Annual pilot overview report 2020

26.06.2021, v1.0

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Title:

Annual pilot overview report 2020

Contractual date of delivery:

June 2021

Actual date of delivery:

June 2021

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Platform Members:

Austria

Belgium/Flanders

Belgium/Wallonia

Czech Republic

Denmark

Finland

France

Germany

Greece

Hungary

Ireland

Italy

The Netherlands

Norway

Portugal

Slovenia

Spain

Sweden

United Kingdom

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.

The annual pilot overview report should give a summary of the pilot activities performed in each participating European State. This document describes on one hand the technical aspects as well as the budgetary situation.

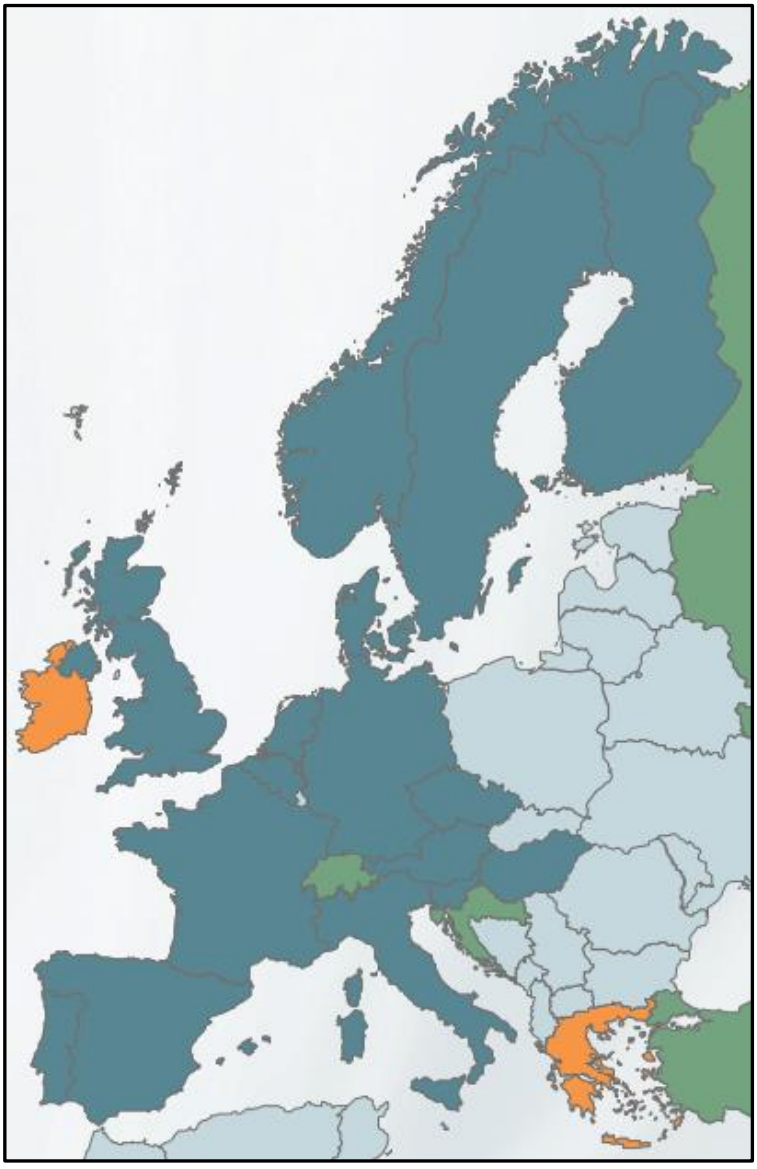

Figure 1: C-Roads pilot sites

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: short-range ITS-G5 and long-range cellular communication (based on harmonized C-ROADS specifications) coexist to deliver the same content over different media. 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 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 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 in 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. 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 will 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. According to the schedule, these roadside stations should be deployed and operational until the end of 2021 in several waves.

First elements of that deployment will gradually supplant the pilot installations from Q2 / 2021 onwards and be available for further 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 was awarded in late 2020 to Kapsch TrafficCom AG out of an existing framework tender, with the aim to have the first batch of vehicles ready and equipped until the end of 2021.

From 2022 onwards, the operational deployment of C-ITS in Austria at roadside, in vehicles and by using trailers will continue in C-ROADS Austria 2. The roadside framework contract allows for the deployment of up to 525 roadside stations on Austria's motorway network. Given an overall network length of around 2250 kilometers, the average distance between to stations would be less than 4 kilometers – with a typical communication radius of 1.5 to 2 kilometers for ITS-G5, this nearly accumulates to area-wide coverage of the whole network.

Additionally, in C-ROADS Austria 2 urban use cases will be implemented in the cities of Graz, Wien and Salzburg. The use cases will focus on public transport services, signalized intersections as well as hazardous location notifications.

Involved partners

- ASFINAG
- Siemens Mobility Austria GmbH (Contractor)
- Kapsch TrafficCom AG (Contractor)
- Stadt Graz
- Land Salzburg
- Stadt Wien
- Wiener Linien

Location

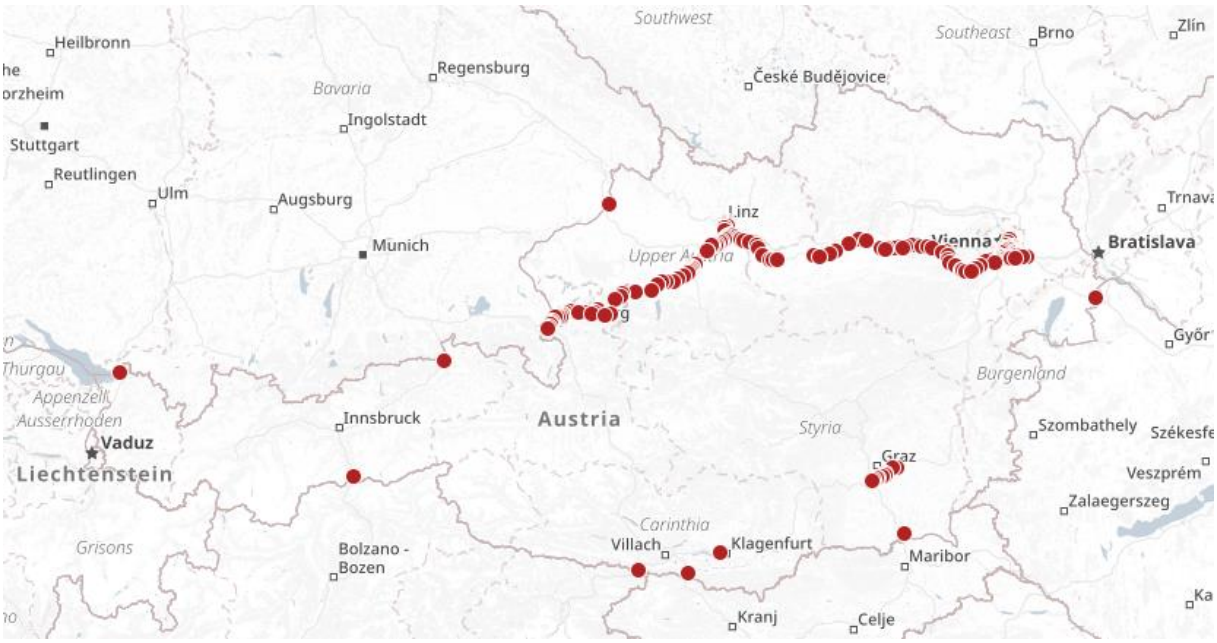

Figure 2: Initial operational deployment of 175 C-ITS roadside stations in Austria in 2021

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”, will be updated to full deployment status
- The motorways from Vienna to Salzburg (including Linz), a stretch of nearly 300 km is the Austrian part of the “C-ITS Corridor” between Netherlands, Germany and Austria, and thus by definition the first C-ITS deployment area, as already declared in an MoU between these three countries in 2013
- The motorways around the city of Graz are part of a proving region for automated driving established in cooperation with the ALP.Lab consortium. Consequently, ITS-G5 roadside equipment had been installed there for testing and will be further extended to be reach operational status
- Further important locations are traffic hot spots and border areas, which are relevant for cross-border deployment and testing
- The roll-out starts with these deployment locations and will then extend to the overall Austrian motorway network, which spans around 2250 km in total. The overall roll-out plan includes up to 525 fixed ITS-G5 roadside locations on the whole Austrian motorway network to be deployed from 2022 onwards

Overview of progress by End of 2020

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. 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 at least 12 years. These first 175 roadside stations will be placed as indicated above: 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 in the future. According to the schedule, these roadside stations should be deployed and operational until the end of 2021 in several waves.

