li> <li>• Green communication</li> <li>• Transdev (until end of 2022)</li> <li>• ATC France</li> </ul>   |

**Table 1: Involved partners of InDiD project**

## Use cases

The following use cases were specified in the InDiD project:

### C-ITS Use Cases

| A – Probe Vehicle Data (PVD)                              |   |     |  |
|---|---|-----|--|
| A5  | Wrong way users detection   |     |  |
| B – Road Works Warning (RWW)                              |   |     |  |
| B1  | Alert neutralization of part of a lane, whole lane or several lanes (for connected Vehicles and Automated Vehicles) | B4  | Dangerous vehicle approaching a road works: warning to the dangerous vehicle |
| B5  | Dangerous vehicle approaching a road works: warning to workers  |     |  |
| C – Signage Applications                                  |   |     |  |
| C6  | Toll Station Approaching: orientation of automated vehicles   | C7  | Toll Station Approaching: enhanced orientation of drivers                    |
| C8  | Toll Barrier Crossing for automated vehicles  |     |  |
| D – Hazardous Location Notifications (HLN)                |   |     |  |
| D9a   | Alert temporary mountain pass route closure   | D9b | Alert approaching a closed mountain pass                                     |
| E – Traffic Information and Smart Routing                 |   |     |  |
| E1  | Traffic information about snow on the road  | E2  | Rerouting  |
| G – Intersection (SI)                                     |   |     |  |
| G1b   | GLOSA TTG (Time To Green)   | G2  | Traffic signal priority request by designated vehicles                       |
| G5  | In-vehicle signage at a merge for vehicles on the entry slip road   | G6  | In-vehicle signage at a merge for vehicles on the main road                  |
| G7  | HD cartography on intersections   |     |  |
| I – Vulnerable users                                      |   |     |  |
| I5  | Vulnerable user at a public transport stop  |     |  |
| K - Level Crossing (Use cases SNCF - open level crossing) |   |     |  |
| K7  | Level Crossing for automated vehicles   |     |  |
| L – Law Enforcement                                       |   |     |  |
| L2  | Stationary law enforcement vehicle  |     |  |
| M – Payment services                                      |   |     |  |
| M1  | Payment service at a toll station   |     |  |

Table 2: C-ITS InDiD use Cases

An amendment to the InDiD project was accepted in November 2022, allowing the arrival of new partners. New use cases to reinforce INDID's initial objectives will be studied, and other use cases already specified will be deployed.

On the metropolitan area of Bordeaux, new cellular services are planned to be studied, and if feasible and consistent, integrated and deployed, such as:

- Parking, park and ride and multimodality at a park and ride located at the entry of Metropolis: improvement of the service with information on 'travel time by modal shift' and information about carpooling areas.
- Road Works Warning and maintenance operation: improvement of the service and standards and flooded roads information.
- Protection and guidance of vulnerable road users in urban areas
- Update of traffic lights delivering C-ITS services.

As for service in the north pilot, the objective is to deploy urban services such as vulnerable users protection, information on bicycle paths, information on parking slots, multimodal traffic information, carpooling information, depending on the prioritization work. Day1 and Day 1.5 services that are deployed in other pilot sites will also be considered for operations, such as accidents, roadworks, VMS, etc.

Regarding service in pilot 'City of Grenoble' and Département de l'Isère, the following specific use cases may be implemented, based on the use case prioritisation:

- Information on 'travel time by modal split' will be considered on RN481 (DIRCE), depending on their equipment.
- Information on roads covered by snow (on roads connecting Grenoble and A480 to ski resorts).

## Location

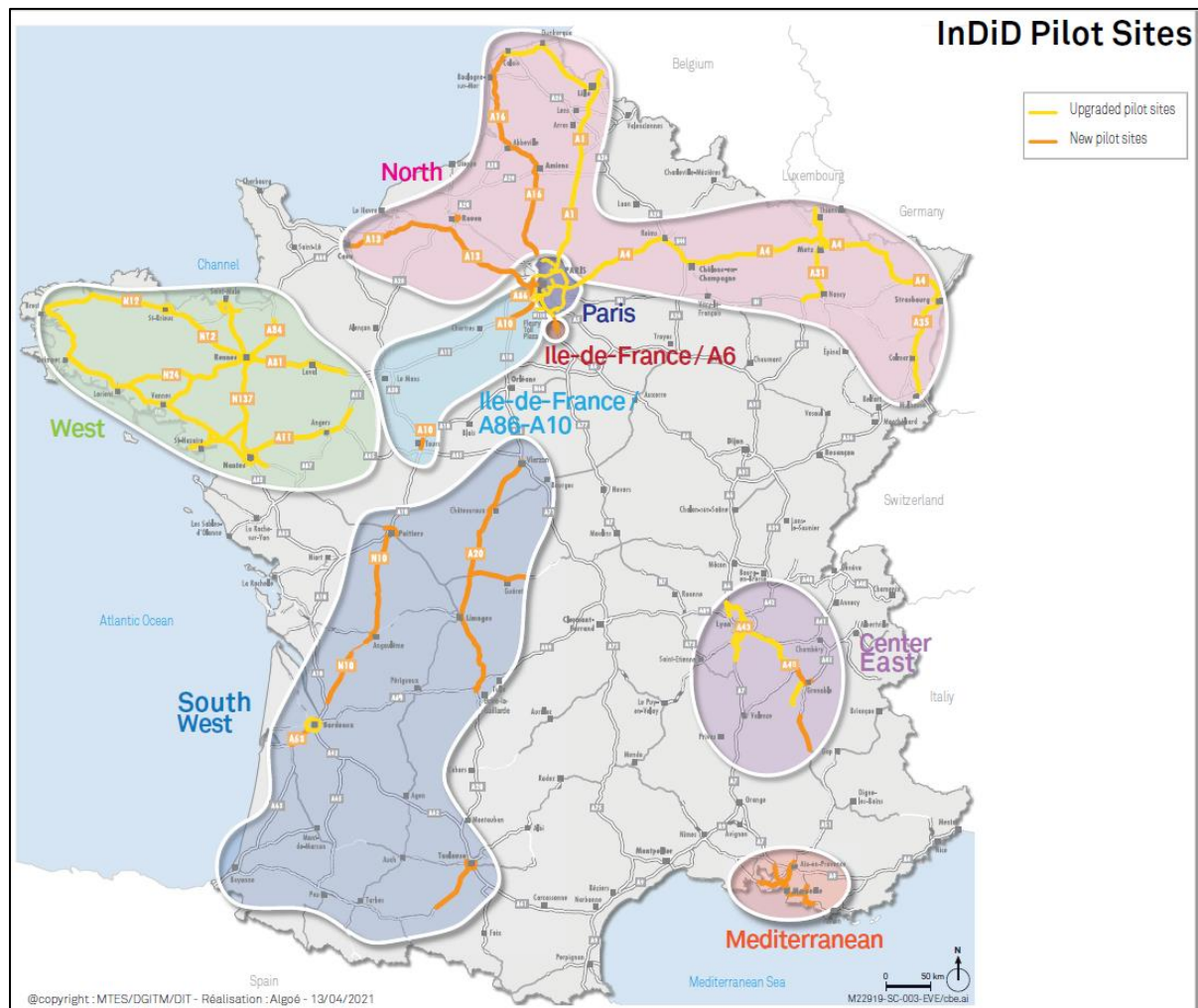


Figure 13: Location of the French pilot sites for InDiD

InDiD is divided into 8 local pilot sites, described in the following map. The roads coloured in orange are those which will be newly equipped within InDiD. Those in yellow colour have already been equipped in the previous C-ITS projects as mentioned above and will be upgraded in InDiD.

## Overview of progress by End of 2022

### INDID

InDiD is a continuation of the C-Roads\_France Project. In terms of architecture, the partners continued the deployment of the hybrid architecture defined in C-Roads\_France.



### **Pilot 'Mediterranean**

Use cases alert road works warning, alert temporary slippery road, alert on the road, alert obstacle on the road, alert stationary vehicle /breakdown, alert reduced visibility, alert wrong way driving, alert unsecured blockage of a road have been developed in TMS. The uses cases traffic signal priority request by designated vehicles and information on car parks location availability and services were chosen. Complete chain tests TCC to RSU and Vro were carried out in December 2022. 3 R-ITS-S were installed in December 2022 in Aix en Provence. The remaining set-up will be carried out in 2023, along with the associated tests.

### **South West Pilot**

Use cases information on parking lots location, availability, road works warning and hazardous location notifications will be released on the new R-ITS-S. All the civil engineering work for the 21 R-ITS-S has been completed, 8 are well established in the field, and other 13 should be installed in the first half of 2023. The deployment of C-ITS is underway on the Poitiers-Bordeaux route. Pilot site moved to platform 4.0.03 and SAGACITE is currently in production. The Pfro will be installed in early 2023.

### **Pilot 'Ile-de-France / A6**

The development phase of the use cases HD cartography extended services, toll station approaching, toll barrier crossing for automated vehicles was completed and accepted. The development of the R-ITS-S Toll Information System dialogue interface is completed and tested. All the R-ITS-S are connected to the field network. The work on the TCU VULCANO was completed in November 2022.

### **Paris pilot**

Use cases Green light optimal speed advisory GLOSA and traffic signal priority request by designated vehicles were deployed and the tests were carried out. The city of Paris launched the procedure for reusing the existing public contracts for InDiD. The operator installed the entire C-ITS infrastructure for the project, which has been in service since mid-February 2021.

### **Pilot 'A86-A10**

VINCI AUTOROUTES plans to deploy Road works warning and Hazardous location notifications use cases in the framework of the use case prioritisation. 16 R-ITS-S were installed, 10 of which are already operational and 6 R-ITS-S are in the process of being put into service. Pilot site is upgraded to platform 4.0.03.

### **Pilot 'North**

COOPITS downward chain in test has been proposed in production at the end of 2022/beginning of 2023 with the most common use cases (alert obstacle on the road, alert stationary vehicle /breakdown, alert accident area, alert end of queue). Use case alert wrong way driving has been developed and validated. Use case in-vehicle signage at a merge for vehicles on the entry slip road is developed on some of the R-ITS-S and first tests have already taken place in 2022. Specifications of Toll station approaching use case was completed. 11 R-ITS-S were installed in 2022, making a total of 46 R-ITS-S deployed.

### **Pilot West**

Use Cases Information on parking lots location, availability and services and road works warning, hazardous location notifications were implemented. All R-ITS-S were installed on this site. Preparation of the production launch in cellular on the TCC => Pfro => Nfr => CoopITS chain. This pilot site moved to platform 4.0.03.

### **Centre East pilot**

10 R-ITS-S were installed on two mountain roads (RD1075 and RD531), and at the entrance to the Grenoble agglomeration. Two snowploughs were equipped with Vro-ITS-S and they operate a portion of the A480. In the Isère department, 10 Vro-ITS-S were deployed. The Pfro was installed and connected to the R-ITS-S.

## **Installed RSUs based on funding by CINEA**

At the moment, 342 RSUs are in service, 138 are installed but not yet in service and 91 will be installed or are in the process of being integrated.

## 9. The German Pilot sites

Germany as Member State contributes to the C-Roads cooperation by the findings of the implementation and operation of in total eleven different C-ITS services, which are deployed in five different pilot sites and harmonised by the Federal Highway Research Institute (BAST).

The national action promotes an ideal manner for the future rollout/larger scale deployment of Cooperative ITS in whole Germany by deploying additional new and extending already existing C-ITS services, respectively. Following goals should be achieved in this project:

- Provision of a deployment pattern for a roll-out of these C-ITS services in Germany according to EU regulations and standards and in line with the recommendations/outputs of the "C-ITS platform".
- Demonstration of long-term viability and scalability of C-ITS (in terms of technology, financial sustainability, governance) as well as in combination with legacy systems.
- Encouragement of the German automotive industry to equip their cars with appropriate devices and thus incentivising end-users to buy V2X-enabled cars to benefit from the services.

To achieve these goals, the mentioned services will not only be deployed but also delivered as a transferable C-ITS framework, harmonised on European level in cooperation with other pilot sites in the frame of the C-Roads Platform. This comprises:

- an **organisational pattern** (roles and responsibilities) for the development and deployment,
- a **work program** for the development of needed infrastructure and equipment including open technical specifications and standards, and
- **appropriate methods and KPI** for the evaluation and assessment of the deployed C-ITS services.

In C-Roads Phase 1 the **C-ITS Pilot Hessen** contributed to the C-Roads cooperation by implementing and deploying the following C-ITS services:

- Road Works Warning Service Deployment (RWW) (extension of the existing service for long-term roadworks)
- Maintenance Vehicle Warning (MVW)
- Emergency Vehicle Approaching Service Deployment (EVA)
- Traffic Jam Ahead Warning Service Deployment (TJW)
- Shockwave Damping Service Deployment (SWD)
- Green Light Optimal Speed Advisory Service Deployment (GLOSA)
- Probe Vehicle Data (PVD) Service Deployment (extension of the existing version to support the services TJW and SWD)

In C-Roads Phase 1 the **C-ITS pilot Niedersachsen** contributed to the C-Roads cooperation by implementing and deploying the following three C-ITS services:

- Maintenance Vehicle Warning (MVW)
- In-Vehicle Information/In-Vehicle Signage Service Deployment (IVI/IVS)
- Probe Vehicle Data Service Deployment (PVD)

The C-Roads Germany – **Urban Nodes pilot Hamburg** contributes to the C-Roads cooperation by implementing and deploying the following C-ITS services:

- Green Light Optimal Speed Advisory Service Deployment (GLOSA)
- Probe Vehicle Data Service Deployment (PVD)

In addition to the C-Road Pilot implementations Hamburg is deploying the Traffic signal priority request by designated vehicles (TSP). The expenditures are covered by other means, but the pilot is participating in the harmonisation.

The C-Roads Germany – **Urban Nodes pilot Hessen/Kassel** contributes to the C-Roads cooperation by implementing and deploying the following C-ITS services:

- Road Works Warning (RWW)
- Emergency Vehicle Approaching (EVA)
- Connected and cooperative navigation into and out of the city (route advice)
- Green Light Optimal Speed Advisory (GLOSA)
- Traffic signal priority request by designated vehicles (TSP)
- Probe Vehicle Data (PVD)

The pilot is the next necessary and important step to an area-wide pilot deployment of urban and interurban C-ITS services on the Scandinavian-Mediterranean and the Rhine-Alpine Corridors. The aim of this activity is the development and improvement of the Hessen and the city of Kassel's C-ITS infrastructure by extending the existing services and by implementing new C-ITS services.

The pilot focuses not only on the expansion of Day 1 and the development of Day 1.5 services in the city of Kassel, but also on an interface between the city of Kassel and the interurban area in cooperation with the German motorway operator "Die Autobahn GmbH des Bundes".

The services Road Works Warning (RWW), Green Light Optimal Speed Advisory (GLOSA) and Probe Vehicle Data (PVD) are already implemented.

The implementation of the services Emergency Vehicle Approaching (EVA), Connected and cooperative navigation into and out of the city (route advice) and Traffic signal priority request by designated vehicles (TSP) is in progress.

The C-Roads Germany – **Urban Nodes pilot Dresden** contributes to the C-Roads cooperation by implementing and deploying the following five C-ITS services:

- Probe Vehicle Data Service Deployment (PVD)
- Green Light Optimal Speed Advisory Service Deployment (GLOSA)

- Traffic Signal Priority Request Service Deployment (TSP)
- Emergency Vehicle Approaching Service Deployment (EVA)
- Vulnerable Road User Protection Service Deployment (VRU)

## Involved partners

Pilot activities at test and validation locations are prepared by different bodies. In phase 1, the Hessen pilot site was organised by the German motorway operator Autobahn GmbH, while the companies NORDSYS and OECON Products & Services, supported by the associated partner Deutsches Zentrum für Luft- und Raumfahrt (DLR) were responsible for the local activities of the Niedersachsen pilot site.

Starting in 2019 additional bodies representing the Urban Nodes pilot sites were integrated in the C-Roads activities.

Consortium members C-Roads Germany – Urban Nodes (CRG-UN)

- ITS mobility GmbH
- Federal Highway Research Institute (BAST)
- Freie und Hansestadt Hamburg, Behörde für Verkehr und Mobilitätswende
- Keysight Technologies Deutschland GmbH
- Hessen Mobil Straßen- und Verkehrsmanagement
- Magistrat der Stadt Kassel
- OECON Products & Services GmbH
- Fraunhofer-Institut für Verkehrs- und Infrastruktursysteme IVI
- SWARCO Traffic Systems GmbH
- GEVAS software GmbH
- The German motorway operator (Die Autobahn GmbH des Bundes)

## Location

The C-ITS pilot in Hamburg comprises a set of C-ITS services that will make Hamburg's roads safer, efficient, and environmentally friendly. The test track runs along on heavily loaded city streets, including main roads and district roads. The Free and Hanseatic City of Hamburg is gradually upgrading traffic lights for the infrastructure-to-vehicle (I2V) and vehicle-to-infrastructure (V2I) communication.

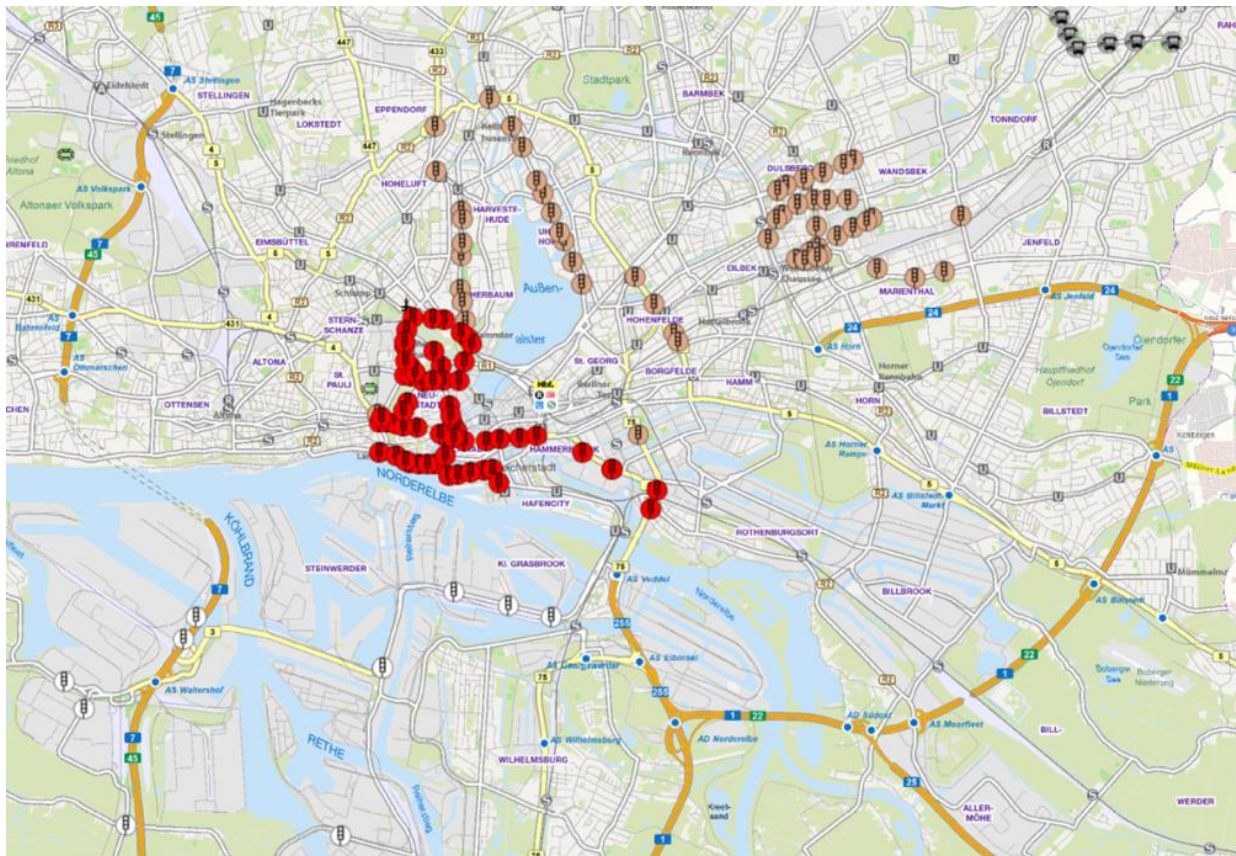


Figure 14: ITS Services in Hamburg

The activities of the Hessen/Kassel Pilot will be realised in the Test Field Germany for connected automated traffic in the southern part of Hessen around Frankfurt and in the digital test site for connected driving Kassel in the northern part of Hessen.

Different services will be implemented in and around the city of Kassel.

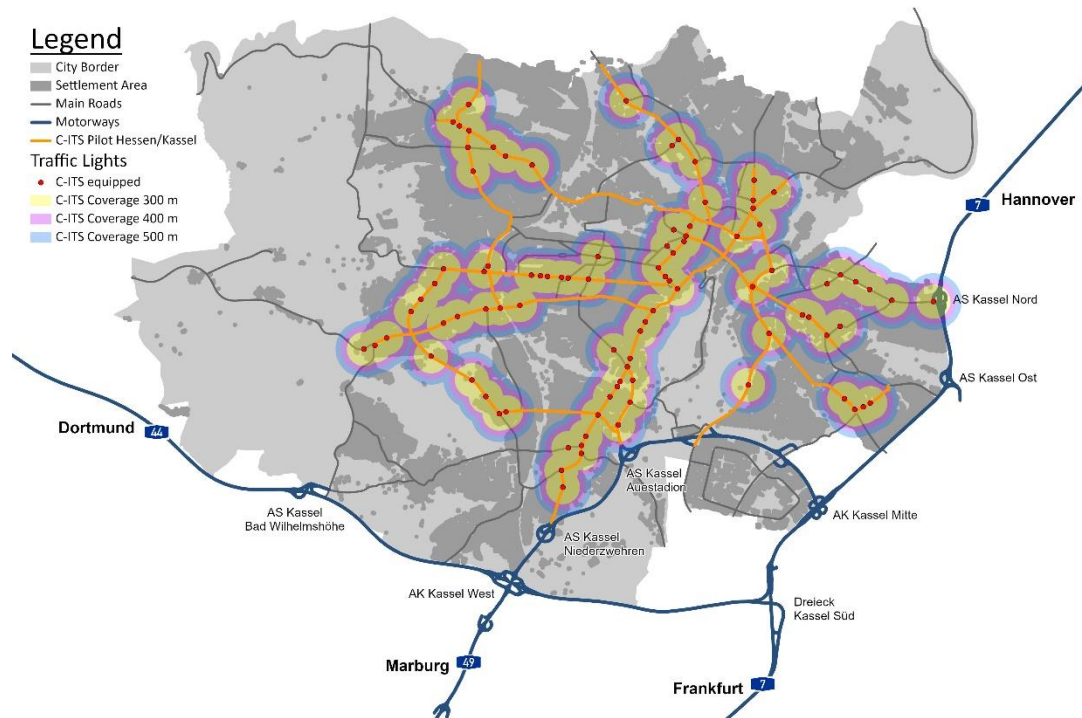


Figure 15: Overview of the equipped routes and C-ITS coverage (300, 400 and 500 metres) in the city of Kassel

The digital test site for connected driving Kassel covers modern technical equipment in the traffic management center of the city of Kassel and almost 100 (93 R-ITS-S by July 2023) C-ITS roadside stations on main roads of the urban traffic network.

The map of the city of Kassel (with the surrounding motorways A7, A49 and A44) illustrates the Kassel test field with the main roads leading into the city centre of Kassel, where the traffic light infrastructure will be upgraded towards an ETSI ITS-G5 I2V- and V2I-communication. Additionally, the C-ITS coverage by the R-ITS-S is illustrated with a radius of 300, 400 and 500 metres (**Fehler! Verweisquelle konnte nicht gefunden werden.**). By end of 2023, the test site in Kassel will comprise 100 C-ITS capable traffic lights (by 07/2023 93 R-ITS-S are already in operation, including R-ITS-S from other projects).

The C-ITS pilot in Dresden focuses on the deployment of Day 1 and Day 1.5 services. The test track runs along on heavily loaded city, including main roads and access roads. The traffic lights in the corridors will be gradually upgraded for the vehicle-to-infrastructure-communication (V2I). The pilot is coordinated by Fraunhofer Institute for Transportation and Infrastructure Systems IVI and benefits from a close link to the standardization work of ETSI.

Five additional C-Roads R-ITS-S went into operation in 2022. Up to 20 R-ITS-S with ITS-G5 and/or cellular-V2X are planned for the C-ITS Pilot in Dresden.

Key facts:

- Extension of Day-1 and development of Day-1.5 services to improve traffic flow and increase road safety
- Implementation of the services for the urban test and the application by industry and science
- Integration of highly complex urban corridors



Figure 16: Overview on the Dresden pilot. Source: [maps.google.de](https://maps.google.de)

## Overview of progress by End of 2022

C-Roads Platform has established solid structures for harmonisation of C-ITS specifications and alignment of C-ITS deployment across Europe (Activity 1). In parallel to that, C-Roads Germany – Urban Nodes (CRG-UN) has maintained the corresponding structures for aligning the German C-ITS pilot sites and the work has become routine.

The harmonisation of the German activities (Activity 2) within the CRG-UN Coordination Group and the established Expert Groups has been continuously refined and consolidated. In 2022, two Steering Committee meetings took place to discuss results and urgent topics. An amendment to the Grant Agreement was completed in 2022 to integrate Die Autobahn GmbH des Bundes as beneficiary after the legal transition of tasks from the federal state's road operator Hessen Mobil.

The Pilot Hamburg (CRG-UN Activity 3) further increased the number of intersections equipped with ITS-G5 technology. At the end of 2022, 118 intersections broadcast MAPEM and SPATEM for the respective intersection to provide all necessary data for the SI-SPTI and SI-GLOSA services. The PVD service is based on mobile stations involved in different city internal projects, i.a., an emergency vehicle prioritisation project. At the end of 2022, only a few intersections are



collecting CAMs for PVD. The roll-out is planned for 2023. All necessary hardware is already installed.

In 2022 the MAP provision, according to the C-Roads harmonisation, was strongly enhanced by improvements in the MAP design software. This could be achieved by closer cooperation with the respective software supplier. Besides optimising the MAP output, the internal processes necessary for GLOSA deployment were also improved. Much effort was put into the progress of the PKI used in the pilot and into the preparation of hybrid communication.

In 2022 the city of Kassel (CRG-UN Activity 4) fulfilled milestones M47 and M48. According to the defined milestone, the services Roadwork Warning (RWW) and Probe Vehicle Data (PVD) are operational in the digital test field for connected driving in Kassel. The Route Advice service was tendered, and the implementation also started. Also, in 2022 further traffic lights in Kassel were equipped with functions for the traffic signal priority request (TSP) of public transport vehicles.

In 2022, the city of Kassel installed 14 C-ITS capable traffic light systems equipped with R-ITS-S (at the end of 2022 there were 58 C-ITS capable traffic light systems realised in the project. Additional 20 R-ITS-S from other projects, so in total 78 R-ITS-S). During the operation periods, the R-ITS-S transmit the ETSI ITS-G5 messages MAP, CAM, DENM, SPaT, SSEM and IVI. Moreover, the expansion of broadband connections between several signalised intersections and the traffic light control centre proceeded. In 2022, further civil engineering works were carried out for the broadband connection of the traffic lights with optical fibre. In 2022, the German motorway operator Autobahn GmbH has discussed the internal interfaces for the upcoming C-ITS-implementations. As a consequence, specifications and required tender documents was carried out and finalised for the implementation of Emergency Vehicle Approaching (EVA) (sub-activity 4.3; four R-ITS-S) Route Advice Service (sub-activity 4.4; four R-ITS-S). Next steps are to proceed the procurement process and to award contracts in order to start the realisation phase. PVD will be implemented within the roll-out of Autobahn C-ITS Road Works Warning (12-R-ITS-S).

In 2022 Fraunhofer fulfilled one planned milestone in the Dresden pilot (CRG-UN Activity 5). The C-ITS service EVA went operational (M63) in September 2022 with a delay of three months. EVA is the final service planned in Dresden within this project, such that the pilot is ready for the final demonstration event of all services in 2023. In 2022 Fraunhofer installed 8 R-ITS-S (total of 13 R-ITS-S) with ITS-G5 and connected to traffic lights for the services GLOSA, PVD, TSP and VRU.

## Installed R-ITS-S based on funding by CINEA

All together 236 R-ITS-S have been installed so far, and 98 are planned for installation in the upcoming years.

## 10. The Greek Pilot site

C-Roads Greece is a newcomer within the C-Roads Platform since mid-June 2019. The main objective of the Greek pilot is to conduct a national pilot on a specific set of Day 1 and Day 1.5 C-ITS services, by using a balanced mixture of ETSI ITS G5 and cellular communication technologies.

The ultimate goal of the action is to pave the way and contribute for large-scale deployment of interoperable C-ITS services in Greece and Europe-wide. Greece is fully committed to contribute to the C-Roads Platform and be aligned with its results.

The selected Day 1 C-ITS services are the following:

- Road Works Warning (RWW)
  - Lane closure and other restrictions (RWW-LC)
- Hazardous Locations Notification (HLN)
  - Stationary Vehicle (HLN-SV)
  - Weather Condition Warning (HLN-WCW)
  - Obstacle on the Road (HLN-OR)
- In vehicle signage (IVS)
  - Embedded VMS “Free Text” (IVS-EVFT)
  - Shockwave Damping (IVS-SWD)
- Probe Vehicle Data (PVD)
  - Cam Aggregation (PVD-CA)

The only selected Day 1.5 C-ITS service for the Greek action is Smart Routing (SR).

The above will be inclusively achieved per case through two pilots:

- “Egnatia pilot”: 30 km of Egnatia Odos motorway with special attributes (geometry, traffic volumes, rural environment, mountainous area, successive tunnels and bridges) in northern Greece
- “Attica pilot”: 20 km road section of Attica Tollway (central sector) within the Prefecture of Attica.

### Involved partners

The Hellenic Ministry of Infrastructure and Transport is the coordinator of the C-Roads Greece action. Apart from the beneficiaries a number of organizations are considered implementing partners under the auspices of the Ministry. The participating partners in the Greek pilot are the following:

- Hellenic Ministry of Infrastructure and Transport (MIT)  
The following implementing bodies are under the MIT:
  - Institute of Communication and Computer Systems, designated by MIT;
  - University of Patras, designated by MIT;
  - Centre for Research and Technology Hellas – Hellenic Institute of Transport, designated by MIT;
  - EGNATIA ODOS S.A., designated by MIT
- COSMOTE Mobile Telecommunications S.A. (Cosmote)
- G4S TELEMATIX S.A. - G4S PRIVATE COMPANY OF SECURITY SERVICES, TRADING AND PROVISION OF ADVANCED TELEMATIC AND INFORMATION TECHNOLOGY SERVICES AND PRODUCTS (G4S TELEMATIX)
- TELENAVIS S.A. (TELENAVIS)
- HELLENIC ASSOCIATION OF TOLL ROAD NETWORK - HELLASTRON (HELLASTRON)
- Attikes Diadromes S.A. Operation and Maintenance Company for the Elefsina Stavros Spata Airport Free Motorway and Imitos Western Peripheral Motorway (Attikes)
- INTRACOM S.A. TELECOM SOLUTIONS (INTRACOM)

During C-Roads Greece action a number of partners will be engaged following specific contractual tendering procedures. In specific:

- Egnatia Odos SA will award one or more contracts through open tendering procedures related to:
  - a) supply and installation of RSUs and OBUs with their required configuration, control and adjustment support systems
  - b) supply of services for the appropriate development and extension of Egnatia Odos TMS software applications for the provision of C-ITS services under the C-Roads Greece pilot project
- Attikes Diadromes SA will award contracts with regard to the equipment or the services to be purchased for the project (for installation, customization of equipment or software development).
- MIT intends to award contracts for the purchase of software, and possibly specialized hardware, administrative, evaluation and control services.

## Location

As mentioned above C-Roads Greece will participate through two pilots.

- A. The Egnatia Odos Motorway is a motorway extending along 660 km and is part of the TEN-T Core Network Corridors, which crosses Greece from its westernmost edge (Igoumenitsa port) to its easternmost borders with Turkey (Kipoi, Evros). It has two separate directional carriageways, each consisting of two lanes (in few sections three lanes) and an emergency lane. Egnatia Odos motorway is equipped with many ITS devices and safety systems that aim at providing travel safety and comfort to end users. Along with a set of five vertical axes of 330 km connects Greece with all its north neighbouring countries (Albania, FYROM,

Bulgaria). The road section of Egnatia Odos motorway that will be included in the C-Roads Greece pilot is a rural road section with continuous bridges and tunnels of approx. 30 km with Average Annual Daily Traffic (AADT) of 11,230 (HGV: 16%). It is managed by a Traffic Control Center (TCC) and equipped with ITS related equipment (i.e. Variable message signs, CCTV traffic cameras, traffic detection inductive loops, meteorological & smoke sensors). This equipment will be utilized alongside with the C-ITS field equipment that will be installed in the course of the pilot.



Figure 17: Location of the “Egnatia Odos” Greek pilot site

B. Attica Tollway is a motorway extending along 70 km and is part of the TEN-T Core Network Corridors. It constitutes the ring road of the greater metropolitan area of Athens and the backbone of the road network of the whole Attica Prefecture. It is an urban motorway, with two separate directional carriageways, each consisting of three lanes and an emergency lane. The suburban railway of Athens has been constructed in the central reservation of the motorway. Below are some key figures of Attica Tollway (H1 2018): Average Daily Toll Transactions: 225,000, Average Annual Daily Traffic (AADT): 53,000, Average number of Daily Incidents: 70. The pilot will be deployed on the central sector of Attica Tollway, a road segment of 20 km with the heaviest traffic. The already installed ITS related equipment (Variable message signs, CCTV traffic cameras, traffic detection inductive loops, meteorological & smoke sensors) will be utilized alongside the C-ITS field equipment that will be installed in the course of the pilot.

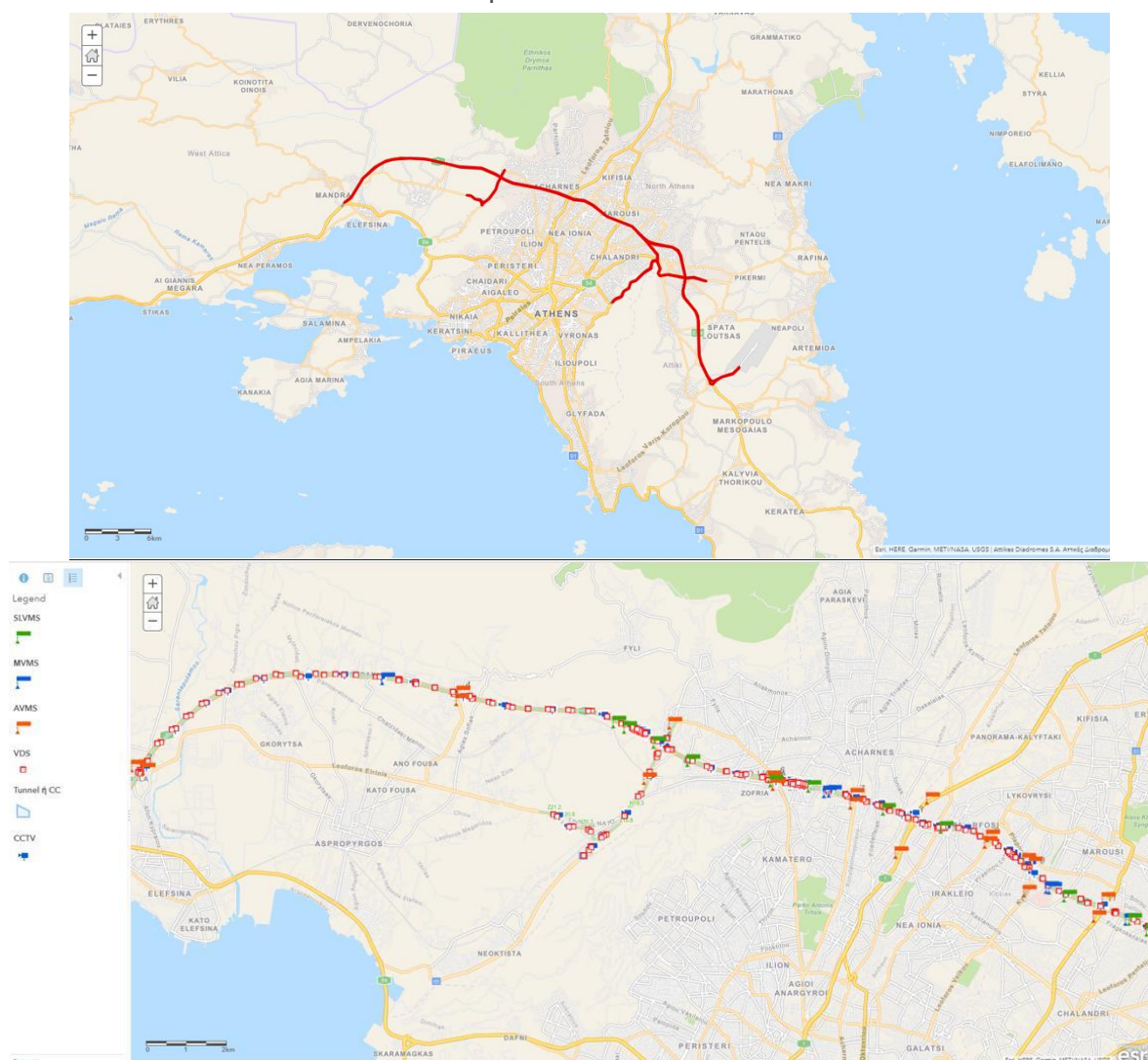


Figure 18: Location of the “Attica Tollway” Greek pilot site

10 RSUs and 1 mobile unit have been installed in Attica Tollway. As far as Egnatia Odos Motorway is concerned, 25 RSUs and 1 mobile unit have already been installed since mid-2022.

## Overview of progress by End of 2022

C-Roads Greece is implemented according to the timetable set in the Grant Agreement work plan. In total, 35 out of 43 milestones have been achieved, i.e. approximately 81% of the overall progress in terms of absolute milestones completed.

Activity 1: “C-Roads Platform”. C-Roads Greece actively took part in the physical meetings and teleconferences of Working Groups 1-5 and Task Forces 1-5 of the WG2 of the C-Roads Platform. Best practices on technical and administrative issues are followed.

Activity 2: “Greek Pilot Management”. C-Roads Greece organised in total four stakeholder workshops, two of them within 2022. Three of them were conducted under the auspices of the annual ITS Hellas Conference, showcasing the progress of the two Greek pilots, the deployment results and attracting 150 individuals in total.

Activity 3: “Pilot Design and Specification of the C-ITS Services”. Finished in previous periods.

Activity 4: “Procurement and Components development”. All equipment was purchased by the two pilots, adhering to the schedule of the relevant MS35 (All equipment and components purchased). During 2022, all components needed mainly for implementation of ITS-G5 were purchased/delivered gradually in Q1 and Q2 while work continued including developing the components needed for the more complex use cases in the Greek pilot site.