Pilot Vienna

In the first quarter of 2020, the update process for the Sitraffic Scala traffic computer was completed and the corresponding C-ITS module is ready for use since then.

Furthermore, it was decided to include Wiener Linien, the public transport provider in Vienna, into the project as they are an important stakeholder for use cases related to public transport, e.g. Traffic Light Prioritisation (SI-TLP). This was followed by the decision on a set of use cases that will be deployed and tested in the pilot site Vienna together with relevant stakeholders.

After completing the preliminary concept for the implementation of Road Side Units (RSU) in Vienna, the first RSU was implemented at the intersection Weißgerberlände # Rotundenbrücke. The RSU was connected with the already existing traffic light at this location and serves the use cases Signal Phase and Timing Information (SI-SPTI, SPAT and MAP messages) as well as Working Zone Notification (DENM messages). Additionally, Wiener Linien entered into an agreement with two suppliers of On-Board-Units (OBU) to include OBUs into some of their tramways.

Pilot Graz

In 2020, the CMS has been set up for the pilot site in Graz. At three traffic lights necessary adaptions had to be made before further installations of Roadside stations were possible.

The first set of Roadside stations has been ordered and will be installed as soon as possible from the beginning of 2021 onwards. Five Onboard Units have already been ordered but not yet implemented. Those will be installed in public transport vehicles, maintenance vehicles and other vehicles owned by the city.

Together with the local transport provider of Graz, a concept for public transport use cases has been made. The next step is to work on a solution for the implementation together with the technology partner.

Pilot Salzburg

By the end of 2020, the deployment plan for the deployment of Day 1.0 use cases and services at the Salzburg Pilot Site including deployment corridors and locations of Road Side Stations (RSS) has been finalized. The deployment plan includes a detailed description of the envisaged

deployment of the Day 1.0 including the involved systems and data flows. The deployment plan for Day 1.5 use cases and services will be extended as soon as stable specifications are available. If specifications are available, the deployment of Day 1.5 use cases is envisaged starting in 2022.

During the second half of 2020, the procurement of RSS has been prepared. This includes the definition of technical specifications and requirements. The procurement should be carried out in the first quarter of 2021. In 2020, an open source message broker (Apache ActiveMQ Artemis) has been set into operation. The message broker acts as the C-ITS central station handling all C-ITS messages between the RSS and other subsystems such as ITS Austria West and the Salzburg Traffic Management Centre (TMC). Moreover, it provides functionalities to monitor the health of RSS as well as the status of received and delivered messages. The message broker is also capable of connecting to other C-ITS systems via the C-Roads IP Based Profile being currently under specification. Additionally, in the context of the national flagship project Digibus® Austria, the project partner Kapsch TrafficCom has installed 5 test RSS. These RSS where connected to the C-ITS central station.

As a first use case, in 2020, the PVD use case has been deployed. Therefore, CAM messages of passing C-ITS-enabled vehicles (e.g. VW Golf 8) are forwarded via the 5 test RSS to the C-ITS central station. The C-ITS central stations forwards the CAM messages to ITS Austria West. In the C-ITS system, the CAM messages are analysed and the vehicle paths and time stamps are used to improve local traffic state estimation. This use case is already working with the 5 test RSS and can be easily rolled out to all RSS after deployment. The next use cases to be deployed in 2021 will be Road Works Warning (RWW) and In-vehicle Signage (IVS).

Concerning the deployment of Signalized Intersection (IS) use cases as well as Hazardous Location Notification (HLN) use cases, a data exchange with the existing TMC is necessary. The supplier of the TMC is the German company GEVAS Software GmbH. GEVAS is also involved in the German C-Roads project and has considerable experiences with C-ITS deployments. To enable this data exchange, the TMC has to be upgraded in order to support interfaces for exchanging C-ITS-relevant messages. Moreover, especially for prioritizing vehicles at signalized intersections, an additional module has to be installed. In order to prepare the upgrade, a working group with the TMC supplier has been initiated. The work on upgrade plans has been started. The upgrade is envisaged for the second half of 2021, continuing in 2022.

Still, by the end of 2020, the definitions/specifications of city-related Day 1.5 use cases are not available yet. Nevertheless, the proposed use-cases *"Park & Ride information"*, *"Off Street Parking Information"* as well as *"Connected and cooperative navigation into and out of the city"* have been selected for deployment within the Salzburg pilot and active participation in the work on definitions and specifications of the above mentioned use cases within WG 4 has been agreed upon. However, the deployment of these use cases starting in 2022 is depending on the C-Roads progress regarding definitions/specifications.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021

335	1 266	1 919	1 100	4 099	0

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
105	597	826	5 208	6 262	

3. The Belgium (Flanders) Pilot site

The main objective of the C-Roads Flemish pilot is 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 also will 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 will be used in combination with the HERE Location Cloud and the local Traffic Management Centre, which should allow a group of approximately 1000 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 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 3: Location of the Belgium (Flanders) pilot site

The pilot will cover 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 will be given to the E313/ E34 segments.

Overview of progress by End of 2020

Beginning of March 2020 the pilot system was fully functional, and ready to go in the pilot fase with the ambition to reach 1000 users. The pandemic caused then again another delay, but finally in September we could start the volume deployment of the pilot. A specialized recruitment bureau was used to provide the candidate pilot users.

Finally the amount of users reached was only 650, mainly also because of the irregular situation we were in. The database of the bureau was over 20.000 candidates, and they never had such a low response rate.

To compensate for this we will do a complete detailed evaluation for all of the 650 users, instead of the 250 foreseen in our grant agreement. We also did a limited cross border test and tested the system in Wallonia and the Netherlands.

Main objectives for 2021 are:
Q1: Evaluation report of the Belgian (Flanders) pilot.
Q2: Evaluation report of all available pilots.

Virtual demonstration of the pilot (with recordings made during trips)

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
20	560	1670	1510	340	123

4. The Belgium (Wallonia) Pilot site

In Belgium-Wallonia, C-ITS deployment started end of 2017, the improvement of road safety was the key issue.

The SOFICO is financing an extensive ITS strategy from 2017 onward to renovate and increase C-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 for road user information.

As member state of the C-Roads platform, Wallonia is participating in the testing and implementing of harmonised and interoperable C-ITS services. Through a Partnership in between SOFICO, Tractebel and ITS Belgium, **two pilot projects** for C-ITS use cases deployment will be implemented on part of the Wallonia highway network.

- For the first one, the focus has been placed on the ITS - G5 technology: **5 RSU's** 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.

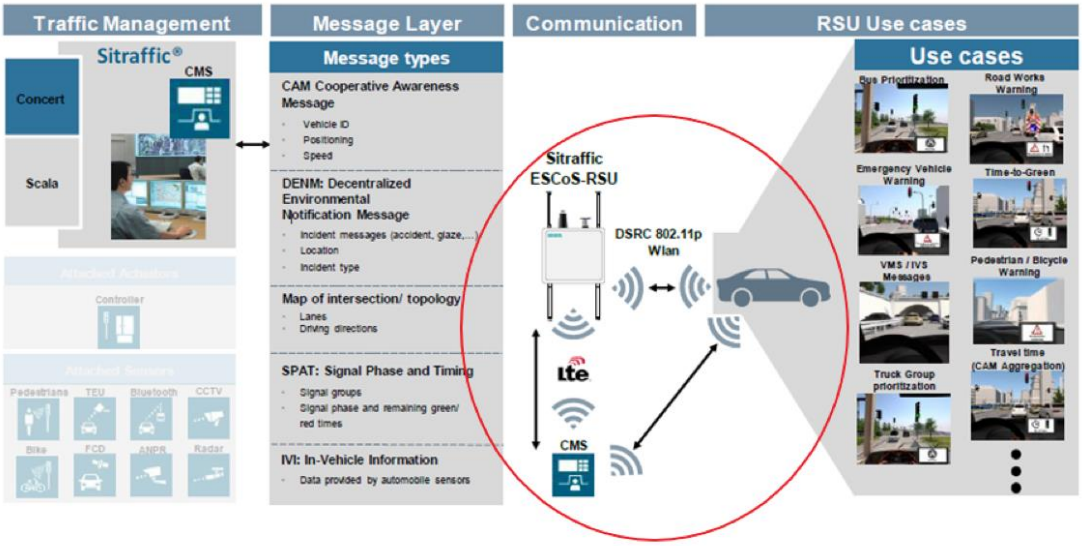

Figure 4: Data flow in the C-Roads Wallonia pilot site (image: V2Wal)