Activity 5: “Pilot Integration”. In MS36 (Launch and verification of the 1st set of services of the Greek Pilot), the first set of services for the two pilots of C-Roads Greece relied on mobile (LTE/4G) long-range communication, which through the GeoMessaging server implements direct C-ITS services without the need for infrastructure (RSU / OBU equipment). The results of the verification were presented both to back-end and front-end for this first set of services. DENM and IVIM messages were verified to be sent correctly by the back-end to front-end application. In MS37 (All services of the Greek Pilot launched), the other implemented services were presented, using both the long- and short-range communication channels. In MS38 (All services of the Greek Pilot verified), the services developed by the Greek pilots were verified. Three methods were used for the verification; unit testing, integration testing and system testing. For each category several parameters were documented, including the description of the test, the expected result, the priority, the final result (positive/negative) and the unit system that was used.

Activity 6: “Pilot Execution and Evaluation”. In MS39 (Completion of the Pilot execution plan and impact assessment methodology) the methodology for the assessment of impact areas was developed. The data collected during the execution of the work and the links between this data and the research questions were presented. MS40 (Completion of the Pilot execution plan and impact assessment methodology) describes the initialization of the two pilots data collection process. The methodology followed to start collecting pilot data consisted of three distinct steps; the backend preparatory activities, that structure the spine of the process, the frontend preparatory activities that offer the HMI mobile application, being the means to collect the desired data, and technical training for users to run the pilot in both sites, including both TCC users and end users. MS41 (Start of pilot data collection in both pilot sites) depicted the typical end of the pilots data collection process. The contractual data collection period is defined as the

quarter from March 2022 to May 2022, but it had been agreed to be prolonged to gather more data to be used for qualitative and quantitative analysis beyond this period. The initial recruitment of users engaged around 60 individuals, who periodically reached the one hundred, mainly belonging to staff from the consortium (Implementing Bodies and Partners). They were all granted to download and use the HMI android app that was developed by the project partners through three pairs of baseline and treatment phases that were spread throughout the whole year (2022). The rationale was that the road operators created messages through the back-end system and the test users were either in place to 'see' the corresponding events in their smart device (treatment phase) or not (baseline phase), offering this way the consortium with the capability of monitoring any potential change in the driving behaviour. The impact assessment and evaluation results from the use of the C-ITS services in the Greek pilots is described in MS42 (End of pilot data collection in both pilot sites). The used methodology included user acceptance through two questionnaires (one for road operator users, one for drivers/pilot test users), real-life logs collected from the two pilots, and two simulation experiments that were conducted for the services. Due to the limited number of logs collected during the initially set pilot phase, it was decided to extend the collection of pilot data during 2022 and a bit beyond, so as to grant more data that could be analysed qualitatively.

Activity 7: "Roadmap for Large-scale Implementation of C-ITS in Greece". The roadmap for large-scale deployment of C-ITS services in Greece is monitored in MS43 (Completion of the evaluation of C-Roads Greece pilot). All partners and implementing bodies documented their approach on this roadmap based on their expertise. The main referenced topics include updates on the architecture, C-ITS services implemented in Greece, extended services that could be used on freight and logistics, future C-Roads use cases to be adopted, the usage of and the role of Living Labs, the extensibility to each pilot operator and/or all other national road operators, the stakeholders' potential roles and responsibilities, as well as the various challenges in the CCAM ecosystem.

## Installed RSUs based on funding by CINEA

All together 37 RSUs have been installed so far in the two Greek pilots (two of them being mobile RSUs). There is no planning for further installations in the upcoming years.

## 11. The Hungarian Pilot site

In Hungary, C-ITS deployment started within CROCODILE project Phase I in 2015, the improvement of road safety – especially in work zones – was the key issue.

A 136km-long stretch of the M1 motorway between Austria and Budapest was selected for C-ITS services pilot deployment, what successfully developed during the first phase of the C-Roads and CROCODILE project. For maintenance vehicles, mobile RSUs were also installed, which can operate in stand-alone mode as well. The communication between RSUs and OBUs is thus far based solely on ITS G5. The system itself covers ‘Day-1 services’ and the ‘Day-1,5’ comply with ECO-AT specifications (‘Traffic jam ahead warning’, ‘Hazardous location notification’, ‘Road works warning’, ‘Weather conditions’, ‘In-vehicle signage’, ‘In-vehicle speed limits’). The system architecture – the 3 components – follows the ECO-AT specifications.

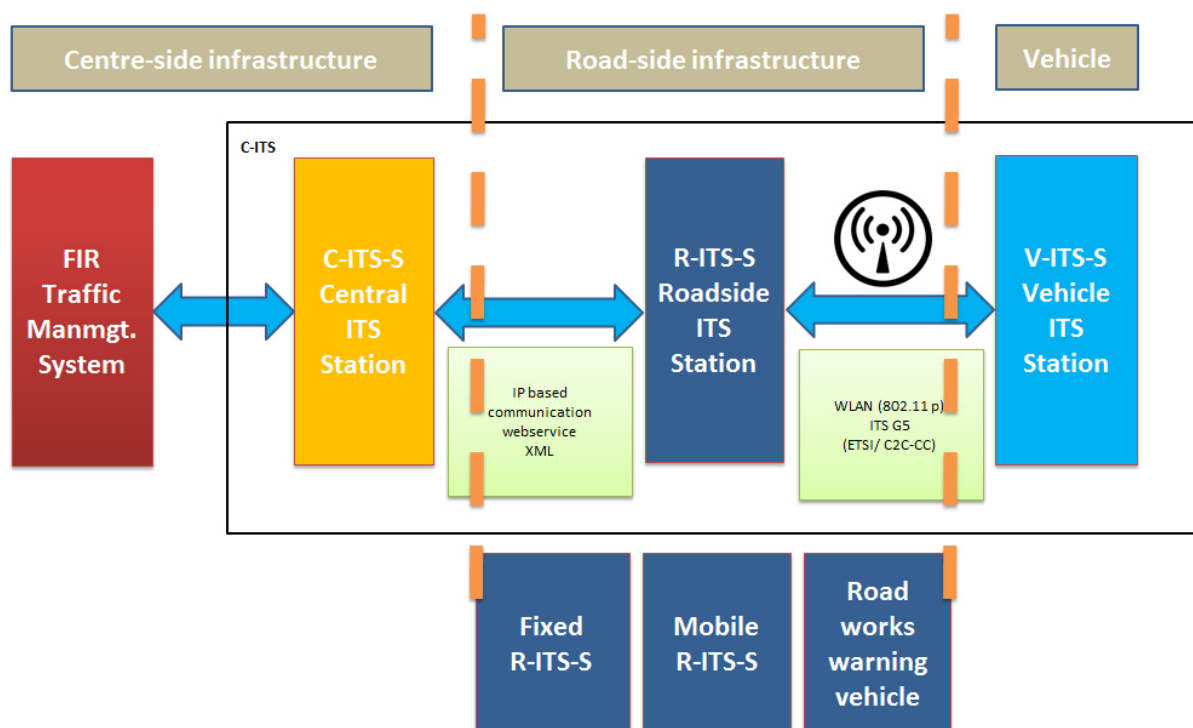


Figure 19: System architecture

These ITS G5 transceivers are compliant with the C-Roads specifications Release 1.3, and they are operational, ready for testing. In the third phase of CROCODILE we planned to raise coverage along expressway M0 via implementing additional 8 fixed RSUs at 4 locations, and besides 2 signalized junctions at JCT No. 16 (*Halásztelek*), by the end of 2021. As a result of this extension there will be an RSU in every 5 km along expressway M0.

In the framework of **C-Roads Hungary** the Implementing Body carried out a larger scale extension of the C-ITS infrastructure both in terms of geographical coverage, and offered services. Emphasis was laid on urban deployment, in particular GLOSA/Time-to-green as well as intersection safety (signal violation). The communication technology is planned to be



upgraded, too – deployment of hybrid DSRC and preparation of cellular technology that is envisaged in near future.

The **C-Roads 2 Hungary** work programme devotes particular attention to the creation of the urban test environment for the autonomous and connected vehicles in the town of Zalaegerszeg linked to the Automotive Proving Ground Zala, building on the experiences of the pilot project in the city of Győr, implemented in the 1st phase of C-Roads (Hungary). The envisaged investments will be a part of a Smart City concept, of Zalaegerszeg. The deployment will focus on Day-1 and Day-1.5-C-ITS-services with option to be up scaled to Day-2-C-ITS-services. The so called ZalaZone is the greater area of the town, including the test track, that will be ready for autonomous vehicle testing, but the plans are even more ambitious. With a trilateral multi-level cooperation, Austria, Slovenia, and Hungary plan to implement cross-border test routes. C-Roads 2 Hungary will boost this effort by implementing C-ITS services in the greater city area, and TEN-T corridors (with domestic, and cross-border sections).

Figures of the action (Urban C-ITS pilot & CCAD test infrastructure):

- Rapid prototyping (to prepare physical implementations properly with 3D computer aided design)
- At least 8 junctions equipped with C-ITS applications
- At least 40 test vehicles equipped with OBUs

### Planned progress of the Action

The new locations and use cases have been defined according to the following map. The main Pilot site for C-Roads 2 stays Zalaegerszeg. The intersections have been chosen after detailed research and in accordance with the local authorities for the best possible effect. There will be one intersection dedicated to test and validate only VRU use cases.

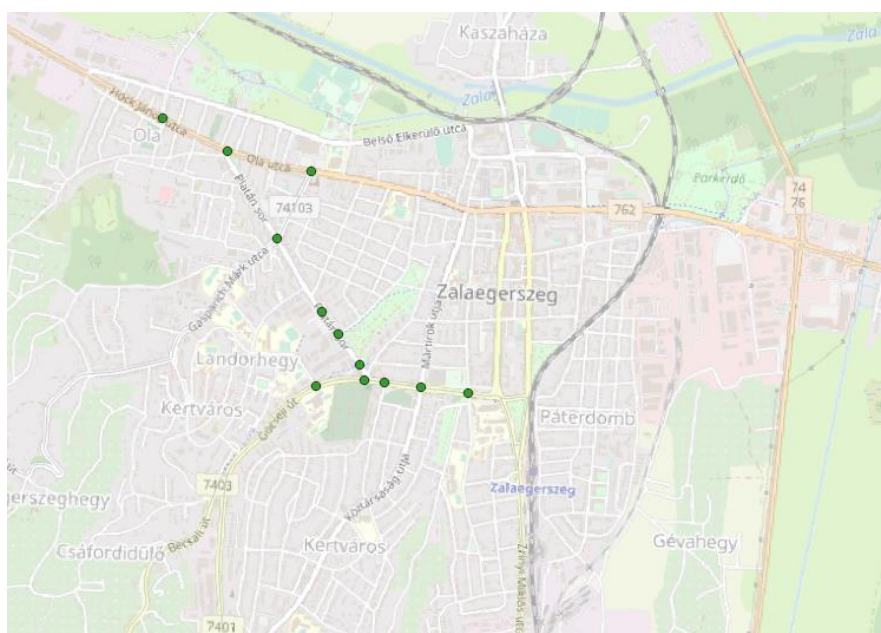


Figure 20: Intersections in C-Roads 2 in Zalaegerszeg

## Involved partners

- Beneficiary: Ministry for Innovation and Technology (formerly Ministry of National Development)
- Implementing body: Hungarian Public Roads

Other stakeholders:

- Budapest University of Technology and Economics (BUTE)
- Budapest Public Road Plc
- Automotive Proving Ground Zala Ltd (APZ)
- Municipality of Győr
- Municipality of Zalaegerszeg
- Commsignia Ltd
- Microsec Plc
- Transport Research Institute Non-profit Ltd. (KTI) – Mobility Platform (PKI issues)
- ITS Hungary Association (dissemination)

## Location

With the extension, major part of motorway M7 (Mediterranean corridor) has been covered, and urban deployment have been carried out in the city of Győr by motorway M1 (Orient-East Med corridor). In order to improve coverage and ensure continuity of service, new transceivers were implemented on motorway M1 Győr bypass section at the same time. This Győr bypass section is part of the existing 136-km-long M1 pilot section, motorway M1 between km 105-130. In the C-Roads Hungary project we are focusing on motorways M1, M7 and urban pilot in the town of Győr by motorway M1, and the town of Zalaegerszeg by the Automotive Proving Ground.

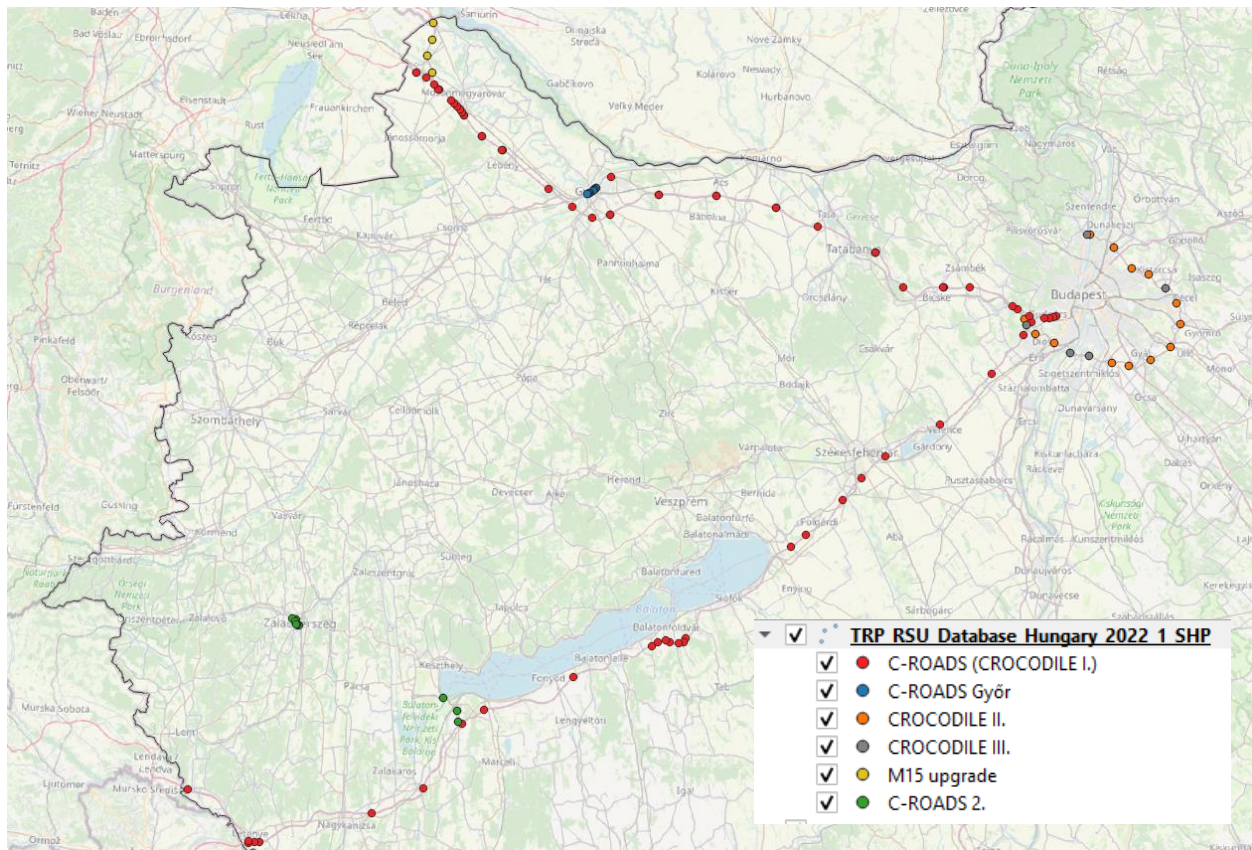


Figure 21: Location of the Hungarian RSU Positions

## Overview of progress by End of 2022

The first phase of C-Roads was successfully closed in 2021 and the preparation of the second phase has begun. In accordance with the Steering Committee, the closure of the first phase was prerequisite of the start of the second phase. The public procurement documents were prepared and submitted to the procurement department. Due to external reasons the technical documentation had to be recalled and some parts had to be changed and the procedure restarted. In the summer of 2022, the final technical content was approved and the procurement process was started. After all necessary approvals arrived from the Ministry, the procurement was published on the 27th of December.

## Installed RSUs based on funding by CINEA

Altogether, 123 RSUs have been installed so far, and approx. 15 are planned for installation in the upcoming years.

## 12. The Irish Pilot site

The Irish C-ITS pilot will test and evaluate a range of day 1 and day 1.5 C-ITS services on both Transport Infrastructure Ireland's road network (i.e. the TEN-T road network) and within the urban centre of Dublin using V2V, I2V and V2I communications. Figure 22 shows the location of the pilot corridors, which have been divided into the following sections where specific services will be piloted:

- Section 1: M1 between the border with Northern Ireland and Drogheda – a range of services.
- Section 2: M1 and M50 between Drogheda and the M50/M7 interchange – on this section hybrid communications will be piloted once the ITS-G5 infrastructure has been installed and commissioned such that a range of day 1 services can be piloted and evaluated
- Section 3: M7 and M8 between M50/M7 interchange and Cork – a range of day 1 services across the service categories will be tested together with development and testing of day 1.5 services
- Section 4: Dublin – C-ITS services will be piloted within Dublin.
- Section 5: M7 and N18 between Limerick and the M8 intersection - a range of services are to be piloted on this section, which will include adverse weather warnings.

### Involved partners

The implementing body is Transport Infrastructure Ireland. Partners established so far are listed below:

- **DoT** (Department of Transport) – the beneficiary of the Grant Agreement
- **Dublin City Council** – the urban centre where urban based C-ITS services will be piloted
- **Road Safety Authority** – Ireland's primary road safety organisation and an official statutory body charged with reducing the number of fatalities and injuries on Irish roads
- **Enterprise Ireland** – a government organisation responsible for the development and growth of Irish enterprises
- **IDA** – (Industrial Development Authority) a semi-state organisation promoting overseas direct investment into Ireland
- **Kapsch** – A partner to provide C-ITS central station support and services
- **Swarco** - A partner to supply and install RSUs and OBUs together with the provision of C-ITS service application software
- **University College Cork** – an academic partner to provide input to the technical evaluation focussed on communications performance
- **South East Technological University** - an academic partner to provide input to the technical evaluation focussed on the security and privacy of C-ITS users

Ongoing discussions about potential partnering opportunities are currently being held with a number of organisations, including mobile network operators, car manufacturers and other innovative future mobility initiatives.

## Location

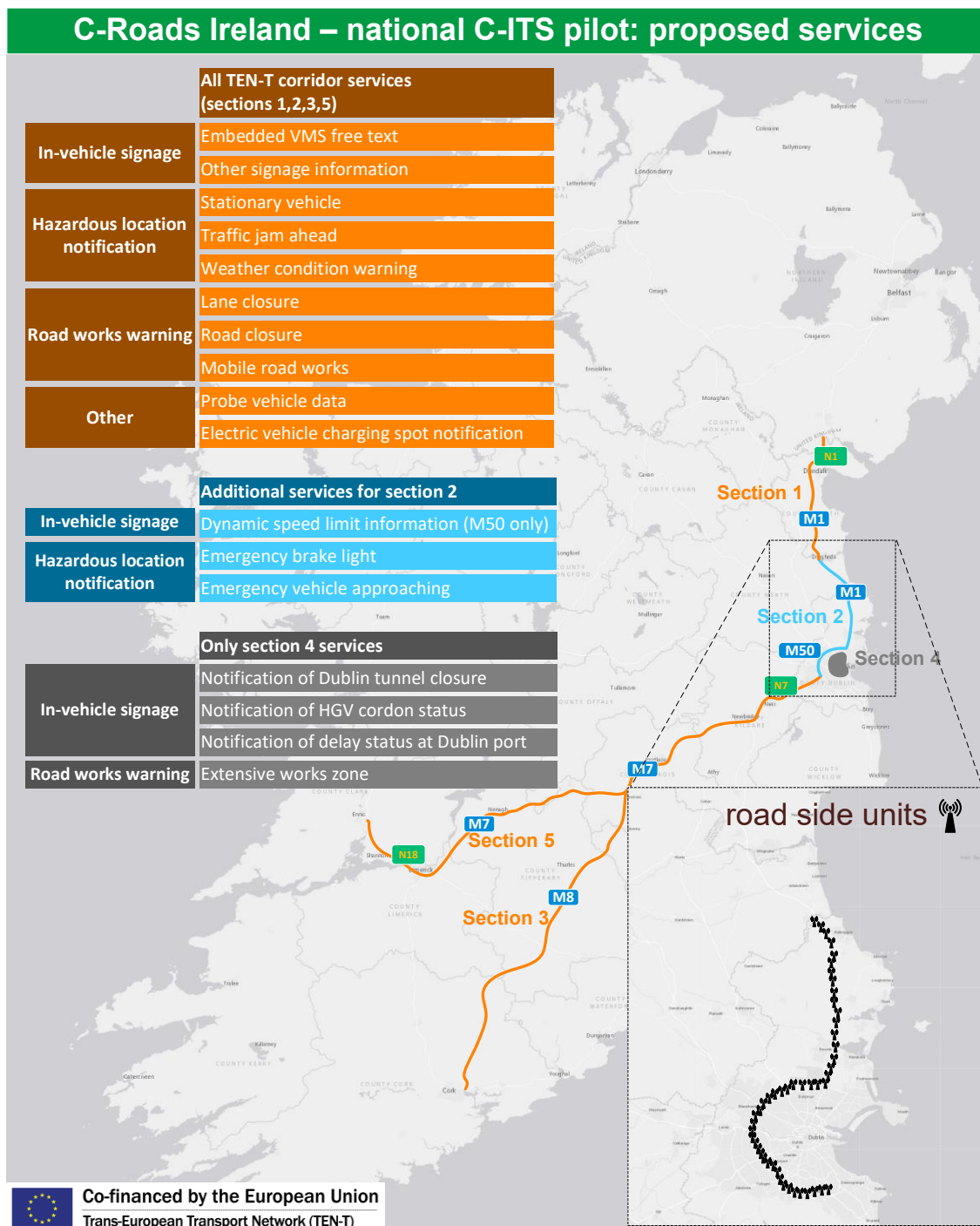


Figure 22: Location of the Irish pilot site and use cases

## Overview of progress by End of 2022

Significant work was undertaken to prepare an outline design of the pilot, covering both system and roadside infrastructure design in order to issue specifications as part of the suite of tender documents. The pilot components were then procured via two contracts that Transport Infrastructure Ireland (TII), as the action's implementing body used to procure a replacement traffic management system (NIMS) and the necessary roadside equipment/support to deliver variable speed limit functionality on the M50 (MTFO ITS DC). The C-ITS programme therefore became linked to the NIMS and MTFO ITS DC programmes. Kapsch was appointed to provide the central C-ITS control station (a component of NIMS) and Swarco (formerly Dynniq) was appointed to provide roadside equipment and in-vehicle equipment together with software application development.

Civils designs for the M1 in-fill RSU sites were completed and were issued to appropriate civils contractors. Costs received from contractors for the construction of sites on the M1 was much higher than budgeted. A value engineering exercise was undertaken and a decision was made to relocate 13 RSUs from the northern end of the scheme to the southern end of the M50 on existing infrastructure to allow all 74 RSUs to be installed within the overall budget whilst maintaining the overall 60km of continuous coverage on the TEN-T network.

Significant progress was made on the development of the central C-ITS station, with a demo provided at the end 2022, with completion anticipated for Q2 2023. OBU application software was also progressed for the each of the use-cases being implemented in Ireland. Similarly, development on the C-ITS smartphone app has taken place with a demo provided in December, with completion expected by Q2 2023.

In respect of the urban use cases outlined in the grant agreement, a detailed specification was prepared in collaboration with Dublin City Council and a contractor appointed to deliver the services. The pilot project team has engaged with Dublin City Council to discuss and agree responsibilities during the pilot operational phase and an approach to the evaluation of each use-case. Dublin City Council are poised to support the pilot operational phase just as soon as the system is available. Staff at the council will receive log-in details to access a central system user interface to support the implementation of the use-cases, along with the necessary training and support.

In parallel with the progress that has been described above, a number of other key activities have been completed.

A specialist company has been appointed to recruit the necessary number of pilot participants, targeted at approximately 1500. A pilot participant data platform is being prepared to administer the recruitment process and to provide a portal to enable user acceptance questions to be issued/accessed and for pilot participants to access training/briefing materials.

In addition, a data analysis platform is being prepared. The platform will receive raw encoded C-ITS log data from the contractor's central C-ITS system and perform the necessary translations to enable data analysts to run queries and interrogate the data such that the effectiveness of C-ITS can be evaluated. The platform will be developed in compliance with GDPR.

A C-ITS pilot safety plan was developed that describes the safety governance methodology that will be followed throughout the pilot. The plan also demonstrated that all the foreseen safety risks have been identified and appropriate controls have been put in place to minimise the risk of harm. The safety plan was developed based on relevant TII publications, standards, and other tried and tested approaches to safety risk assessment as followed by other C-Roads pilots. Thus, it ensures the potential risks of trialling C-ITS technology on public roads is reduced to as low as reasonably practicable.

In terms of C-ITS security and privacy, the Irish pilot was registered with the EU PKI Level 0 service provided by Atos. A part 1 factory acceptance test was undertaken of RSUs and OBUs and demonstrated the registration of both unit types with the EU PKI service and receipt of Level 0 PKI certificates for EU PKI service for signing the messages. Registration of the central C-ITS station with the EU PKI service will be undertaken in early 2023.

A C-ITS test and evaluation plan was prepared and shared with the C-ITS steering committee. The plan documents how a phased approach to testing will be implemented that is designed to expedite data logging activities in light of dependencies on other parallel work streams. The plan lists evaluation questions for both the technical evaluation (aligned to C-Roads working group 2) and the impact evaluation (aligned to C-Roads working group 3). The proposed approach to answer the evaluation questions is in accordance with C-Roads developed methodologies.

## **Installed RSUs based on funding by CINEA**

All together 3 RSUs have been installed so far, and 74 are planned for installation in the upcoming years.

## 13. The Italian Pilot site

### C-Roads ITALY (2017-2021)

The main goal of the C-Roads ITALY project (2017-2021) was to implement and test, in real traffic conditions, a set of “Day1” and “Day1,5” C-ITS services as recommended by the EC C-ITS Platform as well as cooperative systems based on V2X technologies, for the following automated driving applications:

1. trucks Platooning
2. passenger cars Highway Chauffeur
3. combined scenarios of trucks and passenger cars.

### Involved partners

The Beneficiary (Member State) is the Ministero delle infrastrutture e dei trasporti.

The following entities are considered as implementing bodies:

- Iveco S.p.A.;
- North Italy Communications S.r.l.;
- Ministero dell’Interno – Dipartimento della pubblica Sicurezza – Servizio Polizia Stradale;
- Autostrada del Brennero S.p.A.;
- Codognotto Italia S.p.A.;
- Politecnico di Milano – Dipartimento di Design;
- Centro Ricerche FIAT S.C.p.A.;
- CAV Concessioni Autostradali Venete S.p.A.;
- Telecom Italia S.p.A.;
- Azcom Technology S.r.l.;
- Autovie Venete S.p.A.



## Location

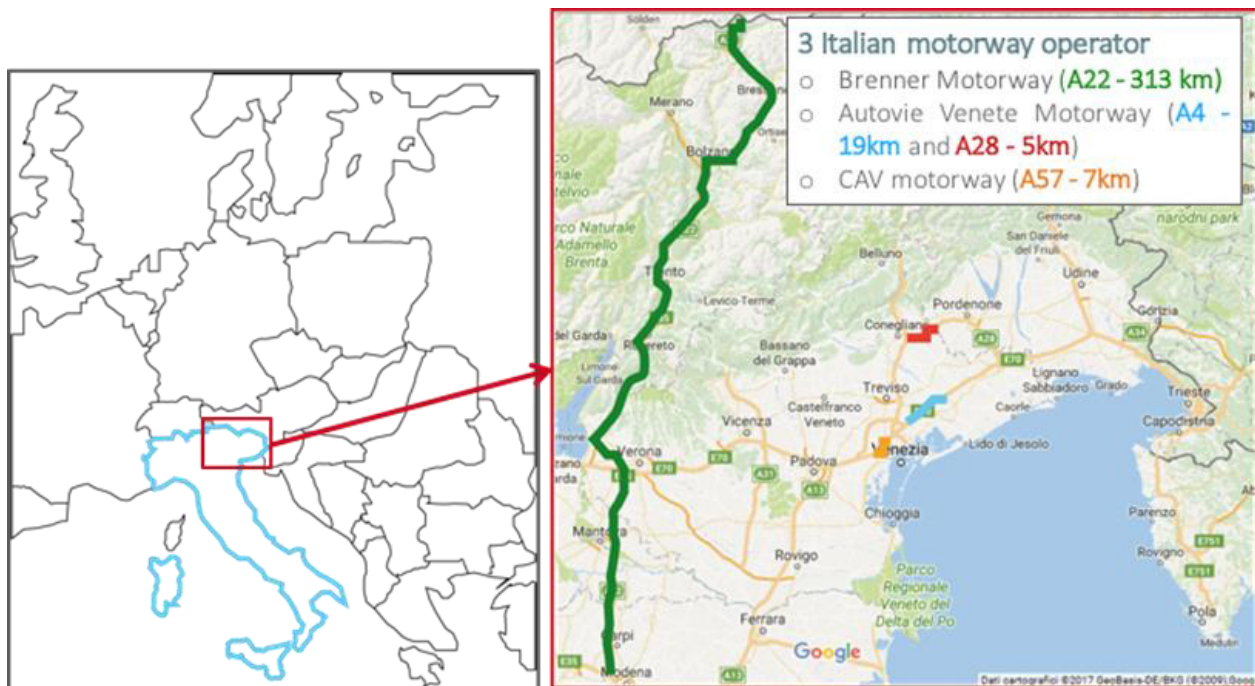


Figure 23: Location of the Italian pilot site

## Final status by end of 2021

84 RSUs have been installed along the 368Km (slight enlarged in comparison to the planned Km on the map) of road sections involved in the first pilot (C-Roads Italy 2017-2021).

### Trucks Platooning

From December 2020 till the end of 2021 an extensive driving activity has been done; around 300.000 km and 3.500 hours, were driven with the Platooning functionality active. Different phases of the Pilot passed, with different combination of Platooning (2+2, 3, 4 vehicles in the convoy). All along the Pilot, C-ITS events have been received and shown to the drivers that used them to improve the safety of driving. A logging device was installed in the trucks, collecting all the messages of several vehicle networks from a specific subset that has been identified for the project. Moreover, test sessions have been organized by the Politecnico di Milano for specific UCs testing needed to complete the evaluation. The goal was to collect useful data for its improvement to ensure the most effective application in real conditions of use. On the same occasion, the Vehicle communication has been tested to Infrastructure (V2I) and related C-ITS services, such as Electronic Emergency Brake Light (EEBL), the Slow or Stationary Vehicle Warning, Traffic Jam or Road Works Warnings, In-vehicle signage or In-vehicle speed limits.

## Highway Chauffeur (passenger cars)

### Italian tests

CRF equipped vehicles ran extensive pilots on the A22 motorway, where more than 2500 km were run. The kinds of tests regarded the interoperability with Iveco Trucks, preparation for and demonstration of the system to 14 end users (June 2022), application scenarios data collection for fine-tuning and evaluation of the following C-ITS services: Stationary Vehicle, Slow Vehicle, Road Works evaluation. The objective was to drive through controlled C-ITS scenarios with and without the C-Roads Italy connected Highway Chauffeur system, and provide POLIMI with driving data for evaluation. For evaluation, CRF also performed two test sessions on both A4-A28 managed by Autovie and on the Venezia tangenziale managed by CAV.

Additional testing activities were carried out as C-Roads Italy pilot support, including: multiple tests on A22 motorway to verify standard compliance; dedicated on-road sessions to collect PCAP files of the messages sent by A22 infrastructure, to provide those recordings to C-Roads platform; pre-tests offline (PCAP) and online (AMQP) of messages by CAV and Autovie to prepare for the field trials.

### Cross-border tests with Austria

On December 3rd, a dedicated C-Roads Italy session was planned. The equipped vehicles drove to Brenner to perform Cross Border tests. It have been performed the round trip 5 times for about 110 Km along the path, whereby the first 3 drives validated the service chain, and the remaining 2 the correct handling of messages by the Highway Chauffeur. The tested messages were: Road-Works Warning RWW, Weather Condition Warning WCW and Stationary Vehicle Warning SVW. The assessment gave positive results, namely:

- C-ITS events, generated by CRF through the ASFINAG Technical Exercise on the Austrian broker, were exchanged to the Italian broker through the BI and received by the CRF client that forwards them to the V2X OBU.
- Received C-ITS messages tested were correctly decoded and output to the vehicle network for the (1) actuation of the longitudinal controls (slowing down manoeuvre in RWW and WCW), (2) request of assuming manual control of the vehicle (SVW) (3) suggestion to the driver linked to the lateral dynamics (lane change in RWW).

### Virtual tests

Virtual Test Site trials have been performed replayed PCAP of 1 test site in Belgium (Wallonia) and 4 test sites in France. The methodology followed was compliant to C-Roads platform “C-ITS Cross-Border Testing: PCAP Exchange Specification”. a total of 39 «Test Cases» was analyzed (21 in FR, 18 in BE).

## C-Roads Italy 2 (2018-2023)

The main goal of C-Roads Italy 2 is to study and pilot, principally in real urban traffic conditions of Torino, Verona and Trento cities, a set of “Day1” and “Day1,5” C-ITS services as for example:

- Green Light Optimal Speed Advisory (GLOSA)
- Traffic signal priority request by designated vehicles
- Signal violation/Intersection safety
- On street parking management & information
- Traffic Information and Smart Routing

## Involved partners

The Beneficiary (Member State) is the Ministero delle infrastrutture e dei trasporti, the following entities are considered as implementing bodies:

- ALMAVIVA
- Autostrada Brescia-Padova (BS-PD)
- North Italy Communications (NICom)
- Centro Ricerche FIAT (CRF)
- Comune di Verona
- Comune di Torino
- Comune di Trento
- MOVALIA
- Politecnico di Milano (PoliMi)
- Telecom Italia (TIM)
- TTS Italia

## Location



Figure 24: Locations of the C-Roads Italy 2 pilots

## Overview of progress by End of 2022

Regarding the participation of the C-Roads Italy 2 Implementing Bodies to the C-Roads Platform activities, it is important to highlight the participation at all WGs and TFs where they were involved, in order to share and discuss the experience matured at national pilot test and developments, to achieve a common understanding and harmonization and contribution to new use case & new scenario (I2V) proposal, creation of message profiling for such cases and providing feedback for each new release candidate documents.

In 2022 it has been worked on improving the C-ITS server in order to enhance the security and performance and to support the message flow to the RSU management systems of the national Implementing Bodies (Implementation and testing of MQTT broker & client for Verona, Trento and Torino). This work also included the creation and adjustments of topics and message modelling to fit the needs of each IB. Furthermore, it has been implemented additional session layer security, TLS, to AMQP and MQTT connection as well as message-level security to sign all outgoing messages with PKI in line with C-Roads requirements. As far as robustness of the C-ITS server is concerned, it has been implemented and tested filtering and recovery mechanism in order to minimize the impact from the interruption in the service chain. To support the new DAY 1.5 use case “On-Street parking” service, the new message has been implemented (Parking Availability Message) in C-ITS server; the related functionalities will be available through the C-Roads Service Provider in addition to the ones already implemented.

Moreover APIs have been implemented to interface the C-ITS server to the different use-cases planned in C-Roads Italy 2 in the different test-sites of Torino and Trento and the automatic link for connecting the DATEX II node of Verona TMC to the C-ITS server itself has been designed and a good part of the ETSI messages have been tested for correct translation and forwarding to the IP interface.

Regarding the activities dealing with the “In-vehicle use cases” in regards to the vehicle functionalities of Emergency vehicle approaching, Weather conditions, GLOSA / Time To Green (TTG), Signal violation/Intersection safety, VRU protection, smart e-Coasting, Smart routing and on modifying the use cases (e.g. HMI), they have been validated. CRF tested the vehicles (HeV and Highway Chauffeur Vehicle) in scenarios that are representative of the intended use. Almost all Use Cases were validated on site, except from emergency vehicle and Smart Routing, planned on site for 2023.

First functional tests were done on vehicles close to CRF facilities in Trento and Torino/Orbassano. After a second round tests addressed the whole service chain, and were focussed on the connectivity and interface among all involved actors. Dedicated sessions were planned and executed, in Turin and Trento for SPATEM/MAPEM, on Brescia-Padova highway testing DENM and IVIM. Additional tests on the A22 (closer to CRF premises) were done.

Regarding Hybrid communication, the Italian Interchange Entity (basically, an AMQP broker), released in 2020, enables long-range, IP-based communications between C-ITS stations. In 2022 the Interchange Entity has been involved in virtual and on-field testing phases at a national and European level.

The AMQP broker forwards these messages to subscribers (Stellantis' vehicles and Interchange Entities of other Member States). At a European level, the Italian Interchange Entity has been connected to France and Austria (it was already connected to Slovenia and Spain). National C-ITS messages were shared between Member States for interoperability checks.

Other Member States are using the Italy-France connection to receive French C-ITS messages (not being able to connect to France through an IPsec tunnel). Moreover, feedback session meetings have been organized and held by CRF with Hungary, Germany, Greece to share the Virtual Test Site tests and analysis that were carried out by CRF within Activity 2.

About evaluation, activities focused on the evaluation of some Day 1.5 services, specifically "Traffic Information and smart routing" and "Off street parking information". A methodology was designed to evaluate specific applications developed in C-Roads Italy 2 project capable of providing, via C-ITS services, information on traffic and parking facilities in the urban area of Verona. The other activities carried out involved refining some of the modelling evaluations conducted earlier, particularly concerning GLOSA, and outlining the evaluation methodology and related field tests that will cover other use cases to be carried out once the services become operational in the following months.

Moreover, a socio-economic evaluation has been done in order to investigate the feasibility of investing in GLOSA/SPTI in the test sites of Trento and Turin by means of conducting a thorough socio-economic assessment employing common industry techniques and practices (i.e. CBA) in order to examine whether cumulative benefits and systems costs associated with the test sites deployments would result in a profitable investment in the long-term.

In the test site of **Verona** the following activities have been performed:

The planned Design activities for detecting parking areas and slots by means of cameras and artificial intelligence have been completed, including also the definition of the communication protocols according to the operational standards. That allowed to start the commissioning and installation phases.

Completion of Design phase for Off street parking information

- Communication between the parking lots and the mobility centre already established
- Upgrading to the European standards of interoperability of the user information system connected to all the car parks in the Verona structure completed
- Local ITS of Verona just connected to all parking areas like as 'off street' by direct communication with vendor & local automation system

Completion of activities for Traffic signal priority request by designated vehicles

- system extension to other vehicles in transit such as the Fire Brigade, Public Transport, Police Forces. In addition, the system has been enhanced to extend it to the entire urban traffic light network, increasing the MSW from 4 to 10 and the centralized intersections from 62 to 140.

Completion deployment and start operation for Emergency vehicle approaching

- the service is now active for emergency vehicles in red code. Additional tests were made and are on-going to ensure its full compliance with the C-Roads standards.