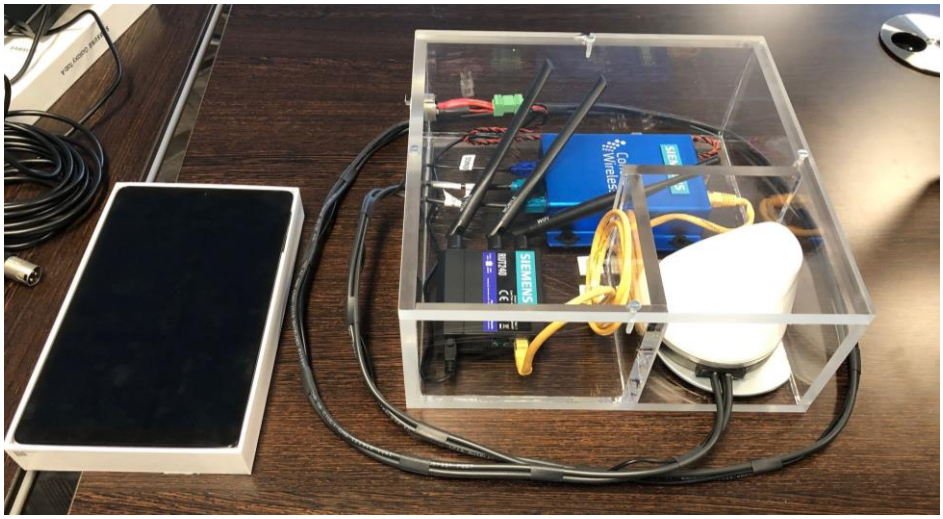

Figure 5: Pilot On Board Unit (photo : Tractebel)

- 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 will be deployed along approximately **427 km of Walloon motorways** via the Coyote community.

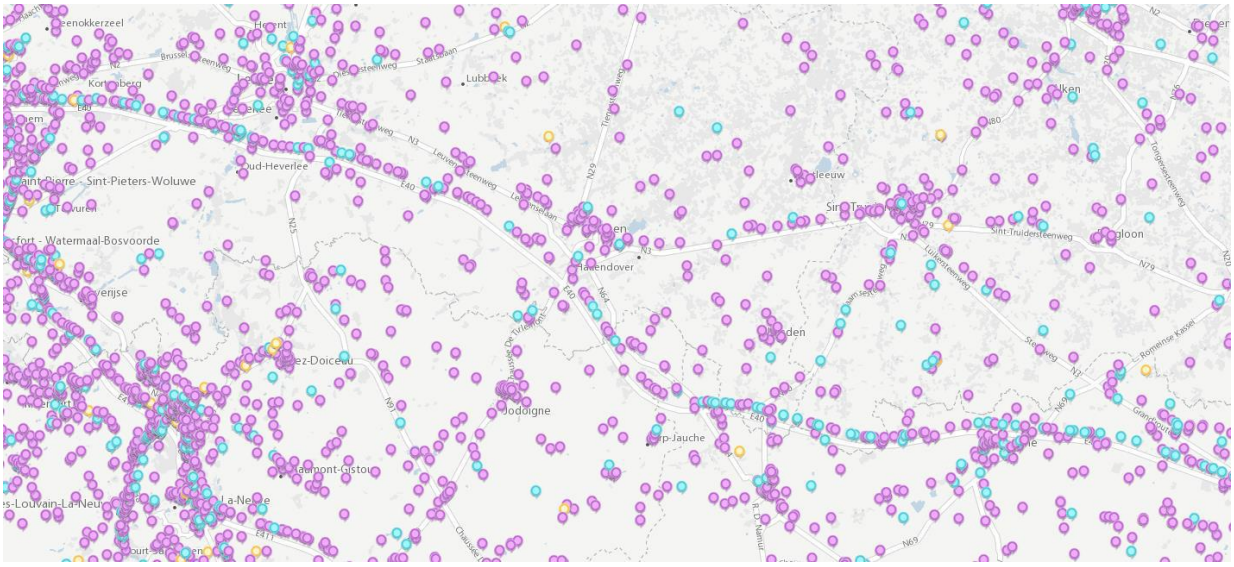

Figure 6: Coyote Community coverage in Wallonia (Zoom on E40 between Brussels and Liège, image: Coyote)

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Involved partners

- Partners C-Roads Wallonia

- (1) RSU

- (2) 4G

Location

- ITS - G5 technology: **5 RSU's** have been installed on the A602 junction as well as a C-ITS messages server.

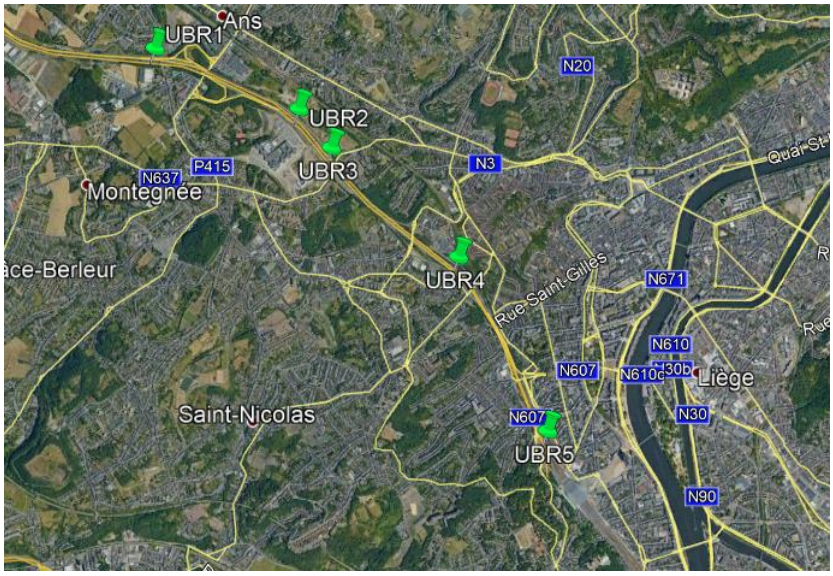


Figure 7: Localisation of the RSU's near Liège (background : Google Maps)

- **Cellular communication** (4G) technology: The pilot will be deployed along approximately **427 km of Walloon motorways** via the Coyote community.

Overview of progress by End of 2020

The project has entered its last phase consisting in validation before deployment in real conditions and evaluation.

a) The Datex 2 node is set up and the interface with the traffic management system has been completed.

b) ITS-G5 RSU network is operational on A602 highway. The mapping of information from Datex 2 to DENM format is nearly completed. Some problems regarding localisation still need to be solved. The implementation of the use cases is in progress. The full communication chain from the TMC to the driver HMI is ready to be tested in the frame of the interoperability tests scheduled in Spring 2021.
c) The development of the use cases in the mobile app is in progress and should be completed in the next weeks.
d) C-Roads platform work on harmonization of cellular based solutions, let alone hybrid solutions, is not yet conclusive. At this point, interoperability with C-Roads Flanders Action seems difficult to achieve. Cellular app contract will allow to evaluate services over a large perimeter but services are not part of the C-ITS trust domain. Security and interoperability will only be addressed in the ITS-G5 experimentation.
e) Day 1.5 service parking information relies on infrastructure works to install measuring equipment on each of the 58 highway parking areas. Due to technical problems, these works have been significantly delayed. We will still intend to test this use case but on a reduced number (4) of parking areas.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
-	24	204	778	840	2400

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 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 CZ 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 will be carried out at least on the following parts of the Czech road network split into individual DT´s:

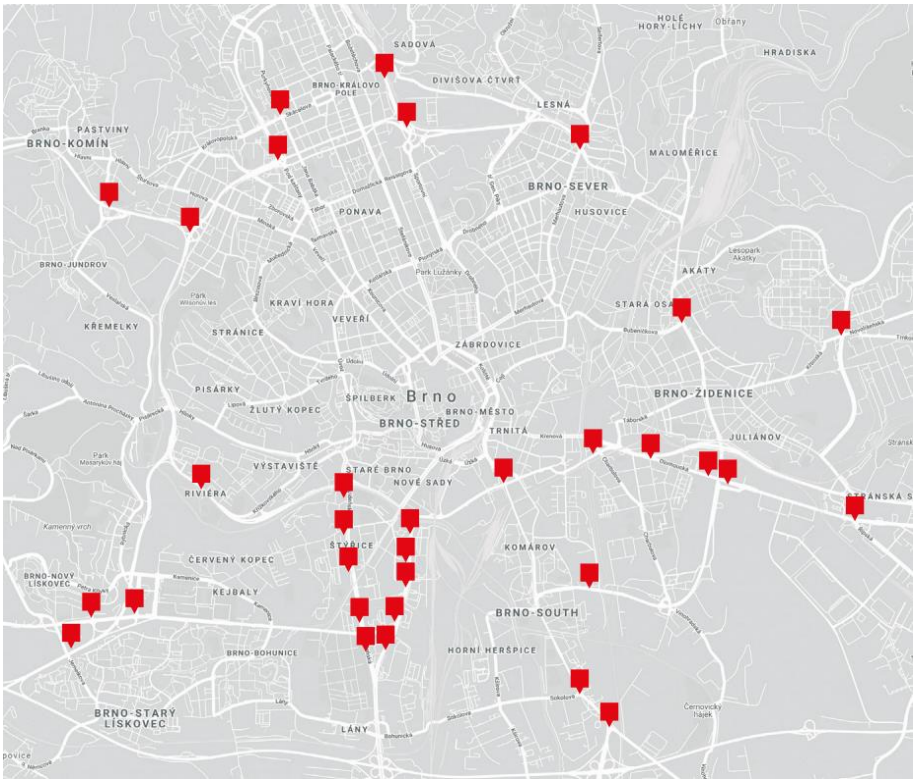
- **DT1 Brno agglomeration** covers the southern sector of the city of Brno, in particular the following roads / motorways:
  - Part of motorway D1 (E50/E65) in approx. length of 28 km between km 182 and km 210
  - Part of motorway D2
- **DT2 Brno city,** this pilot will take place on the 1st class radial 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 8: Deployment Brno.

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- **DT3 – Motorways D1, D5, D11 and I/52 / D52** C-ITS equipment and services are being 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 is being 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 is being deployed on the section between Prague and Plzeň (km 6 – km 90) and cellular technology is being 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 covers the whole motorway section and cellular technology is being used as a secondary communication tool for C-ITS service provision.
    - Combined motorway D52 and 1st class road I52 (E461) from Brno to the Austrian border is covered by cellular technology to provide C-ITS services.
- **DT4 – Public transport deployment in cities of Plzen and Ostrava** is 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 will be identified for deployment of safety related applications.
- **DT5 – Railway crossing pilot** - Správa železnic (Railway network operator - SŽDC) together with project partner AŽD are 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 2 level railway crossings. Both are equipped with security systems where one is equipped with barriers and one is without barriers. Another 2 level crossings have been identified and selected for enlargement of the pilot testing in the CR on the line no. 113 in the Ústí nad Labem region for deployment in the 1st half of 2020.
- **DT6 – Cross border testing,** is situated mainly on the D5-A6 motorway (Czech - German border) and the I/57 – E59 road (Czech - Austrian border), but other C-ROADS CZ test sites may be selected as well. Cross-testing with other C-Roads Platform members on their pilot sites is also part of this activity. All C-ROADS Platform partners are invited to the testing.

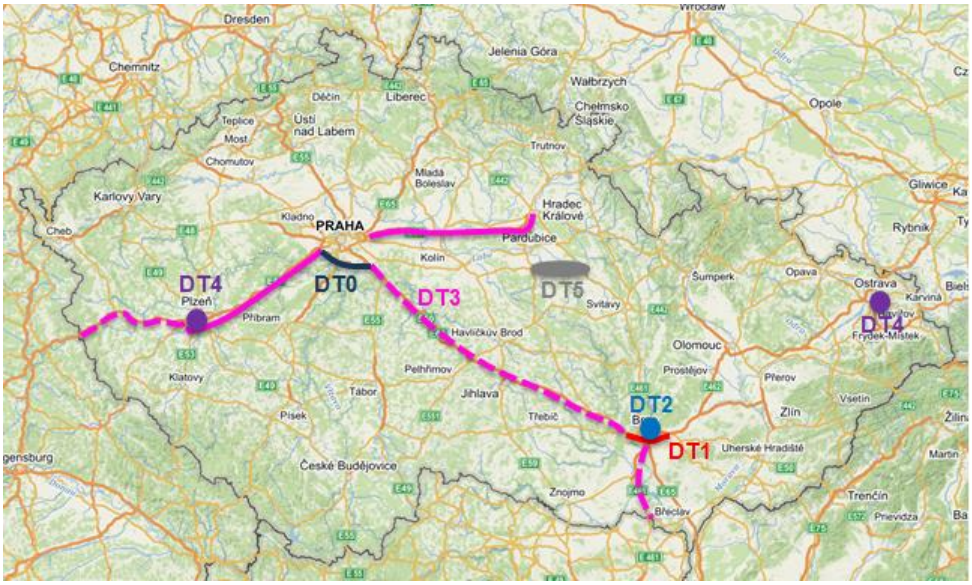


Figure 9: Location of the Czech pilot site

Overview of progress by End of 2020

DT5 – Railway crossing pilot was started on the 2 railway level crossings the Pardubice region: 1. on the Chrudim – Moravany railway line – the crossing P5013 only with warning lights without barriers, and the Pardubice - Havlíčkův Brod line at Horka – the crossing P5238 with warning lights and barriers. The ITS-G5 RSU units were deployed at both crossings in 2019. One solution uses G5 transmitters on both sides of the railway line and the second solution uses a high pole on side of the crossing but capable to transmit radio signal to both directions of the road coming to the crossing. The passing train shall not prevent the transmitted signal access the cars coming from both sides of the line. The transmitted messages comply with the Specifications of RLX Use case. The additional 2 crossings in the Ústí n. L. region were equipped with ITS-G5 RSU units the 1st half of 2020. Both level crossings are located at the line nr. 113 between Čížkovice and Obrnice which connects two bigger towns – Lovosice and Most. The first crossing P9240 is protected with warning lights and barriers, while the second one is protected only with warning lights. Both C-ITS installations were activated and tested for compliance with C-Roads specifications in the second half of 2020.

O2 Czech Republic report:

At the beginning of the year all C-Roads units and backend systems have been completely enrolled in the PKI system and the system is thus fully secured and functional. The PKI is fully connected to the European TLM at the current L0 level.

The main activities in 2020 focused on the completion and evaluation of measuring the quality of communication on highways and in cities using ITS-G5 and LTE, where the main output is that

LTE technology is fully applicable for most implemented scenarios and delays in LTE communication in the vast majority of measured cases did not exceed 150 ms, in dense urban areas LTE communication proved to be an even more reliable technology.

In addition, intensive testing of the hybrid vehicle unit was carried out by independent users from among O2 employees and the public. The test took place for 3 months on all types of roads throughout the Czech Republic. The result is practical feedback in several areas - system functionality, sufficiency and quality of information messages, unit functionality, user experience, loading of backend systems. A video is made from this pilot, which summarizes the essential findings commented directly on the pilot's participants.

The last activity is the addition of a new version of security to the mobile application so that it can be used as a full-fledged actor capable of receiving and validating C-ITS messages, as well as creating and signing broadcasted messages from the application. The technical implementation of the new security into the application has been completed and the mobile application will be tested in a similar way as the unit in 2021.