In the test site of **Torino** the following activities have been performed:

Tests have been performed in order to verify the level of agreement between the implemented behaviour and the reference C-Roads technical specifications (release 1.8) concerning SPATEM/MAPEM and related logics.

In the test site of **BS-PD motorway** the following activities have been performed:

Internal tests, using OBU installed on company vehicles, have been performed during the entire year 2022. A Cross border test session has also been formally organized and performed on 10/11/22, involving Greece, Ireland and Austria.

## C-Roads Italy 3 (2020-2023)

C-Roads Italy 3 is a natural follow up of the Actions named: C-Roads Italy and C-Roads Italy 2.

The main goal of C-Roads Italy 3 is to maximize the impact on road safety and traffic efficiency, achieving the continuity of C-ITS Services by extending the geographical coverage of national road network along the Core Road network of the SCAN-MED and MEDITERRANEAN European Corridors, deploying and implementing, principally, a set of C-ITS "Day1" Services and also "Day1,5" as recommended by the EC C-ITS Platform. That implies that roads infrastructure must be equipped or upgraded with innovative technologies to allow the interaction and information exchange between road operators infrastructure and vehicles (I2V) - (V2X).

Within C-Roads Italy 3, the communication design and the related architecture will be based on hybrid solution, notably: "ITS-G5" and "cellular long range network". The aim is also to further develop what was already implemented within C-Roads Italy by adding further scenarios of already developed "Use Cases" or by adding "new" Use Cases (e.g. mobile Road Works Warning and RWW - Winter Maintenance).

## Involved partners

The Beneficiary (Member State) is the Ministero delle infrastrutture e dei trasporti, the following entities are considered as implementing bodies:

- Autostrada del Brennero (A22)
- Autostrade per l'Italia (ASPI)
- Concessioni Autostradali Venete (CAV)
- North Italy Communications (Nicom)
- Roma Servizi per la Mobilità (RSM)
- S.p.A. Autovie Venete

## Location



Figure 25: Location of the C-Roads Italy 3 pilots

## Overview of progress by End of 2022

In the test site of **A22 Brenner motorway** the following activities have been performed:

- Installation of 20 new Road Side Units, 5 fixed and 15 mobile
- Development of the 2nd set of new UCs
  - HLN – Emergency Vehicle Approaching (HLN-EVA)
  - RWW – Road Operator Vehicle Approaching (RWW-ROVA)
  - HNL - Emergency or Prioritized Vehicle Approaching (HLN-EPVA)

In the test site of **Autovie Venete motorway** the following activities have been performed:

- Upgrade of C-ITS Server, the activity and the upgrade of the server includes the links and integration of the IT network set up for new RSUs, configuration and upgrade for the new releases of firmware, for the security issues and hybrid communication.
- Start of implementation of RSU on A4, the preliminary civil works for the implementation of the first set of RSU on the section of motorway A4 from Portogruaro to Gonars (from km 459 to km 489) have been completed.

In the test site of **CAV motorway** the following activities have been performed:

- DATEX II and C-ITS software upgrade, the following activities has been implemented
  - implementation of a new C ITS software release to connect the new RSUs on field
  - upgrade of the C ITS translation software layer from DATEX II to ETSI protocol
  - upgrade of the C ITS RSUs management software layer to better connect and control the RSUs with G5 and hybrid AMQP broker protocol
  - upgrade of the DATEX II software layer to integrate the TCC – RSUs communications
  - implementation of on board unit in two CAV fleet vehicles
  - firmware upgrade activities on the RSUs
  - C-ITS software tuning activities
  - field test activities with the CAV fleet vehicles.

In the test site of **Roma Servizi Mobilità** the following activities have been performed:

- Procurement activities completed in order to provide the city of Rome territorially with harmonized C-ITS systems and services to ensure the interoperability of implemented services at interurban level and urban level.

In the test site of **Autostrade per l'Italia motorway** the following activities have been performed:

- Concluded the surveys in December 2022 for the civil work project
- Scouting for RSUs concluded
- Programmed the purchasing of RSU/OBU from 30/06/2023

## Installed RSUs based on funding by CINEA

All together 123 RSUs have been installed so far, and approximately 30 are planned for installation in the upcoming year.



## 14. The Dutch Pilot site (2016-2019)

The Dutch pilot area is situated in the south of the Netherlands. The area consists of the TEN-T Core Network road section from Europoort Rotterdam to the Belgian border, A15 A16 and the motorway section from the Belgian border via Eindhoven to Venlo, A67. To connect these two Core network sections and have a meaningful ongoing corridor to roll out the proposed services, the road section Breda to Eindhoven (A58, A2) of the comprehensive network, has been added because of the major C-ITS developments which take place there. Next to that also the Core network section on the A2 around the Leidsche Rijn Tunnel was added. The total network stretches across 268km of which 60km or 22% are comprehensive network. Next to these road sections the port of Rotterdam, industrial and logistic area makes part of the Dutch corridor. Also the Moerdijk industrial area and the Venlo Trade Port are included. Both Rotterdam and Moerdijk are seaports on the core network. Venlo Trade Port is a multimodal platform on the CEF Corridor North Sea Mediterranean. To strengthen the corridor A58 and A67 in the Province of Noord Brabant, budgets have been allocated for innovative solutions. To improve the accessibility of the region “Smart Mobility” solutions were piloted and implemented. Combining the Brabant Corridor initiatives with the services proposed within the InterCor project, the region benefits even more.

### Involved partners

The project coordinator was Rijkswaterstaat, a part of the Dutch Ministry of Infrastructure and Water management. Furthermore the Province of Noord-Brabant and the Province of Utrecht were involved.

### Location

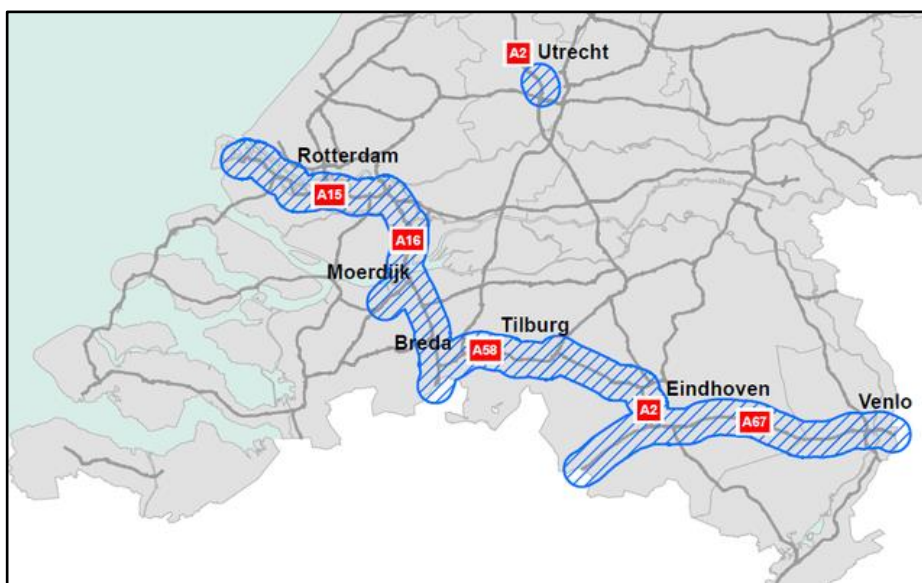


Figure 26: Location of the Dutch pilot site

The services were piloted along the Dutch part of the Rhine-Alpine corridor, formed by the Dutch motorways A67, A2, A58, A16 and A15 as well as along the A2 in the area of the city of Utrecht.

## Final status

In 2016 first activities on the road started, regarding RWW (trailer based portable solution) and PVD with ITS-G5 communication. In March 2017 this was followed by first trials with RWW and IVS (fixed roadside units) on motorway A16 south of Rotterdam. Later on, PKI has been added as well as the hybrid approach (including cellular communication). Taking into account the experience from the first activities, the A16 test site was extended, in order to be able to organise the first interoperability TESTFEST on services, using ITS-G5 communication (RWW, IVS and PVD) in July 2017. Experiences from the subsequent TESTFESTs led to further adaptations of the A16 test-site.

In addition to the Rijkswaterstaat test vehicle - which was available for data collection since the start of InterCor - 14 vehicles have been equipped with ITS G5 and cellular communication for pilot operation: 10 vehicles of Rijkswaterstaat especially allocated for InterCor, 2 vehicles of traffic officers and 2 vehicles of subcontractors. They all have been in use for data collection on RWW, IVS and PVD during naturalistic driving. The 10 vehicles of Rijkswaterstaat have been used also for the controlled drives during roadworks on the A16. These drives were on 9 selected evenings: April 5, 8 and 9 (50 test drivers - one of the 4 tubes of the Drechtunnel closed for roadworks), May 10, 11 and 12 (60 test drivers – roadworks on the Van Brienoord bridge) and July 16, 17 and 18 (30 test drivers). For the controlled drives, Rijkswaterstaat has asked a specialised company to supply a representative group of test drivers. Drivers for the naturalistic driving have been found within Rijkswaterstaat; 10 employees - not involved in InterCor in any way - were willing to drive the 10 equipped test vehicles as part of their regular commuting during several months.

Data from the PVD service have been collected during all naturalistic and controlled driving in the InterCor pilot. For this service, Rijkswaterstaat has commissioned TNO to organize a dedicated workshop with representatives from road authorities, service providers and the automotive sector. This workshop focused on the value of the data from the PVD service, its impact on the respective organisations, the challenges and solutions. The outcome of the discussions has been reported in InterCor deliverable M13 on evaluation.

The Dutch InterCor GLOSA pilot site is located in the city of Helmond. It was operational in a first phase from the beginning of 2018. During this phase the site has been extended to 29 intersections. The second phase in 2019 focused on GLOSA, as a hybrid service (ITS-G5 and cellular). Early 2019 the Province of Noord Brabant and the city of Helmond deployed intersection controllers, according to the hybrid InterCor profile of the standards, enabling the start of the second phase of pilot operation. These traffic controllers continuously provide messages on their status. A number of service providers, who are already operational in the Netherlands, are able to process the cellular messages and provide the information on GLOSA to be displayed on a smartphone in-car. The GLOSA service in Helmond will stay active (and

probably also further updated, if necessary), also after the end of the InterCor action (see chapter Antwerp – Helmond Pilot Site).

To carry out the GLOSA pilot, the Province of Noord Brabant has acquired users of this service through its existing relation with a number of transport companies in ongoing projects. The operations started in 2018 (phase 1) with about 50 vehicles using priority and GLOSA services. In 2019 (phase 2) the work has been continued with 20 test drivers. In 2019 there were 10 users driving for a period of two months. In May 2019, 10 instructed users tested the GLOSA service during a special test day. In addition to the user questionnaires that were completed, several of the 10 test-drivers drafted a log, in this way further facilitating the evaluation analysis.

In 2020 Rijkswaterstaat kept the testsites in full operational order. Due to COVID-19 the actual testing was very limited.

## 15. The Norwegian Pilot site

The Norwegian pilot is part of the NordicWay 3 project (2019-2023) pilots running in the Nordic countries Denmark, Finland, Norway and Sweden. The main objectives of the NordicWay actions are to deploy pilot studies in order to further develop interoperable Day-1 and Day-1.5 C-ITS services and support infrastructure readiness for connected and automated driving in Denmark, Finland, Norway and Sweden.

NordicWay 3 project (2019-2023):

- Demonstrates as a large-scale pilot the feasibility of Day 1 and Day 1.5 services using hybrid communication solutions, which are fully based on European and global standards. NordicWay3 will deploy coordinated pilots on Cooperative, Connected and Automated Mobility in urban areas, interfaces between urban and interurban areas and motorway sections.
- Contribute to the harmonisation and interoperability of the C-ITS services in Europe by ensuring that the architecture, systems and services that are put in place are interoperable, in line with European developments and developed in close cooperation with industrial partners
- Supports the development and implementation of C-ITS services, adapted to the conditions, urban and interurban environments in the Nordic countries.
- Further elaborates and expands the business models and eco-systems required for large scale implementation of services as well as sharing of the required data.

The results of NordicWay 3, as well as of the previous NordicWay projects, can be viewed in the [www.nordicway.net](http://www.nordicway.net) webpage. NordicWay 3 continues to harmonise and build European C-Roads specifications for hybrid communication. The NordicWay 3 project aims to close gaps regarding C-ITS messages and security in new pilots taking place between 2022 and 2023. The goal is to take part and verify cross border tests with other pilots in European countries who have implemented the C-Roads hybrid communication specification.

### Norwegian national pilots

Norway has set up an interchange node, operated by Bouvet, which aims to be compliant with the II (Improved Interface) and BI (Basic Interface) protocols, which are specified in C-Roads WG2 TF4. The following use cases are piloted in NordicWay3:

#### C-ITS Day-1 services:

- Connected Traffic Signals including:
  - Traffic signal priority request by designated vehicles (TSP)
  - Green Light Optimal Speed Advisory (GLOSA)
  - Signal Phase and Timing Information (SI-SPTI)
- Roads works warning.

### C-ITS Day-1.5 services:

- Road pricing (not yet specified in C-Roads)

## Involved partners

The Norwegian Public Road Administration and the following public and private organisations:

- Combitech
- Aventi
- Bouvet
- Q-Free
- Vianova
- SINTEF
- City of Oslo
- Audi
- BMW
- Volvo Car Corporation
- Polestar
- FourC
- COWI

## Location

Norway has the following pilot sites:

- Trondheim (RWW-RC, RWW-RM, SI-SPTI, SI-GLOSA)
- Oslo (RWW-RC, SI-TLP)

## Overview of progress by End of 2022

In the S-SPTI pilot, 75 intersections in Trondheim transmit real time data. Traffic Technology Services, TTS, are producing the SPAT/MAP data. The SPAT/MAP messages are signed and standardised in accordance with C-Roads. The information sent out to the Android Auto application is to be received by cars (Audi, Bentley, Porsche, Volvo, and Polestar).

The purpose of the Norwegian RWW pilot is to improve data quality as well as sending and receiving data through an Interchange Node. Norwegian pilot actors: the Norwegian Public Roads Administration (NPRA), BM Systems, Mesta, Aventi, QFree, Teskalabs, FourC and Bouvet. Mesta is the entrepreneur/ road contractor that delivers data to BM systems back-office system that receives the data, produces an ETSI message (excl. signing) and sends it to the central C-ITS station operated by Aventi. Aventi adds signing on behalf of the NPRA and sends the signed message to the Bouvet Interchange Node. The Interchange publishes the RWW message for distribution to vehicles through the FourC Android Auto application. The messages are consumed by the NPRA Polestar fleet.

## Installed RSUs based on funding by CINEA

No RSUs have been installed so far, and none are planned for installation in the upcoming years.

## 16. The Portuguese Pilot site

### C-Roads Phase 1 (2017-2021)

C-Roads Portugal consists in the deployment of 5 C-ITS testbed Macro Pilot cases in the Atlantic Corridor in Portugal, covering relevant sections of the core network and comprehensive network and of its two urban nodes.

Combined with the testbed pilot cases, the project will also develop a study aiming for the National large-scale deployment of C-ITS services, notably Day-1 services and, selected, Day-1,5.

### Involved Partners

The C-Roads PORTUGAL involves 31 Partners from the public and private sector:

- Instituto da Mobilidade e dos Transportes, I.P.;
- Infraestruturas de Portugal, I.P.
- IP Telecom, S.A.;
- Câmara Municipal de Lisboa;
- Câmara Municipal do Porto;
- STCP - Sociedade de Transportes Coletivos do Porto, S.A.;
- EMEL - Empresa Publica Municipal de Estacionamento de Lisboa, E.E.M.;
- FEUP - Faculdade de Engenharia da Universidade do Porto;
- Brisa Concessão Rodoviária, S.A.;
- Ascendi Beiras Litoral e Alta, Auto Estradas das Beiras Litoral e Alta, S.A.;
- Autoestradas Norte Litoral – Soc. Concessionaria - AENL, S.A.;
- Autoestrada do Algarve - Via do Infante – Soc. Concessionaria - AAVI, S.A.;
- CaetanoBUS - Fabricação Carroçarias, S.A.;
- Brisa Inovação e Tecnologia, S.A.;
- GMVIS Skysoft, S.A.;
- ARMIS, Sistemas de Informação, Lda.;
- Siemens Mobility Unipessoal Lda.;
- Vialivre, S.A.;
- DMS Displays & Mobility Solutions Lda.;
- Scutvias - Autoestradas da Beira Interior, S.A.;

- Lusoponte - Concessionaria para a Travessia do Tejo, S.A.;
- Brisal - Autoestradas do Litoral, S.A.;
- AEDL - Autoestradas do Douro Litoral, S.A.;
- AEA - Autoestradas do Atlântico- Concessões Rodoviárias de Portugal, S.A.;
- Ascendi Grande Lisboa - Autoestradas da Grande Lisboa, S.A.;
- Ascendi do Grande Porto - Autoestradas do Grande Porto, S.A.;
- Ascendi Norte - Autoestradas do Norte, S.A.;
- Ascendi Costa de Prata - Autoestradas da Costa de Prata. S.A.;
- Norscut Concessionaria de Autoestradas, S.A.;
- TIS.PT, consultores em Transportes, Inovação e Sistemas. S.A.;
- Via Verde Serviços, S.A.;

## Location

Region(s) (using the NUTS2 nomenclature): Alentejo (PT18), Algarve (PT15), Centro (PT) (PT16), Lisboa (PT17), Norte (PT1 1)

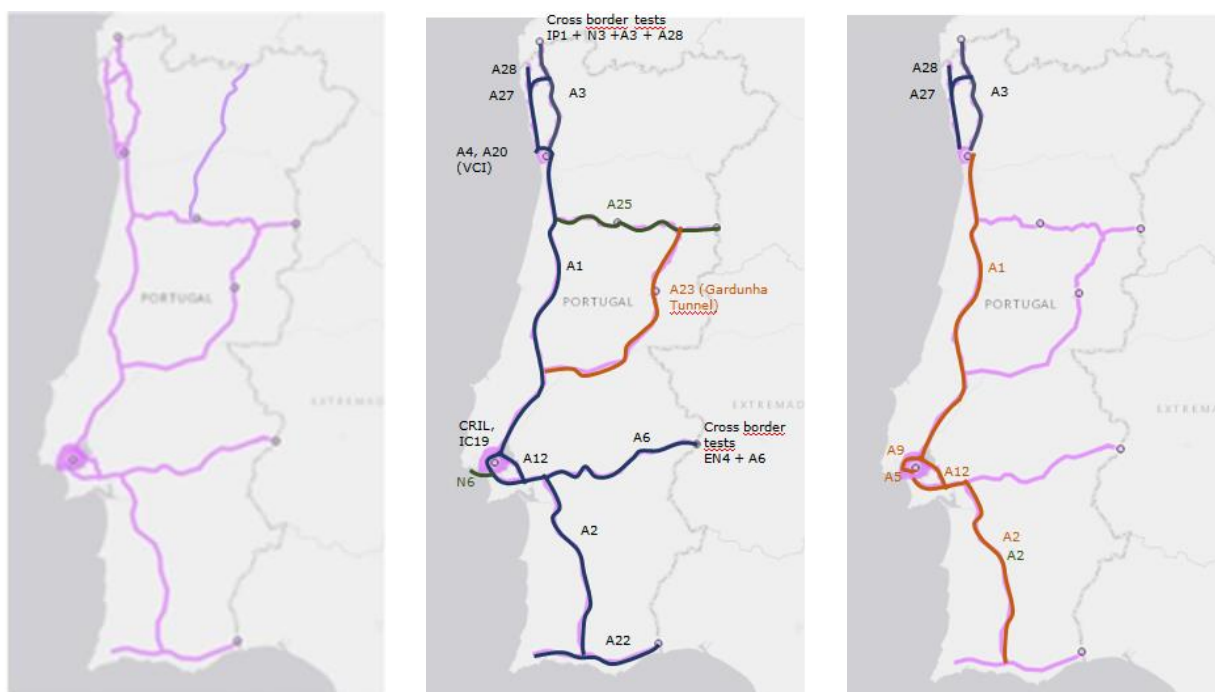


Figure 27: Location of the Portuguese pilot site 1 - 3

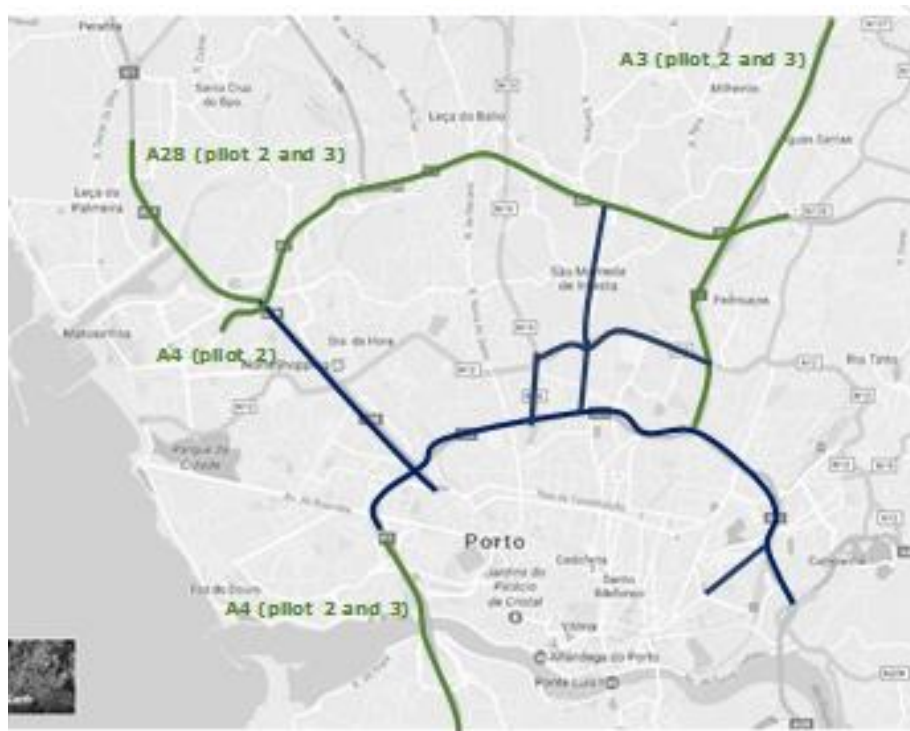


Figure 28: Location of the Portuguese pilot site 4-5



## Final status

The five planned pilots have been successfully deployed.