DT2 Brno city, is fully deployed and operational. All 31 RSUs were deployed on their location and all 11 OBUs are also mounted in their respective vehicles. System was tested by C-Roads Czech Republic project partners in national test day and undergone evaluation by ČVUT (Czech technical university in Prague). OBU equipped cars are in regular service in the city.

In 2020 we managed to conduct some additional activities by deploying use case public transport preference and testing compatibility with onboard units of public transport company of Brno city purchased in other (non-C-Roads) project RIS II. Cross tests between C-Roads and RIS II units were successful, therefore public transport prioritization is in everyday use on all C-Roads RSUs in Brno that are connected to traffic lights controller with active public transport prioritization.

In 2020 project was seriously affected by COVID-19 restricting travel and personal meetings to minimum. Pandemic restrictions forced us to reschedule international tests from spring 2020 to autumn 2020 and later to spring 2021.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
122	821	1 970	5 498	4 524	1 973

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 2 and 3 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 2 and 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 2 project (2017-2020):

- Contributed to the harmonisation and interoperability of the C-ITS services in Europe with requirements agreed by the C-Roads Platform.
- Supported the deployment of new Day-1 and Day-1,5 C-ITS services in Nordic countries and its use in vital road freight transport routes subject to extreme weather conditions and in urban and interurban environments.
- Supported the infrastructure readiness for connected and automated driving in Nordic countries in snowy and icy arctic conditions.
- Evaluation results (2020) include technical feasibility, ecosystem and business models, socio-economic impacts of the piloted Day-1 and Day-1.5 C-ITS services as well as the effect on user´s mobility and traffic behaviour and on public acceptance. Final evaluation results are available at www.nordicway.net.

NordicWay 2 project was successfully completed in 2020 and the project's evaluation results as well as the knowledge gained in C-roads TF2 Service definition and TF4 Hybrid communication were addressed in the planning of the new NordicWay 3 project. The full NordicWay 2 (2020) and in future NordicWay 3 results and reports can be viewed in the www.nordicway.net webpage.

From 2021 forward the NordicWay 3 – Urban connection project, with more cities involved, will continue to harmonise and build European C-Roads specifications for hybrid communication. 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 board tests with other pilots in European countries who has 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 2020

Danish Road Directorate contributed through the NordicWay 2 and NordicWay 3 projects to the C-Roads TF2 Service Harmonisation as well as communication and dissemination activities.

NordicWay 2 pilots were completed in 2020 and results published at www.nordicway.net

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	50	130	170	180	0

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
5	40	200	170	170	

7. The Finnish Pilot site

The Finnish pilot was part of the NordicWay 2 project (2017-2020) and currently 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 2 project (2017-2020):

- Contributed to the harmonisation and interoperability of the C-ITS services in Europe with requirements agreed by the C-Roads Platform.
- Supported the deployment of new "Day-1" and "Day-1,5" C-ITS services in Nordic countries and extend its use in vital road freight transport routes subject to extreme weather conditions and in urban and interurban environments.
- Supported the infrastructure readiness for connected and automated driving in Nordic countries in snowy and icy arctic conditions.
- Evaluation results (2020) include technical feasibility, ecosystem and business models, socio-economic impacts of the piloted Day-1 and Day-1.5 C-ITS services as well as the effect on user´s mobility and traffic behaviours and on public acceptance. Final evaluation results are available at www.nordicway.net.

NordicWay 2 project was successfully completed in 2020 and the project's evaluation results as well as the knowledge gained in C-roads TF2 Service definition and TF4 Hybrid communication were addressed in the planning of the new NordicWay 3 project. The full NordicWay 2 (2020) and in future NordicWay 3 results and reports can be viewed in the www.nordicway.net webpage.

From 2021 forward the NordicWay 3 – Urban connection project, with more cities involved, will continue to harmonise and build European C-Roads specifications for hybrid communication. 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 board tests with other pilots in European countries who has implemented the C-Roads hybrid communication specification.

Finnish national pilots

The Finnish NordicWay 2 project's pilots in 2017-2020 were (1) the Artic Challenge for Automated driving in snowy and icy arctic conditions and (2) relevant C-ITS Day 1 services on core corridor.

1) Artic Challenge for Automated driving in snowy and icy arctic conditions

This pilot addressed automated driving in snowy and icy arctic conditions. The pilot included posts and poles for guidance and positioning, C-ITS hybrid communication, communication infrastructure including pre-5G and remote driving as well as vehicle positioning. The pilot studies were completed with prototype automated vehicles around Finland and evaluated in Muonio Intelligent Road in North Lapland to guarantee winter conditions. Project results are available in the Finnish Transport Infrastructure Agency publication online: https://julkaisut.vayla.fi/pdf12/vt_2019-19_arctic_challenge_web.pdf

2) Relevant Day 1 services on core corridor

This Activity piloted relevant Day 1 and Day 1.5 services. The services piloted in Finland were based on cellular communication. Therefore, the physical coverage of almost all services were addition to the Scan-Med core corridor, the whole main road network in Finland (80,000 km). However, service providers' data collection (e.g., weather data) scope varied and most of the data was provided around ring roads and major incoming roads in the Helsinki region and from E18 between Helsinki and Turku as well as Helsinki and Tampere. The full evaluation results of the Finnish and other NordicWay 2 pilots are available at www.nordicway.net.

The Finnish pilot deployed following Day 1 and Day 1.5 services and use cases:

- Slow and stationary vehicle(s) & Traffic ahead warning
  - Use case: Traffic jam ahead
- Road works warning
  - Use case: Road and lane closure
- Weather and road condition
  - Use case: Weather conditions, Reduced visibility, Temporary slippery road
- Other hazardous location notifications (OHLN)
  - Use cases: Accident zone description, Emergency vehicle approaching, Animal or person on the road, Obstacle on the road
- In-vehicle signage
  - Use case: In-vehicle speed limits
- Probe vehicle data
  - Use case: Single-vehicle data
- Traffic information and smart routing

The Finnish NordicWay 3 C-ITS pilots in Med-Scan E18 corridor as well as whole main road network and urban environment, using cellular network and C-Roads hybrid communication Interchange Node architecture, will be implemented between 2021-2023.

Involved partners

The Artic Challenge – Automated driving in snowy and icy arctic conditions – is led by the public authorities of the Finnish transport and communication authorities. Studies are carried out by the following three coalitions:

- Lapland University of Applied Sciences (leader) and Roadscanners ltd
- Sensible 4 Ltd (leader)

    - Metropolia University of Applied Science Ltd
    - Sharpeye Systems Ltd
    - MHR Consulting
    - F-Secure Ltd
    - Solidpotato Ltd
    - Nodeon Ltd
- VTT Technical Research Centre of Finland Ltd (leader)
    - Dynniq Finland Ltd
    - Indagon Ltd
    - Infotripla Ltd
    - Ukkoverkot Ltd.

The relevant C-ITS Day 1 and Day 1.5 service providers and partners were procured in 2018 by the Finnish public transport and communication authorities. Pilot fleet was set up from existing fleets, services and users in the market and included in-vehicle displays and nomadic smart devices. The pilot implementation by three industry provider coalitions with 17 companies:

- EEE Innovations Ltd (leader)
    - Driveco Ltd
    - Sensible4 Ltd
    - Swarco Finland Ltd
    - TraffICT Ltd
    - Tietoevry Ltd
    - Defensec Ltd
    - WhereOS Ltd
- Infotripla Ltd (leader)
    - Arctic Machine Ltd
    - Ficonic Solutions Ltd
    - Finnish Meteorological Institute (FMI)
    - RoadCloud Ltd
    - SitoWise Ltd
- Posti Ltd and Vaisala Ltd (leaders)
    - Metsäteho Ltd
    - Ahola Transport Ltd

Location

The Artic Challenge for automated driving in snowy and icy arctic conditions field tests were carried out in Finland. Part of the field test results were verified in the Finnish-Norwegian E8 corridor, on a section of the comprehensive network section with frequent extreme weather conditions and low traffic volumes to minimise the safety risks involved with having automated vehicles driving on an open road together with manually operated vehicles.

The relevant C-ITS Day 1 and Day 1.5 services took take place on the comprehensive Finnish road network, which included core corridor with E18 corridor (Scan-Med corridor) between Helsinki and Turku, urban links and especially the incident prone ring roads and arterials in the Helsinki region.

Overview of progress by End of 2020

Arctic Challenge – Connected and Automated Driving in icy and snowy arctic conditions

Building of infrastructure to support CAD was finalised successfully and last field tests were completed by the three industry coalitions. The final results of the field tests were published openly in the Internet in 26 November 2019 (https://julkaisut.vayla.fi/pdf12/vt_2019-19_arctic_challenge_web.pdf).

The relevant C-ITS Day 1 and Day 1.5 services

Three procured industry consortia and 17 service providers together with the public authorities and traffic management successfully completed the Finnish C-ITS pilot in 2020. The Finnish pilot, based on cellular networks and three NordicWay/C-Roads specifications Interchange nodes, being Interchange network, exchanged their ecosystem's messages with existing users and vehicle fleets. The full results report can be viewed from in the www.nordicway.net webpage under year 2020 and 'NordicWay 2 Final Report Finnish Pilot (2020)'.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	2 300	1 300	1 400	800	

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
100	100	1000	1 400	1 500	

8. The French Pilot site

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

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

Following SCOOP@F, C-Roads France develops 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. Hence, it provides a consistent solution for the deployment of almost all Day-1 services and of some Day-1,5 services as defined by the EC C-ITS Platform.

The Action aims to reach a seamless continuity of services at the urban/interurban interface. It provides 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 is supported by 2 car manufacturers to maximise interoperability with the infrastructure and ensure future roll-out of vehicles.

C-Roads France advocates for a pragmatic and user-centric approach: the Action develops a C-ITS smartphone application supporting early I2V (infrastructure-to-vehicle) services roll up and further scale up. The services are supported by a hybrid technology enabling a seamless switch between ITS G5 and cellular for not safety-critical applications.

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.

Involved partners

	C-ROADS FRANCE	INDID
ROAD OPERATORS	– Ministry: public road operators (DIRs Est, Centre-Est, Atlantique, Ouest) – ASFA: concessionaires road operators (APRR, SANEF, and Vinci Autoroutes)	– Ministry: public road operators (DIRs Est, Méditérannée, Ile-de-France, Ouest, Centre Ouest, Nord, Atlantique) – ASFA: concessionaries road operators (APRR, SANEF, and Vinci Autoroutes)

CITIES / PUBLIC ENTITIES	– Strasbourg Eurométropole – Bordeaux Métropole	– City of Paris – Aix-Marseille Métropole – Département de l'Isère
CAR MANUFACTURERS	– Renault – PSA	
RESEARCH INSTITUTES / UNIVERSITIES	– CEREMA – Université Gustave Eiffel – Université Clermont-Auvergne – Université de Reims Champagne-Ardennes	– CEREMA – Université Gustave Eiffel – Université Clermont Auvergne – Université de Reims Champagne-Ardennes – Bordeaux INP – Institut Mines-Télécom – Université Polytechnique Hauts de France – Eurecom
SECURITY EXPERTS	– IDNomic	– IDNomic
MOBILITY LABS / GOEGRAPHY EXPERTS	– Transpolis	– Institut Vedecom – Le LAB – IGN
SOLUTIONS PROVIDERS: C-ITS / MOBILITY / DIGITAL		– Valeo – TomTom – Green communication – Transdev Autonomous Transport Systems – ATC France

Location

The action will be implemented on 4 local pilot sites combining TEN-T network and urban sections.

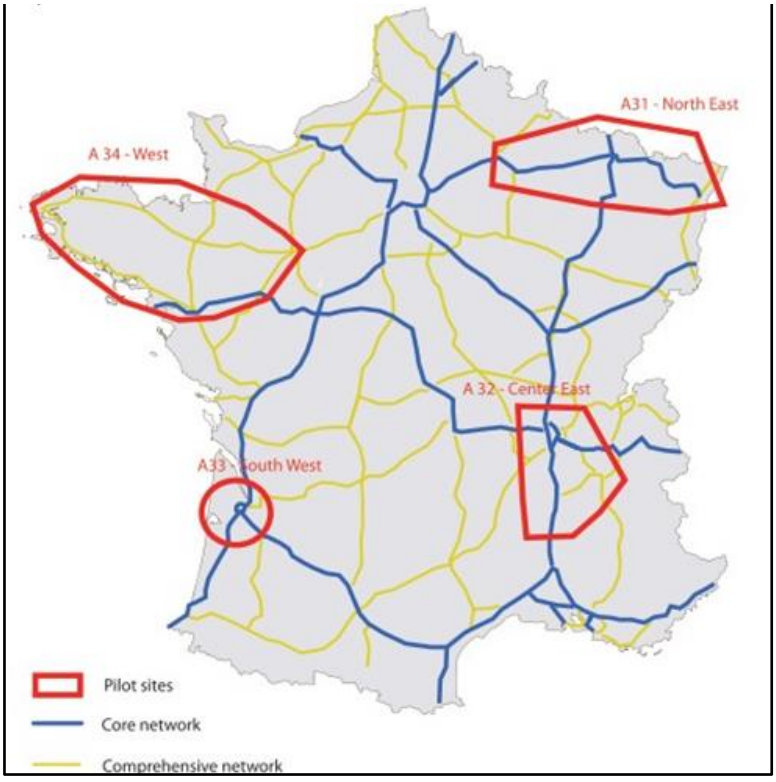


Figure 10: Location of the French pilot sites

InDiD is divided into 8 local pilot sites, described in the following map.

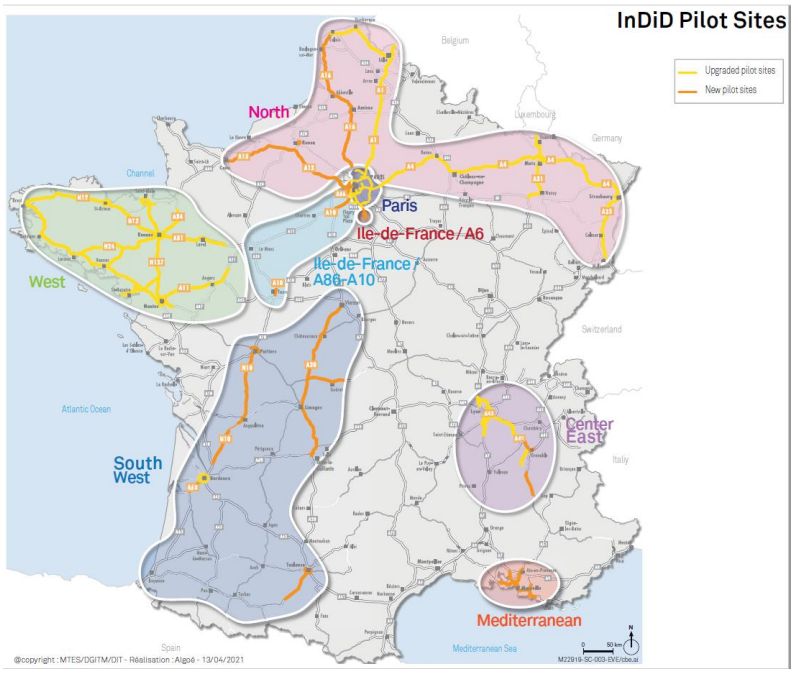


Figure 11: Location of the French pilot sites for InDiD

Co-financed by the European Union
Connecting Europe Facility

Overview of progress by End of 2020

C-Roads France

French beneficiaries are heavily involved in the C-Roads Platform activities, participating both to the strategic discussions and to the technical working groups. The SCOM and the WG2 are chaired by France. France has also actively participated to Cross-border tests. In this matter, even though the initial schedule and methodology were heavily impacted by COVID19 crisis, France held a successful virtual session of interoperability tests with partners from Hungary, Austria, Italy, Czech Republic, and Spain in November 2020.

At French level, C-Roads France has defined and prioritized services to be developed and an important part of specification, development and validation works were executed in 2016 to 2019, arriving to a first validation campaign in Nov. 2019. In 2020, all activities were slowed down due to the pandemics. Nevertheless, partners continued with developments for different use cases and components of the C-ITS chain. All road operators and car manufacturers also pursued development activities to deliver the C-Roads prototypes on their perimeter: from On-Board Units (OBU) in vehicles and Road-Side Units (RSU) to the Traffic Management Systems, and the central national C-ITS station. This work includes the security protocols (PKI) and is done in hybrid technology (ITS-G5 and cellular). This last year, development and validation activities mostly focused on the “migration” of the C-ITS system in order to ensure European interoperability, i.e. ensure continuity of service between France and other European countries.