The integrated security framework is available for all C-ITS projects and deployments in Portugal. Furthermore, this pilot is being continued in a 2.0 version within the Action Cooperative Streets, with the goal of expanding the security services available for C-ITS deployment, namely in urban environment.

The project Parking Availability System had as a main goal the implementation of a monitoring solution to collect and load parking spaces between downtown Lisbon and Campo Grande, but due to a strategic decision of the city, the focus became one of the main existing problems: management of loading and unloading operations and misuse of these parking spaces. However, due to severe constraints in the technical and administrative definition of the international public tender that needed to be put forward, the project could not be implemented, as it was not even possible to award the tender.

The Action's Evaluation was completed delayed. The project coordination believes that the Action had a proper dissemination and C-Roads Portugal benefits from the existence of the Cooperative Streets (Action 2018-PT-TM-0099-S), that allows for the continued dissemination of this Action's results and achievements.

## C-Roads Phase 2 – Cooperative Streets

Cooperative Streets is a study with pilots, aimed to test C-ITS services in several urban areas along / feeding TEN-T transport network that will complement the scope of previous C-ITS projects (namely C-Roads), conducting rigorous, transparent, and replicable testing while addressing long term viability, cost-efficiency, governance models, business cases and overall impacts and benefits before moving towards large scale deployment to most urban areas, municipalities and cities in general, addressing multimodality and the urban expansion of C-Roads Portugal.

While current pilots in EU have predominantly been tested on private passenger cars, 'Cooperative Streets' aims to develop projects and pilots aiming to include a larger amount of vehicles and a wider range of vehicle types, including public transport (bus, tram), emergency vehicles, freight and vulnerable road users (pedestrians, cyclists, motorcyclists, etc.). With the large number of pilot activities under the current Action, together with the overall ambition to lead the working group in C-Roads platform, the establishment of a horizontal layer is essential for the success of pilots and its progressive roll-out. This refers to the harmonisation of technical, organisational and functional requirements for data models to the European Commission, the European Member States, Stakeholders and Standardisation Bodies, providing a common ground for future interoperable, seamless C-ITS services in Europe.

Harmonisation includes, amongst other, the following critical aspects:

- Ensure harmonization of the information communication with the NAP, according to the European standards and profiles

- Understand specific information and communication requirements for each pilot
- Identification of extension proposals to the relevant standards based on the data model to be defined in the project
- Catalogue of mobility services profiles
- Technical and functional Day 2 specifications

Cooperative Streets includes 5 macro pilot cases as facilitators and test bed, listed below:

### **Pilot "Extended Multimodal National Access Point (NAP)"**

The NAP has been developed for a road usage perspective, not fully adaptable to a multimodal and interoperable perspective. This pilot activity targets to pilot an extension of the current NAP designed mainly from a road transport operation to answer the challenges of MMTIS.

The pilot plans to establish the following: The extension of the current NAP Roadway to a NAP platform where there will be two vertical components, Road and Urban (MMTIS Delegated Act), in which, in the scope of this application, the Urban Component will provide a simple, seamless access to the "Endpoints" of each pilot. Each pilot will provide access to their services and information in the correct protocols

Each Cooperative Streets pilot will have to implement the established NAP protocols and send information or make the links available in the various protocols. There will be a major effort to harmonize and monitor the various pilots to ensure that the various implementations of the various protocols follow good practices, ensuring at this stage and in the future, there is genuine data exchange and interoperability between the various entities. A transversal monitoring team will be established for all pilots to guarantee this task. By having such a global scope of different drivers and such a wide universe of information, associated with the Delegated Act A in the Urban domain, through this transversal activity it will be possible to identify specific needs, extensions required, profiles of each service and information contributions or inputs to the various European study groups.

It will be possible, in the future, to evolve the current solution and gradually integrate the information according to a wider strategy of aggregating the information in NAP itself. However, for the pilot deployment a lighter solution with end points has been identified as a better short-term solution strategy.

NAP Pilot deployment will contribute to reach the following objectives and outputs: harmonized information communication with the National Access Point, according to the European standards and profiles create the knowledge basis for a large-scale, operational roll-out, exchanging the good practices and lessons learned.

### **Pilot "From C-Roads to Cooperative Streets"**

This pilot sets the links between C-Road's deployment pilots and the Cooperative Streets project. Therefore, the integration of connected and autonomous vehicles on the road infrastructure within the framework of Cooperative Streets is taken one step further.

It is also taken into the connections with urban nodes and sets the interaction of C-ITS various Day-1 and Day-1.5 services between non-urban and urban environments.

Main objectives:

- Test the deployment of Day-1 and Day-1.5 cooperative ITS services
- Development of back office services to process data and segment drivers and behaviours
- Develop a set of services to disseminate in-route warnings and strategic information for selected drivers
- Contribute to interoperability of cooperative ITS in the EU
- Transition C-Roads to Urban context

### **Pilot "Cooperative Streets"**

Implementation and testing of platform for multi-mode, variable architecture, shared services – carsharing, bike-sharing, moto-sharing, scooter-sharing – addressed at individuals and organizations, based on predictive algorithms for overall and service specific supply-demand optimization. Coordination with public transit and park & ride data and service operations for first mile / last mile. The solution shall build on real-time data (including “Day-1” and “Day-1.5” C-ITS data), connectivity and integration of users, operators, vehicles, infrastructure, and devices, anticipating the evolution of current shared services and namely the incremental introduction of automated solutions. The pilot will result in studying the impact of setting and testing a platform for integrated shared mobility, based on machine learning predictive algorithms on user adoption of shared mobility services and overall mobility efficiency in the pilot area of Lisboa.

Implementation of flexible on-demand solutions in the pilot area, both by building on existing operators’ services (e.g.: use of dynamic vehicle routes in low-demand periods for on-demand transport in low-density areas) and by introducing new services addressed at specific demand (e.g.: school bus, hospital, and public services, etc.). The solution aims at redefining a new approach at flexible and on-demand services based on service (and operator) integration and coordination and shall build on real-time data (including “Day-1” and “Day-1.5” C-ITS data), connectivity and integration of users, operators, vehicles, infrastructure and devices, and predictive algorithms, looking ahead at emerging automated or semi-automated services. The pilot will result on studying the impact of setting and testing a platform for flexible on-demand mobility services applied to specific segments on overall mobility efficiency on the pilot location, user adoption and introduction of new services – namely those building on C-ITS data - in the urban area of Lisboa.

1. Public Transport - This pilot includes the development of several new functions and solutions for public transportation in the main Portuguese urban areas. The ultimate goal is to accelerate the introduction of existing and future connected and automated mobility services and enable city managers, MaaS providers and service operators to offer a true seamless mobility experience for users (with continuous and ubiquitous access to real-time data through mobile, in-vehicle or infrastructure-based interfaces), universal access to services and selection of payment choices.

#### Main objectives:

- Real-time information for passengers on bus occupancy levels, estimating fraud for real-time allocation of inspections, adapting operations in real-time to address demand peaks and/or to react to network disturbances or disruptions.
- Implementation of public transport priority systems and real-time information, improving public transport operation, making rides more reliable for passengers and more attractive for new users.
- Studying the impact of setting and testing a ubiquitous digital ticketing solution that supports full flexibility and complexity of MaaS packages (addressed at different profiles of individuals and corporations), over a fully digital experience, and builds on the ability to anticipate C-ITS based services in the urban area of Cascais.

Urban Traffic Management - Cities rely on multiple sources of data and need to perform a merge / fusion in order to obtain the best / more reliable single outcome dataset. This outcome shall be shared with other services (internal or public) and serve for real time journey planners as well as forecasting algorithms. This pilot overlooks at best practices regarding traffic management and operation, with the goal of achieving safe and efficient flows in the infrastructure, namely in road intersections, with highly reliable real-time data as well as with a dedicated predictive model that can estimate with high accuracy black spot's locations and congestions.

2. Parking - The main goal of this pilot will be the development of new parking functions beyond the existing parking payment apps to provide information about the availability of on-street parking spaces in Lisbon, based in integration all data available to help citizens and users to reduce the time they spend in searching for parking. Furthermore, the pilot will include the implementation of an information platform for mobility services with the capacity to provide information not only to the National Access Point but also to the general public.

The platform should be able to integrate information from parking allowing the municipality to manage contracts related with mobility services such as parking. It involves the definition and monitoring of performance indicators, of the information received from parking operators and the evaluation of compliance with contracts, as well as availability of the information to the National Access Point according to the defined protocol (DATEX II).

3. MaaS - Implementation of ICT platform (including backend, web services, user mobile interfaces and vehicle and infrastructure integration gateway) for integration of cooperative connected and automated mobility in Mobility as a Service (MaaS) dynamic environments, building on live data gathering and live integration and interaction between vehicles, infrastructure, users, and services in complex urban environments.

The platform aims at integrating public transportation with parking, EV charging or shared transportation modes, supporting quick integration of new mobility services and devices (e.g.: vehicles, traffic, parking or EV charging infrastructure and sensors), static (e.g.: sensors) and dynamic traffic sources (e.g.: users and vehicles) following a “plug&play approach” and

maximizing the value of real-time data, providing users and service operators with “Day-1” and “Day-1.5” services and supporting city level monitoring, management and regulation.

The platform shall support MaaS business and service models in different urban environments, thus ensuring inter-city data and service roaming, in coordination with the Portuguese NAP.

The pilot will consist of studying the impact for users, operators and the city of setting and validating the ICT platform based on a real-life implementation and testing of a MaaS environment in several urban areas.

### **Pilot "MMTIS"**

MMTIS solution with the inclusion of real-time dynamic information, enabling public transport users to make more sustainable travel options according to their preferences (duration, number of transshipments, CO<sub>2</sub> emission ...).

This pilot will ensure the implementation of multi-modal travel information services on the TEN-T network

1. Automatic acquisition of dynamic data (stops, lines, schedules) formatting for SIRI and making available to NAP the following information in real time:
  - a. Lisbon Urban Region - road races (10) + Rail: the Lisbon metro lines + the CP lines, with stations within this urban region + ferry: the Transtejo / Soflusa + Aereiro routes: airlines departing and arriving at LX (desirably)
  - b. Regional / (inter - urban Lisbon Porto) - 10 regional road and rail routes
  - c. Urban Region of Porto: 10 roads and 2 lines of Metro do Porto
2. A multimodal, real-time, door-to-door journey planner involving the careers of previous lines

This pilot, given the conformity of the information that it makes available with the applicable European standards, will allow the exchange at different European level of different types of data between passenger information systems, including data describing stops, schedules, tariffs and also desirably of occurrences with impact on the operation of the careers and lines involved. These data can be used by both management support systems and systems for user travel planning, etc.

Also, this pilot included the implementation of an information platform for mobility services with the capacity to provide information not only to the National Access Point but also to the general public for multimodal travel, according to the European data exchange standard protocols.

The platform should be able to integrate information from the following services:

- Parking Information.
- Traffic Data.
- On demand transport.

The implementation will include the ability to publish transport information in E-papers, PIPs and muppies placed in the stops of the pilot area. The information to publish will come from the NAP.

In order to digitalize traffic information some traffic sensors will also be put in place in the pilot area. In a limited zone some parking detectors will be installed to digitalize availability information, not only to send this information to the NAP, but also to place it in an information panel.

### **Pilot "Urban testbed - Zone to free test technology"**

These "Free Technology Zones" (FTZ) aim at creating technical frameworks for testing and validation in real-life environment of vehicle side solutions, V2V vehicular meshes/networks, V2I connectivity and V2G integration applied to existing and new mobility solutions and services.

These shall include deployment of a selected array of sensing and connectivity solutions and protocols and the setup of adequate ICT systems, user and operator interfaces and infrastructure in the municipalities of Frente Atlântica – configuring different use cases: smart urban logistics, automated on-demand passenger mobility and smart charging of automated fleets.

Pilot tests of fully connected vehicles, infrastructure and users shall build / build on a comprehensive data base of "Day-1" and "Day-1.5" C-ITS services. The Frente Atlântica (Matosinhos-Porto-Gaia) FTZ aims at setting two different yet complementary grounds for rolling out and validating such technologies and services, addressing full interoperability of mobility ecosystems, and supporting the design of regulation and other relevant policies for testing and adoption of automated mobility solutions and services.

This project has the objective of promoting Portugal as a technological centre of excellence, attractive for the experimentation of innovative technological projects, in particular, in the core areas of the future: autonomous driving, connected vehicles, Remotely Operated Vehicles (ROVs), Unmanned Aerial Vehicles (UAV's, or drones), etc.

## **Involved partners**

The Cooperative Streets involves 32 partners from the public and private sector:

- Área Metropolitana do Porto
- Associação Porto Digital
- A-to-Be, S.A.
- BGI - Brisa Gestão de Infraestruturas
- Brisa Concessão Rodoviária, SA (BCR)
- Câmara Municipal de Cascais
- Câmara Municipal de Gondomar
- Câmara Municipal de Lisboa
- Câmara Municipal de Loulé
- Câmara Municipal de Matosinhos
- Câmara Municipal de Santo Tirso
- Câmara Municipal de Valongo
- Câmara Municipal de Vila Nova de Gaia
- GMVIS Skysoft, S.A..
- Infraestruturas de Portugal, I.P.
- Instituto da Mobilidade e dos Transportes, I.P. (IMT, I.P.)
- IP Telecom. Serviços de Telecomunicações, S.A.
- ISEL - Instituto Superior de Engenharia de Lisboa
- Município da Trofa
- Município de Lousada
- Quadrilátero - Associação de Municípios de Fins Específicos Quadrilátero Urbano

- Câmara Municipal de Viseu
- Câmara Municipal do Porto
- CEiiA - Centro de Engenharia e Desenvolvimento
- Companhia Carris de Ferro de Lisboa, E.M., S.A.
- EMEL – Empresa Pública Municipal de Estacionamento de Lisboa, E.E.M.
- TISpt – Consultores em Transportes, Inovação e Sistemas, S.A.
- TML – Transportes Metropolitanos de Lisboa
- Via Verde Portugal (VVP)
- Via Verde Serviços (VVS)
- Yunnex Traffic, Lda

## Location

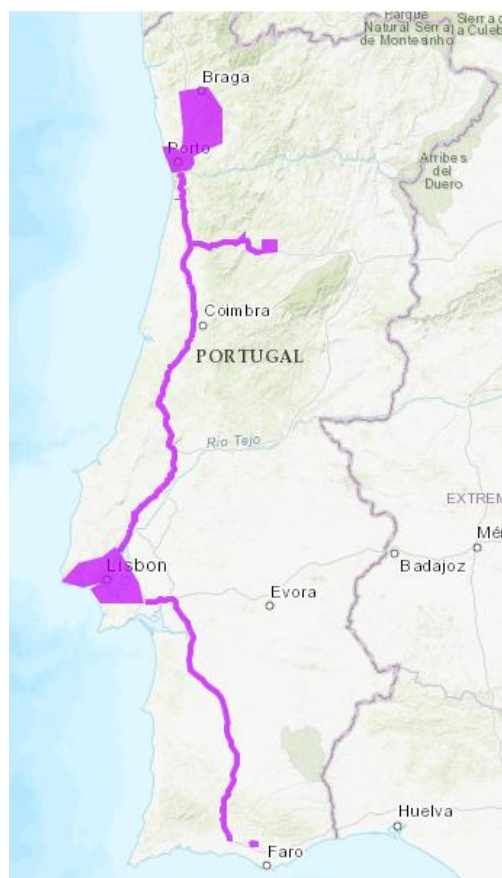


Figure 29: Pilots in Portugal

## Overview of progress by End of 2022

By the end of 2022, part of the deployments planned for that year was delayed, although significant recoveries were possible, reabsorbing some of the delays that happened due to the pandemic situation.

Still, during this period, given the complexity of the Action, the difficulty of integrating new concepts, European guidelines, and other legislation applicable to the Action, it was necessary to involve the teams of the different Implementing Bodies allocated to the Action researching on solutions to be implemented, as well as the preparation of procurement procedures. In 2022, many tenders and procurement procedures were finally launched, and the deployment of many projects allowed a recovery to some extent.

In 2022, IMT prioritized the contact with the multimodal data owners to reinforce the data uploads to the NAP, in its multimodal data register. The NAP is available at <https://nap-portugal.imt-ip.pt/nap/multimodalsupply>. IMT started by publishing on NAP, metadata uploaded by several stakeholders that participate in European projects related to the ITS Directive implementation.

In C-Streets, most of the IB's are developing their projects and still preparing multimodal datasets to be published on NAP. In 2022 IMT had several meetings, mainly with Public Transport Authorities, to train the NAP users, focusing mainly on the data covered and the appropriate standards to use. In September, the second MMTIS workshop was held, with the participation of the implementing bodies that will provide data to the Multimodal NAP. Porto municipality published already some datasets, concerning for instance the cycle network and taxis stops.