French Transport Ministry took on the smartphone application activities following work of road operators on specifications. After a Proof of Concept, a first version of the application was delivered in July 2019 for internal testing by the project. Careful attention was payed to the ergonomics of the application, a dedicated study was carried out by a specialist. Developments continued on this basis. Testing of the second version of the smartphone application started in 2020, but was quickly stopped by the COVID19 pandemics. Work was resumed progressively and a new version was developed and ready for release to general public by September 2020. Partners decided to delay the release while waiting for a more suitable time slot as France faced the second COVID wave in October 2020. In the meantime, work continued on the following version and on communication campaign. The smartphone application was released in Jan. 2021.

Aside of development and validation activities, road operators of the 4 pilot sites have defined which services to deploy and where to deploy them. They have organized calls for tenders to deploy RSUs and road operator OBUs. By end 2020, 148 out of 157 RSUs have been installed, as well as 60 out of 69 OBUs. Bluetooth beacons were also installed within the roadside units.

By the end of 2019, all pilot sites were able to send and receive messages through their roadsides units, enabling services for vehicles. And by end 2020, they have all installed the SCOOP platform, involving evolutions of their traffic management systems.

Finally, 2020 was an important year for impact studies, as most of evaluation protocols were finalized and partners were even able to produce the final version for several studies such as End-user behaviour and Distraction, and studies on Heterogeneous vehicular communications and for Hybrid Architecture ITS-G5/LTE V2X.

InDiD

In 2020, a road map has been implemented for the studies activity and for the 8 pilot sites within which the systems specified will be deployed, developed and validated.

The list of services has been defined and prioritized. The resulting catalogue has been harmonized with French partners of SCOOP@F, C-ROADS France, and InterCor, and includes comprehensive functional descriptions based on a European template. It has been a major contribution to the C-Roads Platform.

Once this work was accomplished, the list of new use cases was put to vote to prioritize the use cases chosen to be studied and undergo the implementation process of technical specification / prototype development / validation / deployment, following an organization in four stages to allow a progressive delivery of components. The developments started after the finalization of specifications for the first stages. InDiD partners that did not participate in a previous French C-ITS project, have been developing all the components based on the existing specifications, produced in SCOOP, InterCor or C-ROADS France projects.

For partners already involved in previous French C-ITS projects, the developments are planned to start in 2021, based on the new InDiD use cases (for example : C6 - Toll station approaching: orientation of automated vehicles, G2 - Traffic signal priority request by buses, or G7 - HD cartography on intersections). Also, road operators who have already equipped their infrastructure on C-ITS hardware and software in previous projects are actively preparing to shift to the production environment, which will allow them to deliver C-ITS services outside the perimeter of these projects, ensuring they respect all French specifications (notably regarding safety and security).

Besides, impact studies have been planned. They aim to demonstrate that the system has all the capacities required to provide efficient, secure and safe services to users. This assessment will be based on tests on pilot sites, and may be supplemented by laboratory tests, simulations and formal studies to validate the size of the system in order to reach a compromise between performance, security, safety, confidentiality and cost.

For the validation activity, the first phase has started, consisting in analysis of use cases and stakeholders. The Covid-19 crisis had a slowdown effect on the validation phase. Therefore, the writing of the test plans was not fulfilled in time. They are in progress and should be terminated by summer 2021, in order to achieve the test campaigns for this stage by the end of the year.

InDiD has also started transversal studies following a roadmap validated in 2020 and the first deliverables have been validated on topics such as hybridation or HD Map studies. Other studies, mainly covering security issues have also started.

Interaction between C-Roads France, InDiD and other French C-ITS projects is guaranteed on the long run notably through a common Steering Committee of Studies. Its objective is to ensure interoperability between all C-ITS initiatives and to allow all French partners to convey a shared approach on C-ITS to the C-Roads Platform.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
167	474	894	1894	2428	1351

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
642	2610	7074	7196	4386	

9. The German (Hessen, Niedersachsen) Pilot site

Germany as Member State will contribute to the C-Roads cooperation by the findings of the implementation and operation of in total seven different C-ITS services, which will be deployed in two 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 rollout 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 conjunction with legacy systems
- encouragement of the German automotive industry to equip their cars with appropriate devices and thus stimulation of end-users to buy V2X-enabled cars to benefit from the services

To achieve these goals, the mentioned services in the Hessian and Lower Saxony pilot road network 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
- **appropriate methods and KPI** for the evaluation and assessment of the deployed C-ITS services

The C-ITS Pilot Hessen will contribute 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) [former Slow or Stationary Vehicle Warning Service Deployment, SSVW)]
- Emergency Vehicle Approaching Service Deployment (EVA) [former Slow or Stationary Vehicle Warning Service Deployment, SSVW)]
- 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)

The Niedersachsen C-ITS Pilot will contribute to the C-Roads cooperation by implementing and deploying the following three C-ITS services:

- Maintenance Vehicle Warning (MVW) [former Slow or Stationary Vehicle Warning Service Deployment, SSVW)]
- In-Vehicle Information/In-Vehicle Signage Service Deployment (IVI/IVS)
- Probe Vehicle Data Service Deployment (PVD)

The C-Roads Germany – Urban Nodes pilot Hamburg will contribute 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 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. Purpose 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 road operator die Autobahn GmbH des Bundes.
In detail, for the Hessen transport network, the service Emergency Vehicle Approaching (EVA) and Green Light Optimal Speed Advisory (GLOSA) will be extended. The following three new services will be implemented:

- Connected and cooperative navigation into and out of the city (route advice),
- Traffic Signal Priority (TSP) for emergency vehicles and
- Intersection safety, Vulnerable Road User protection (VRU).

For the transport network in the city of Kassel the services TSP for public transport vehicles and GLOSA will be extended. The following three new services will be implemented:

- Road Works Warning (RWW),
- Connected and cooperative navigation into and out of the city (route advice) and
- Probe Vehicle Data (PVD).

The C-Roads Germany – Urban Nodes pilot Dresden will contribute 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 single test and validation locations are prepared by different bodies. The Hessen pilot site is organised by the public road operator Die Autobahn GmbH des Bundes. For the Niedersachsen pilot site, the two companies NORDSYS and OECON Products & Services, which will be supported by the associated partner Deutsches Zentrum für Luft- und Raumfahrt (DLR), are responsible for the local activities.

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

Consortium members C-Roads Germany (CRG)

- ITS mobility GmbH
- Federal Highway Research Institute (BASt)
- Hessen Mobil – Straßen- und Verkehrsmanagement
- Continental Teves AG & Co. oHG
- SWARCO Traffic Systems GmbH
- AVT STOYE GmbH
- GEVAS software GmbH
- Heusch/Boesefeldt GmbH
- Bayerische Medien Technik GmbH
- Hessen Digital Radio GmbH
- Garmin Würzburg GmbH
- NORDSYS GmbH
- ESCRYPT GmbH
- INGENIEURGESELLSCHAFT FUER AUTO UND VERKEHR GMBH
- e-Shuttle AG
- Niedersächsisches Ministerium für Wirtschaft, Arbeit, Verkehr und Digitalisierung
- OECON Products & Services GmbH
- Die Autobahn des Bundes GmbH

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
- NORDSYS 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
- Die Autobahn des Bundes GmbH

Location

The seven so called Day 1 Services are trialled in the German testbeds in Hessen (DRIVE-test field Hessen for connected automated traffic around Frankfurt, see Figure 12 and Figure 13), and Niedersachsen (motorway A2 near Brunswick, see Figure 14).

The activities of the Hessen Pilot will be realised on the following motorway sections:

- A3 around Offenbach, Frankfurt and the airport in Frankfurt to Mönchhof-Dreieck
- A5 in the whole area between central Hessen (Wetterau) and the South Hessian state border including Frankfurt and Darmstadt
- A60, A67 and A671 in the whole Hessian area
- sections of the A661 near Frankfurt

Figure 12: Overview of the test field of the C-ITS Pilot Hessen

Furthermore, the GLOSA service will be implemented on national roads in a city in the Rhine-Main region.