C-ITS services in several urban areas in Portugal are being tested, namely in the fields of MaaS platform, shared mobility, parking management, traffic management and on-demand transport, among others. In 2022 the Action included a new IB, responsible for the implementation of a C-ITS security framework.

During 2022, CEiiA finished the elaboration of the official regulation of the ZLT that was approved by the National Innovation Agency, the organization responsible for the management of the network of ZLT in Portugal. To achieve this objective, several meetings were organized between CEiiA and the national regulators in charge of mobility, energy, and communications (IMT, AMT, ANACOM, ANSR, ERSE, APA).

Project Management, Harmonization and Communication tasks were implemented throughout 2022, including writing and collecting delayed documents and procedures. All the Milestones' reports are now up to date.

Also, during Q4 of 2022, a Grant Agreement amendment request was put forward. This request includes five items, namely an extension request, the change of the formal Beneficiary, the exclusion of an Implementing Body and the inclusion of a new Implementing Body. There are no changes in the Total Eligible Costs (overall and for the planned Activities) and the request has no influence in the scope of the Action.

## Installed RSUs based on funding by CINEA

All together 33 RSUs have been installed so far, and 88 are planned for installation in the upcoming years.



## 17. The Slovenian Pilot site

The objective of the pilot is to improve real time traffic information on the pilot section and to test communication solutions for C-ITS Day 1.0 services related to motorways.

The goal of the activity is to equip critical road sections with C-ITS roadside systems with the integration in Traffic Management Centres to provide real time services for the higher level of traffic control and management that would correlate with better real time traffic information and in the preparation for the future full scale hybrid C-ITS services.

The objective of the projects also includes testing the hybrid solution, in particular, C-ITS infrastructure and 3G/4G/LTE cellular connected vehicle, that interacts with the cloud information services to deliver the C-ITS services. An upgrade of existing mobile application with location and driving direction awareness is envisaged to deliver real time traffic information and test “Infrastructure to vehicle” (I2V) and “Vehicle to infrastructure” (V2I) communication.

In order to test the C-ITS services with different solutions, the C-ITS infrastructure needs to be upgraded on the network as well as data integrated into the regional traffic management centre. The development of the software which will serve as messages exchange point for the C-ITS real time traffic information is taken over by the National Traffic Management Centre (Ministry of infrastructure).

The objective of the second phase is the extension of roadside C-ITS infrastructure on selected locations of motorway network. Roadside ITS-G5 stations will also be installed at motorway cross-border areas to ensure coexistence of C-ITS system with RTTT DSRC tolling system. Furthermore, the continued development of hybrid C-ITS solution is envisaged.

### Involved partners

- Ministry of Infrastructure
- DARS d.d. (Motorway Company of the Republic of Slovenia)

### Location

The ITS-G5 implementation of C-Roads Slovenia Pilot currently covers 34 km of TEN-T core network (Baltic-Adriatic and Mediterranean Corridor) in Slovenia and is located on the A1 motorway (section Ljubljana – Koper) between Postojna and Divača and on the H4 motorway between Razdrto and Podnanos. In the second phase it will be extended to the other motorways/sections as shown on the figure below. Cellular connected car and Cloud information services are available on all motorways and public roads in Slovenia by using the mobile application Promet+.

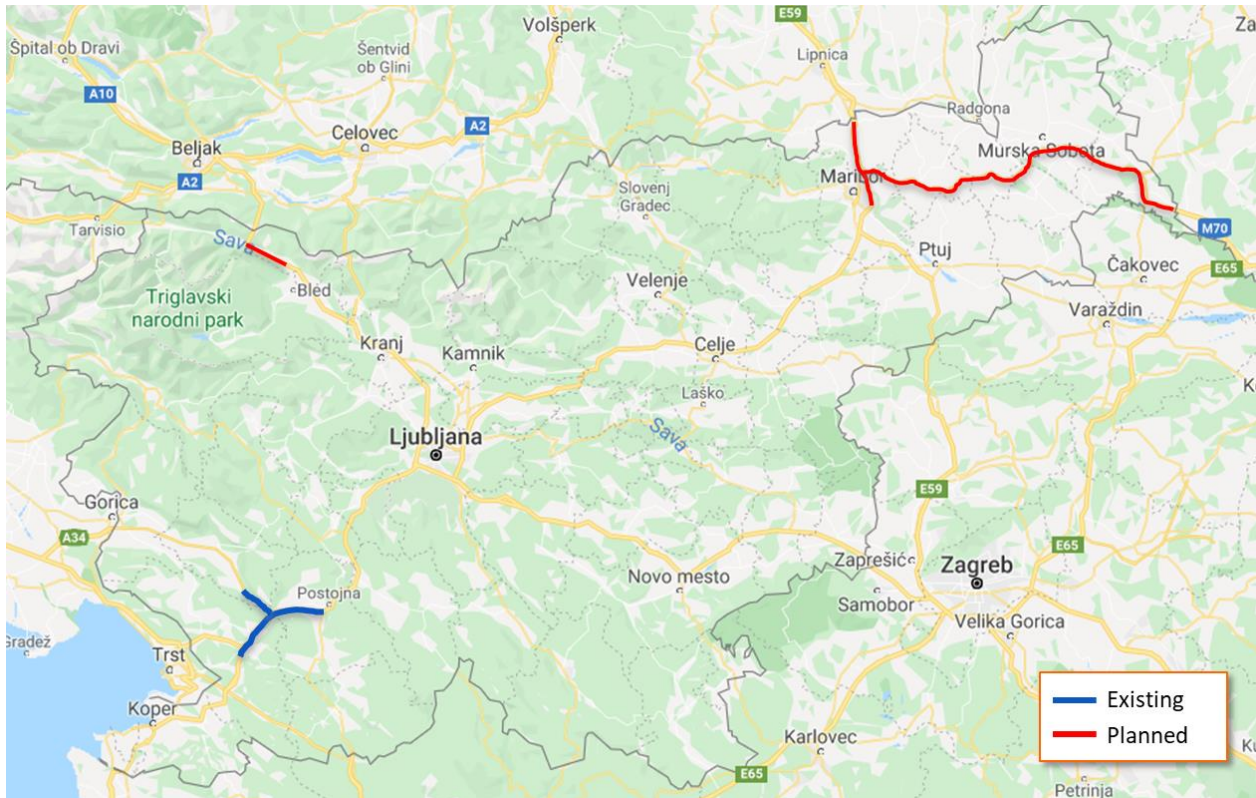


Figure 30: Coverage of ITS-G5 implementation



Figure 31: Coverage of mobile application Promet+ services

## Overview of progress by End of 2022

ITS-G5 infrastructure was deployed including relevant C-ITS Day 1 services on motorways within a limited area of the first pilot phase (A1 motorway section Postojna - Divača, length 24 km with 10 ITS-G5 roadside stations). In parallel, the ITS infrastructure was upgraded by installation of variable message signs with dynamic signalisation, road weather stations and video detection stations with thermic capabilities. Deployed and connected ITS systems were permanently integrated into the regional traffic control centre in Kozina where the systems for traffic control and management were upgraded as well.

3G/4G/LTE Cellular Connected Vehicle with the Cloud Information Services were deployed on the whole motorway network. A mobile application with location awareness was deployed which delivers real time traffic information to all application users and in the same time provides traffic related information gathered from mobile devices. The application was successfully tested and evaluated.

At the end of the first phase, the cross-border interoperability testing of C-ITS services was successfully performed virtually with different C-Roads member states. National assessment plan was drafted and harmonised with the C-Roads Platform assessment and evaluation plans and findings. A final C-Roads Pilot Slovenia evaluation report was delivered and integrated in C-Roads platform Evaluation and Assessment Final Report.

Second phase (C-Roads Slovenia 2) aims to provide a more comprehensive pilot area including new critical motorway sections (e.g. tunnels). The pilot implementation of automatic transfer of traffic events from tunnel control systems into Information cloud and C-ITS system was successfully implemented in Traffic control centre Kozina and supported by installation of 2 additional ITS-G5 roadside units. An extension of the project to the other regional Traffic control centres has been in progress.

Implementation of C-ITS services using 3G/4G/LTE cellular networks and hybrid solutions has been in progress in 2020 and concluded in 2021. Within this Action DARS (Motorway Company in the Republic of Slovenia) has developed solutions that enable information flow using cellular network with connected cars on the basis of local awareness and cloud solutions. The existing mobile app Promet+ has been upgraded to function as On-Board Unit (OBU) that is able to communicate with infrastructure in both directions (receiving and sending information). The system was designed to perform as a hybrid. For this purpose, the interchange node named C-ITS Middleware was created. Transformation of the main traffic information system Kažipot to C-ITS system has been carried out. In this context, the project of further upgrades of the C-ITS Middleware and development of C-ITS IP Basic Interface has been carried out according to the final specifications adopted on the common C-Roads project platform. Using this harmonized interface, in 2022 Slovenia joined the C-Roads hybrid cross-testing group to test cross-border exchange of C-ITS messages via IP protocol.

In 2022, a second wave of cross-border testing sessions with different C-Roads member states has been carried out by physical drives which confirmed cross-border interoperability of implemented C-ITS services.

## Installed RSUs based on funding by CINEA

All together 12 RSUs have been installed so far, and 50 are planned for installation in the upcoming years.

## 18. The Spanish pilot site

The pilot report is meant to summarize the activities carried out within the pilot sites in C-Roads Spain, an action that ended in June 2021, as well as the services and technologies implemented. C-Roads consists of different C-Roads pilots operated in different national environments, being Spain one of their pilot sites' locations.

The Spanish pilot comprises five different pilots, each of them with their unique set of technologies and C-ITS services, and with the involvement of different partners. This heterogeneity is meant to cover a wide spectrum of use cases, for the sake of assessing the impact of connected mobility in many representative scenarios. The set of pilots have been carefully chosen in order to verify interoperability at national and European level, as well as the added value of C-ITS services in different scenarios.

### Involved partners

A multidisciplinary group of partners is involved in the execution of tests:

- Public authorities:
  - Dirección General de Tráfico (DGT) – Ministry of Interior
  - Dirección General de Carreteras (DGC) – Ministerio de Fomento
  - Madrid Calle 30 S.A.
- Associations:
  - Foro de Nuevas Tecnologías en el Transporte (ITS España)
  - Asociación Clúster de Movilidad y Logística de Euskadi (MLC ITS EUSKADI)
  - SEOPAN, Asociación de empresas constructoras y concesionarias de infraestructuras
- Private companies:
  - Transport Simulation Systems S.L. (TSS)
  - Equipos de Señalización y Control (ESYCSA)
  - Indra Sistemas S.A. (Indra)
  - Grupo Mecánica del Vuelo Sistemas S.A.U. (GMV Sistemas)
  - Opus Remote Sensing Europe (OPUS RSE)
  - Gertek Sociedad de Gestiones y Servicios S.A. (Gertek)
  - ICEACSA Consultores, S.L.U.
  - Ingartek Consulting, S.L.
  - Abertis Autopistas España S.A.
  - Automóvil Club Asistencia S.A. (ACASA)
  - Ferrovial Corporación S.A.
  - Kapsch TrafficCom Transportation S.A.U.
- Universities:
  - Universidad Politécnica de Madrid (UPM)
  - Universitat Politècnica de Catalunya (UPC)
  - Universitat de Valencia – Estudi General (UVEG)

- Research Centres:
  - Centro Tecnológico de Automoción de Galicia (CTAG)
  - Asociación Centro Tecnológico Ceit-IK4
- Regional authorities:
  - Council of Vigo city
  - Diputación Foral de Bizkaia - Bizkaiko Foru Aldundia

## Location

The five Spanish pilots are the following:

- **DGT 3.0**, located along the overall road network in Spain with an extension of approximately 12,270 Km. It was deployed using cellular-based communication technologies (3G and 4G/LTE).
- **SISCOGA Extended**, comprehending the extension of an existing test site infrastructure located in the city of Vigo and its metropolitan area already prepared to test ITS-G5 communication technology. It spans 150 Km.
- **Madrid Calle 30**, located along the road "Calle 30" in Madrid, with approximately 32 km. C-ITS services were deployed using hybrid communication technologies.
- **Cantabrian pilot**, deployed along approximately 75 km at the north of Spain using hybrid communications.
- **Mediterranean pilot**, deployed along approximately 125 km at selected road sections located in Catalonia and Andalusia using hybrid technologies.

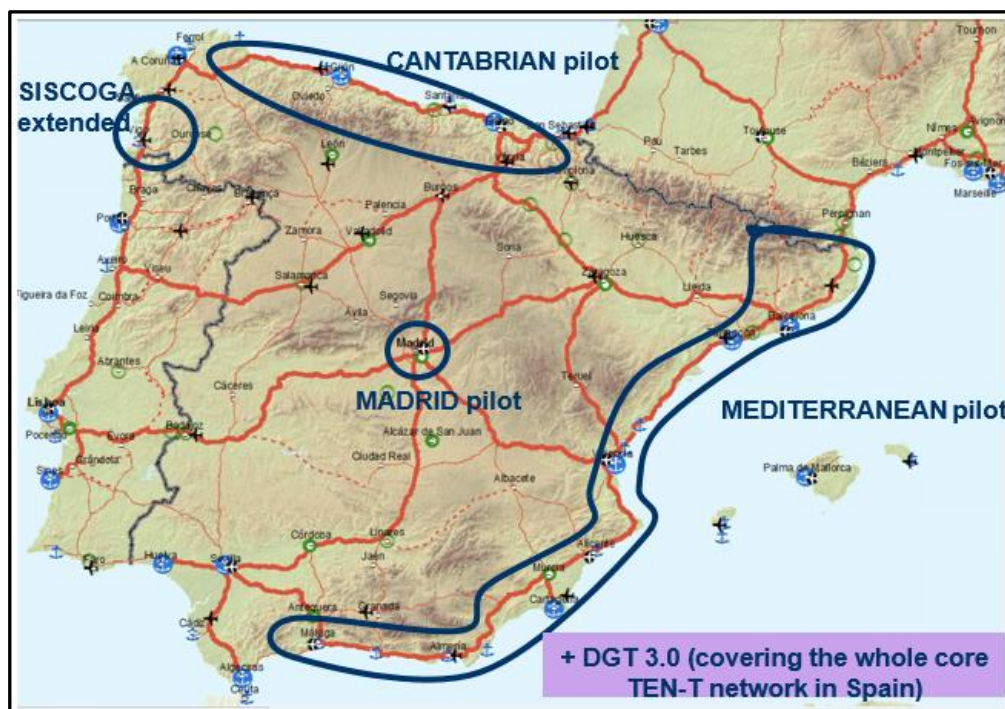


Figure 32: Location of the Spanish pilot site

## Final status by end of 2021

As part of the pilot, **DGT 3.0 platform** went into the public cloud allowing cellular communication between actors that are part of the traffic and mobility ecosystem in real time. A total of 15 use cases applications were defined of which 7 services reached the production phase covering a road extension of approximately 12,270 km.

**SISCOGA Extended Pilot** equipped a total of 80 vehicles with OBUs and an HMI Interface (C-Roads app), including buses, cabs, police and fire vehicles, plus private vehicles. A total of 151 RSUs were installed along 200 kms of the permanent ITS living lab, including urban and intercity environments to implement Cooperative Services validated with hybrid cellular- ITS-G5 communication, while securing PKI technologies during the first Cross Test with Portugal.

Also, CTAG's C-ITS Centre was used to operate and monitor all the deployed RSUs and connected vehicles, while aggregating data from different traffic platforms (including DGT 3.0). This centre also allowed to host the PKI Centre and the developed C-ITS services.

The **Madrid “calle 30”** pilot deployed 34 RSUs, 15 OBUs and the C-ITS Hub that allowed for the integration of multiple sources of information, both internal and external such as number of vehicles and average speed of traffic, traffic interruptions and conditions or weather information among others.

The **Cantabric Pilot** deployed 31 ITS G5 RSUs, 22 OBUs in fleet vehicles, 5 environmental sensors, 62 BT Wifi RSU, 2 mobile apps, and a C-ITS hub in a total of 158 Km composed by three road sections along the A8 – AP 8 corridor existing between Galicia, Asturias and Bizkaia sub-pilots.

The **Mediterranean pilot** of C-Roads Spain was composed of two road sections located in Catalonia near the city of Girona with 35 km of AP7 highway and Andalusia, covering 10 km of AP7 road section. This Pilot completed the deployment of 20 RSUs, 25 OBUs, a microwave traffic monitoring sensor, asphalt sensors and a C-ITS Control Center Application and a C-ITS Hub in each sub-pilot.

The table below summarises the Cooperative Services Implemented in each pilot.

| Pilot                | Services deployed   |
|----------------------|---|
| <b>SISCOGA</b>       | <ul style="list-style-type: none"> <li>• Stationary Vehicle</li> <li>• Road Work Warning</li> <li>• In Vehicle Signage applications (IVS)</li> <li>• Emergency Vehicle Priority</li> <li>• Emergency Vehicle Approaching</li> <li>• Traffic Jam Ahead</li> <li>• In-vehicle speed limits</li> <li>• Signal Phase and Timing information</li> <li>• Emergency Brake Light</li> <li>• Weather Conditions</li> <li>• Embedded VMS "Free Text"</li> <li>• Animal or person on the Road</li> <li>• Vehicle Data Collection</li> </ul>  |
| <b>MADRID</b>        | <ul style="list-style-type: none"> <li>• Roads Work Warning (RWW)</li> <li>• Hazardous Location Notification</li> <li>• In Vehicle Signage applications</li> <li>• Off-Street parking (Serrano Park)</li> <li>• Traffic Information &amp; Smart Routing</li> <li>• Hybrid Services (events received from MC30 and DGT3.0 platform)</li> </ul>   |
| <b>CANTABRIC</b>     | <ul style="list-style-type: none"> <li>• Slow or Stationary Vehicle (Bizkaia)</li> <li>• Traffic Jam Ahead (Asturias,Bizkaia,Galicia)</li> <li>• Road Work Warning (Bizkaia)</li> <li>• Weather Conditions (Bizkaia)</li> <li>• Probe Vehicle Data (Bizkaia)</li> <li>• Park &amp; Ride information (Asturias)</li> <li>• Traffic Information/ Smart Routing (Asturias)</li> <li>• Emergency Brake Alert (Galicia)</li> </ul>   |
| <b>MEDITERRANEAN</b> | <ul style="list-style-type: none"> <li>• Stationary vehicle (Catalonia, Andalusia)</li> <li>• Shockwave Damping (Catalonia)</li> <li>• Traffic Jam Ahead (Andalusia)</li> <li>• Road works warning (Catalonia, Andalusia)</li> <li>• Weather conditions (Catalonia, Andalusia)</li> <li>• Probe vehicle data (Catalonia)</li> <li>• In-vehicle signage (Catalonia, Andalusia)</li> <li>• In-vehicle speed limits (Catalonia)</li> <li>• Obstacle on the road (Andalusia)</li> <li>• Smart Slip Road (Andalusia)</li> <li>• Information on charging station (Catalonia)</li> </ul> |

**Table 3: Summary Cooperative Services implemented in each pilot**

## Installed RSUs based on funding by CINEA

All together 298 RSUs have been installed so far based on funding by CINEA.



## 19. The Swedish Pilot site

The Swedish pilot is part of the NordicWay 3 project (2019-2023) pilots running in the Nordic countries Denmark, Finland, Norway and Sweden. The main objectives of the NordicWay actions are to deploy pilot studies in order to further develop interoperable Day-1 and Day-1.5 C-ITS services and support infrastructure readiness for connected and automated driving in Denmark, Finland, Norway and Sweden.

NordicWay 3 project (2019-2023):

- Demonstrates as a large-scale pilot the feasibility of Day 1 and Day 1.5 services using hybrid communication solutions, which are fully based on European and global standards. NordicWay3 will deploy coordinated pilots on Cooperative, Connected and Automated Mobility in urban areas, interfaces between urban and interurban areas and motorway sections.
- Contribute to the harmonisation and interoperability of the C-ITS services in Europe by ensuring that the architecture, systems and services that are put in place are interoperable, in line with European developments and developed in close cooperation with industrial partners
- Supports the development and implementation of C-ITS services, adapted to the conditions, urban and interurban environments in the Nordic countries.
- Further elaborates and expands the business models and eco-systems required for large scale implementation of services as well as sharing of the required data.

The results of NordicWay 3, as well as of the previous NordicWay projects, can be viewed in the [www.nordicway.net](http://www.nordicway.net) webpage.

NordicWay 3 continues to harmonise and build European C-Roads specifications for hybrid communication. The NordicWay 3 project aims to close gaps regarding C-ITS messages and security in new pilots taking place between 2022 and 2023. The goal is to take part and verify cross border tests with other pilots in European countries who has implemented the C-Roads hybrid communication specification.

### Swedish national pilot

Sweden has set up an interchange node, operated by Monotch, which aims to be compliant with the II (Improved Interface) and BI (Basic Interface) protocols, which are specified in C-Roads WG2 TF4.

The Swedish NordicWay 3 Pilot covers C-ITS Day-1 and Day-1,5 services within urban and interurban areas. The pilot covered the design, implementation, test and evaluation of relevant Day-1 and Day-1.5 services within urban and interurban areas. By including a range of operating environments, from city streets to inter-urban motorways, the pilot has the possibility to assess the viability of different applications on different types of road networks.

The pilot is based on the use of a set of state-of-the-art passenger cars, public transport buses and heavy goods vehicles which were equipped with appropriate driver interfaces and connected through clouds by cellular and, for certain applications, ETSI ITS-G5 communication technologies.

The aim of the Swedish pilot is to demonstrate the possibility to communicate between vehicles, infrastructure and clouds and to show the interoperability, scalability and flexibility of the NordicWay interchange network with connected clouds. This was shown by testing Day-1 and Day-1.5 services.

#### C-ITS Day-1 services:

- Emergency vehicle approaching (EVA)
- Connected Traffic Signals including:
  - Traffic signal priority request by designated vehicles (TSP)
  - Green Light Optimal Speed Advisory (GLOSA)
- Roads works warning

#### C-ITS Day-1,5 services:

- Dynamic and semi-dynamic traffic restrictions

In addition there are some Proof of Concept work being executed.

One (the “Hybrid POC”) aims to investigate whether C-ITS cellular (long range) and C-ITS-G5 (short range) V2X communication successfully can be combined and in that respect increase the value of infrastructure data for automated driving functions. The Urban Transport Administration in Gothenburg is also exploring new possibilities, based on Digital Notifications.

Using vehicles, as “Mobile detectors,” instead of today’s inductive loops, opens up great opportunities to improve Traffic Management Services for all Road Users. Several C-ITS Pilots for cellular and G5 communication have been run in Europe over the last few years but few, if any of them, have combined both communication methods. Hence, NordicWay will be among the first to explore how to set up a true hybrid communication architecture. The Digital Notification use case will also be tested with both solutions.

The second POC (“IVS/MCS POC) connects vehicles to equipment along motorways, exchanging data – in-vehicle-signage with MCS and VMS.

The objective is to develop and demonstrate digital infrastructure for C-ITS services for In-Vehicle services. Cars, Truck, Bus, and Public Transport industries work together with Swedish Transport Administration and data sharing Interchange Node. The aim is to share data to and from Vehicles/OEM’s - In-Vehicle Signage – via the Interchange Node.

In C-Roads terms it is the following services.

1. Display warning sign or speed “limit” in vehicle, IVI-TS (In Vehicle Information - Traffic Sign),
2. Display Variable Message Sign and Free Text in-Vehicle, IVS-FT (In Vehicle Signage - Free text)
3. Send event notification from Road Authority to vehicle, IVS-HLN (In Vehicle S - Hazardous Location Notification)
4. Send traffic data from Vehicle to Road/Transport Authority, PVD-VDC, (Probe Vehicle Data Collection)
5. Transferring flow and speed data from the Motorway Control System to vehicle industry

In the outermost way we follow the standards given in C-Roads different referring and relevant documents, such as ETSI.

## Involved partners

The Swedish Transport Administration and the following public and private organisations are involved partners:

- SOS Alarm
- Carmenta AB
- Monotch
- Scania CV AB
- Volvo Car Corporation
- VTI
- ACTIA
- Knowit
- FourC
- City of Stockholm
- Region Stockholm
- City of Uppsala
- City of Gothenburg
- Swarco Sverige AB
- dynniq
- EVAM
- ITXPT
- RISE Interactive Institute AB
- Technolution
- TTS

## Location

The pilot is cellular based and will thus be functional in most parts of Sweden as well as Norway, Finland and Denmark where the services are applicable. The Swedish pilot focuses on C-ITS piloting in the cities of Gothenburg, Stockholm, and Uppsala including their access routes E6, E4, E20, E18 and RV40 which are all included in the Core Network and part of the Scandinavian – Mediterranean CEF corridor.

NordicWay3 has the following pilot sites:

- Gothenburg (SI-SPTI, SI-GLOSA, HLN-EPVA, HLN-AZ, geofencing)
- Uppsala (SI-TLP, SI-EVP, HLN-EPVA, HLN-AZ, geofencing)
- Stockholm (SI-TLP, SI-EVP, HLN-EPVA, HLN-AZ, geofencing)

## Overview of progress by End of 2022

In the S-SPTI pilot, 24 intersections in Gothenburg transmit real time data. Traffic Technology Services, TTS, is producing the SPAT/MAP data. TTS is producing and quality ensuring data from traffic lights and the information is sent to the interchange and sent out to the Android Auto application to be received by cars (Audi, Bentley, Porsche, Volvo, and Polestar).

For the SI-TLP and SI-EVP pilots, the core technical equipment is deployed at three intersections corridors in Stockholm (with a total of 15 intersections) and at one corridor in Uppsala (5 intersections). In Stockholm, the pilot will validate and test TSP for public transport and in Uppsala TSP for fire trucks and public transport. In total, the same eco-system will be tested for all three different vehicle categories. The priority request service providers are producing SREM messages on a basic level without the full set of data, as profiled by NordicWay 3. MAPEM files are basic C-Roads compliant, without full set of data, as profiled by the project. The priority request service providers are connected to the Interchange Node and the public transport data is available on Trafiklab. The data flow ecosystem is up and running and messages are being produced and consumed by end users.

For the HLN-EPVA pilots, the core technical equipment is deployed. Test vehicles from Volvo Cars and Scania will be utilized to test and demonstrate in-vehicle messages from the warnings. Additionally, the pilot aims to demonstrate the warnings in mobile applications for traffic information. Demonstrations will mainly take place on highways in Sweden. The objective is to distribute EVA warnings from ambulances and fire rescue vehicles in Sweden, as the pilot aims for setting the foundation for a national deployment of an EVA C-ITS service. All connections, from emergency vehicles to Public service access point (PSAP) and to Carmenta, which publishes the C-ITS message, and the interchange, are operational.

For the RWW pilot, devices from Combitech and Ramudden are installed on trailers. In the Combitech pilot, road contractors conducting road works deliver data to Combitech who aggregate and verify the information and then send it to the Interchange Node. Ramudden uses GPS trackers installed on vehicle (currently 3 TMAs and 1 bucket truck) and generate the RWW messages to deliver to the Monotch TLX platform for signing and then on to the Monotch Interchange Node. In both pilots, the OEMs (Scania and Knowit) subscribe to RWW messages from the Interchange Node and make aggregation and filtering. Finally, the information can be sent out to chosen vehicles from Scania. The pilot is operational, except the link between Ramudden and the interchange is still missing (due to Ramudden joining in mid 2022).

## Installed RSUs based on funding by CINEA

No RSUs have been installed so far, and none are planned for installation in the upcoming years.

## 20. The UK Pilot site

The A2/M2 Connected Vehicle Corridor (A2/M2 CVC) is to be established by the Department Of Transport in partnership with Highways England, Transport for London and Kent County Council. It will pilot the infrastructure, data management and service delivery necessary for connected vehicle services. This Corridor offers a variety of operating environments that make it attractive and unique as a pilot. Commencing in inner London near to Blackwall Tunnel with potential links to urban ITS applications; it provides the interface between the trunk road (A2), motorway network (M25 and M2) and Kent local roads (A229/A249).

The Corridor will be a pathfinder for future investment and the blueprint for the wider roll-out of connectivity across the UK road network. Importantly, when it is fully operational in 2019, it will provide an open test-bed where the UK motor manufacturing sector and after-market companies can develop new interactive customer services for C-ITS applications in addition to the core traffic and safety services which are market-ready. It will demonstrate how Connected Vehicle (CV) technology can help highway and roads authorities to manage their urban and inter-urban road network more effectively with the aim of achieving substantial benefits, shown in other trials (i.e. halving incident-related delays, reducing rear-end collisions by up to 12% and lowering fuel consumption /emissions by up to 25%).

The UK recognises the need for interoperability and the need to be able to operate across boundaries. The A2/M2 CVC project is the UK part of the InterCor (“Interconnected Corridors”) programme with France, Belgium and the Netherlands – to develop a network of Corridors which link in to the C-ITS Corridor (Vienna to Rotterdam) and the French projects (SCOOP@F). This close collaboration between European states aims to ensure the interoperability of services. The functional and technical specifications that will be delivered through this project will help to ensure that future UK deployment of these services will be compatible and interoperable with European deployment of the four services (RWW, IVS, PVD and GLOSA).

### Involved partners

- Department for Transport (DfT)
- Highways England (HE)
- Transport for London (TfL)
- Kent County Council (KCC)

## Location

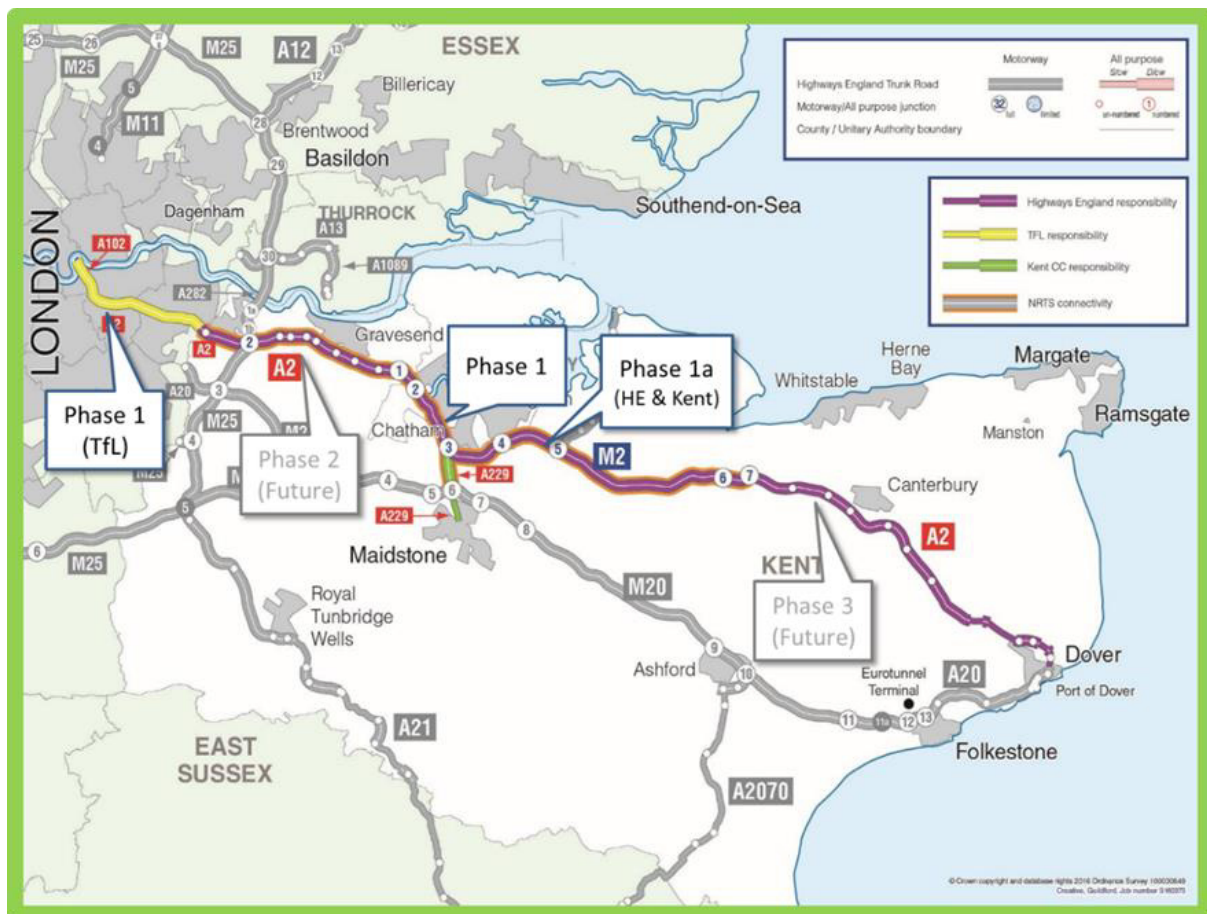
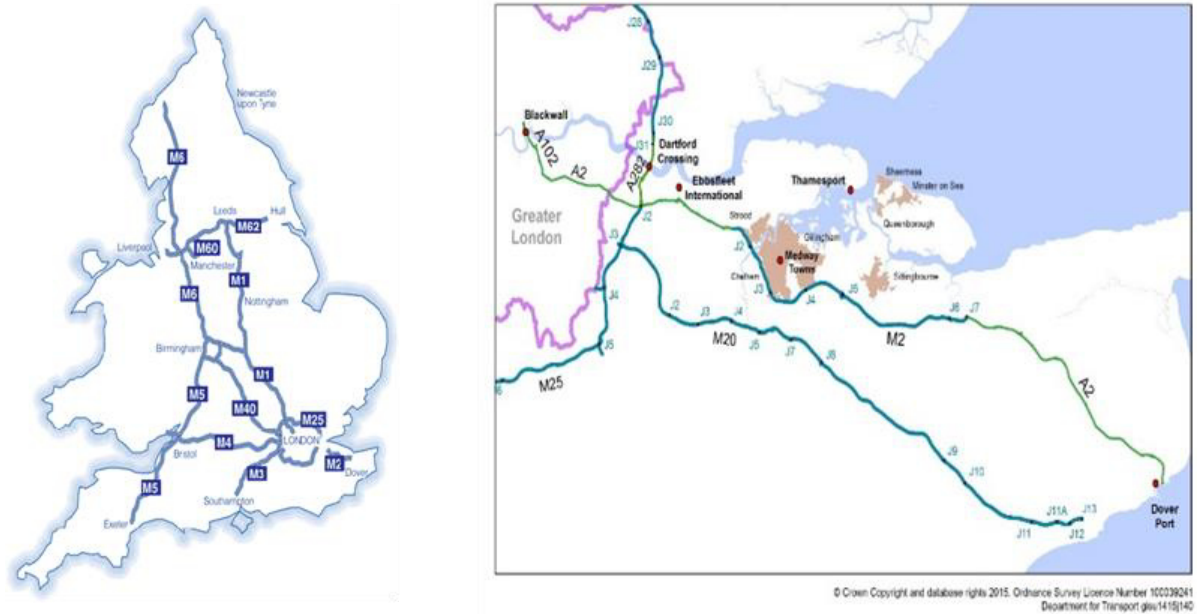


Figure 33: Location of the UK pilot site (Phases 1 & 1a deployed)

## Final status

The InterCor project was completed in March 2020. It achieved cross-border harmonisation and interoperability of C-ITS deployments in four Member States (MS), Belgium, France, the Netherlands and the United Kingdom, linking the different national initiatives towards a harmonised strategic roll-out, and common specifications.

All milestones and reports detailing the UK specific results from the InterCor project were submitted to the chair of Working Group 3 on 9th September 2020 and form part of the final evaluation and assessment report of C-Roads 1.

The A2M2 pilot site is currently non-operational with the learning from the pilot contributing to the development of a connected vehicle strategy for the UK. The UK remain an active, but unfunded member of the C-Roads Platform.

## Installed RSUs based on funding by CINEA

All together 32 RSUs have been installed so far, and no further are currently planned for installation in the upcoming years as the focus is likely to be on 'long range' deployment.

## 21. Summary

Based on the C-Roads basic technical specifications, developed from 2017 on and extended in the year 2022 with the release 2.0.x, and the supporting common test specifications, pilot sites have defined their C-ITS use cases to deploy, and the precise sections on their networks to be equipped with C-ITS stations. Overall the release 2.0.x was the first, which included all “Day One C-ITS services” also to be transferred via IP-based networks and therefore qualify as fully hybrid C-ITS solution. Very active participation and information sharing of many platform partners to prepare public procurement tenders for single deployments also in cities, but as well for the integration of C-ITS system elements into traffic management have been carried out.

To ensure interoperability of C-ITS services in Europe, the basic C-Roads releases have been concluded at the level 2.0.x, in June 2022, with the decision to make this release the basis for the next interoperability x-test cycle. This was again carried out between C-Roads partners and with the participation of external industry partners from the C2C CC. A complete C-ITS test and validation campaign for the release 2.0.x was carried out between October and November 2022 with the participation of cities and their intersection related C-ITS use cases, but also with partners offering their “hybrid connections” and C-ITS Brokers with messages for testing and validation. Here the experiences of partners made in the previous years with the restrictions of the Covid-19 pandemic crisis, made it possible that the virtual test procedure for C-ITS services has been used by some partners to extend the reach out further in their C-ITS x-test campaign and data sharing procedures to successfully confirm the full interoperability of day one C-ITS services also in cities in participating EU member states by December 2022. The complete documented results including the data records of C-Roads partners will be available by June 2023, in order to confirm interoperability of installed C-ITS Stations and their cross-border services in C-Roads partner member states.

The C-Roads x-tests included messages with activated security headers, with C-ITS units registered in the EU – PKI System at level 0, which corresponds to test- and validation purposes. The test demonstrated clearly the need for performing the validation at the different security levels, and showed some stakeholders that their C-ITS stations were correctly registered and therefore the C-ITS messages send recognised to be from a trusted partner.

Additionally it became clear during the x-test campaign, that also series vehicles with activated C-ITS services were driving by during the test campaign and the messages from these vehicles (e.g. CAM, or DENM) were registered as input data from the participating units, and included in the overall data records of the C-ITS x-test and validation campaign 2022. For the C-Roads partners, which have already installed stations in full and regular operation, and are therefore registered at security Level 1, the x-test and validation campaign had to be moved to other sections of their network.

Additionally to the C-ITS installations on motorways, the cities in the C-Roads Member states continued to implement C-ITS stations at intersections with C-ITS Services and use cases based on the SPAT/MAP message in order to facilitate the priorities for Public Transport fleet vehicles at these intersections and enable the swift passage of emergency service vehicles like ambulances and fire brigades. These use cases have different levels of priorities for the



respective city, in the same way that each use case holds benefits that might be more useful/needed for some cities than others. Additionally participating cities in C-Roads started to contribute very actively to new C-ITS use cases, involving VRU, like bike riders. Up to now more than 50 cities are part of the C-Roads Platform and have taken part in the roll-out of C-ITS units, where various use cases were covered out of the different C-ITS Services. In order to further raise awareness of the advantages of C-ITS among city and regional authorities as well as to foster discussions on the role of urban C-ITS for all modes of transport, a collaboration note was signed between the C-Roads Platform and POLIS, the network of European cities and regions. Furthermore, C-Roads will ensure European cohesion and harmonisation of C-ITS deployment in the European Union and beyond.