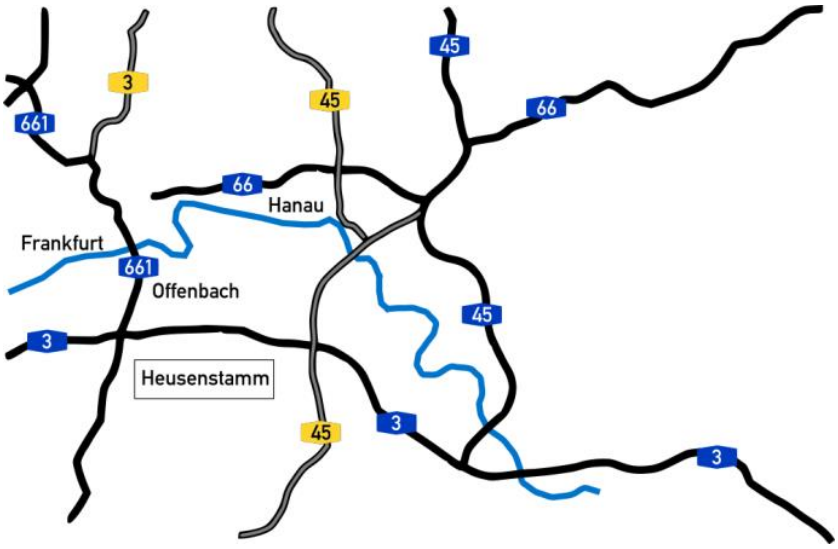


Figure 13: Test area of the GLOSA service in Hessen

In Niedersachsen, the currently existing R&D test area “Application Platform for Intelligent Mobility (Anwendungsplattform Intelligente Mobilität, AIM))” focuses on the urban area in the city of Brunswick and serves as a platform for application-focused science, research and development in the field of intelligent mobility services. Within this year the test field will be enlarged and transferred under the lead of the Ministry for Economy, Labour, Transport and Digitalisation of the Federal State of Niedersachsen (Niedersächsisches Ministerium für Wirtschaft, Arbeit, Verkehr und Digitalisierung, MW) and the German Aerospace Centre (Deutsches Zentrum für Luft- und Raumfahrt, DLR) to federal roads and motorways between Hannover, Brunswick and Wolfsburg. On the motorways (especially on the A2) of this new Test Site Niedersachsen amongst others it is planned to extend existing gantries with ITS Roadside stations (R-ITS-S) to provide C-ITS services for testing and development activities via ITS G5.

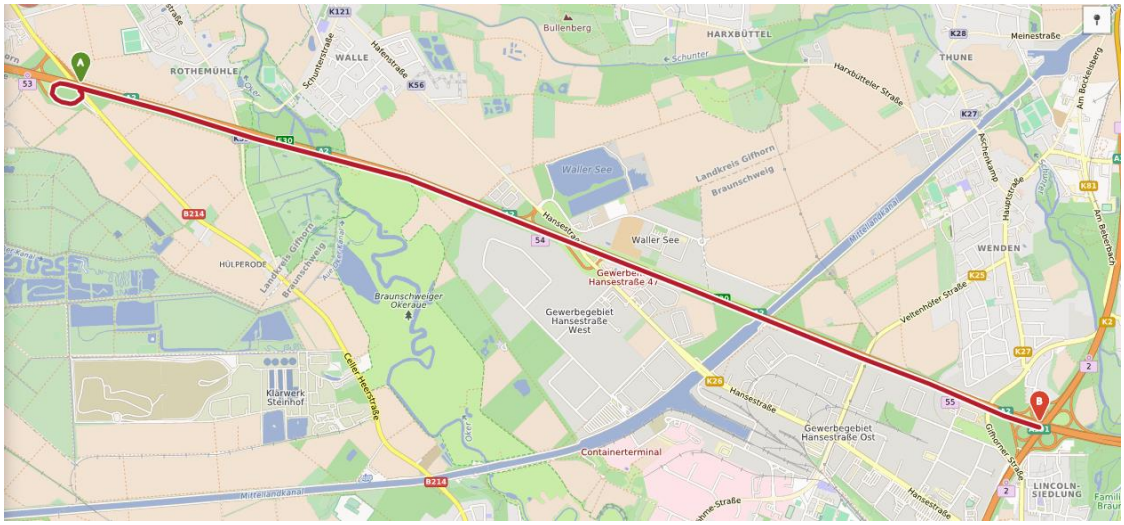


Figure 14: Niedersachsen pilot site stretch[1]

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.

[1] source of the map: © OpenStreetMap

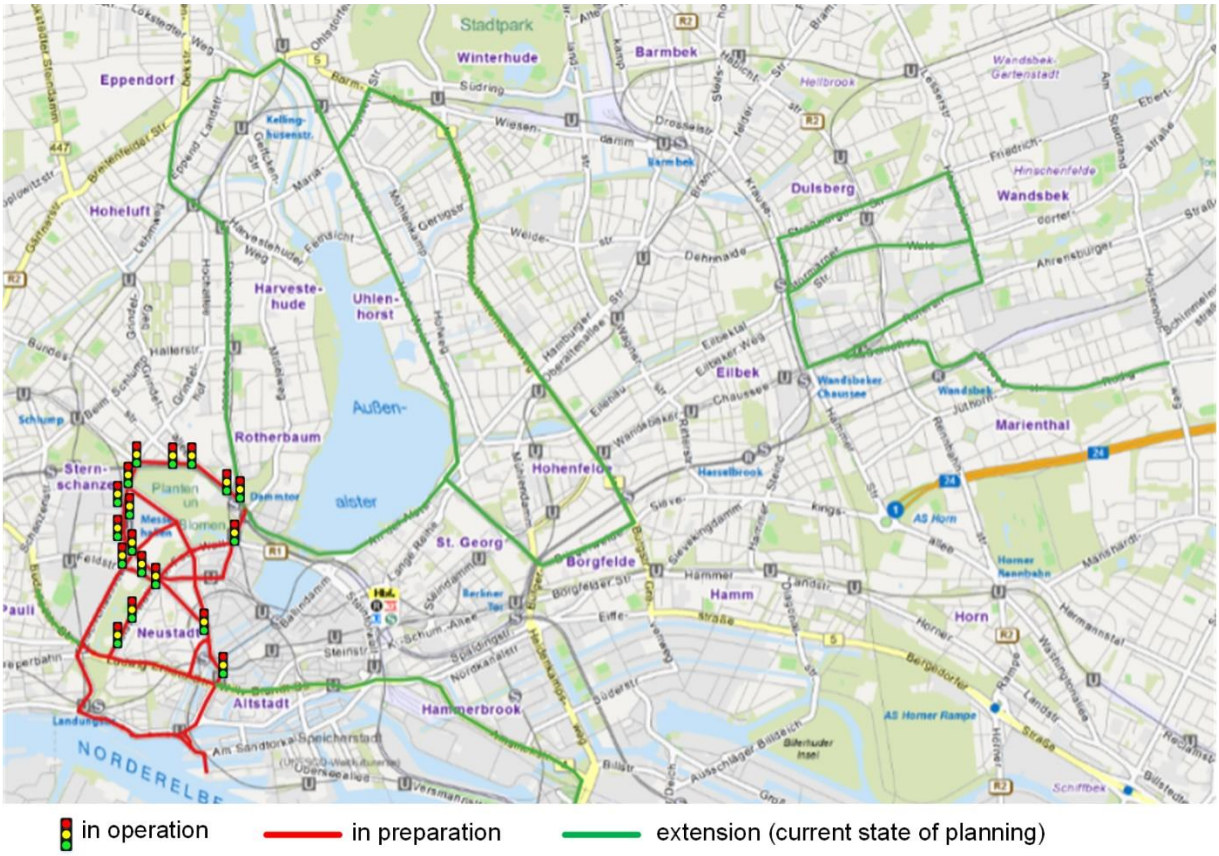


Figure 15: The Pilot Hamburg Site

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.

In Hessen, the test field will be extended due to the Hessen/Kassel pilot. Different services will be implemented in and around the city of Kassel.

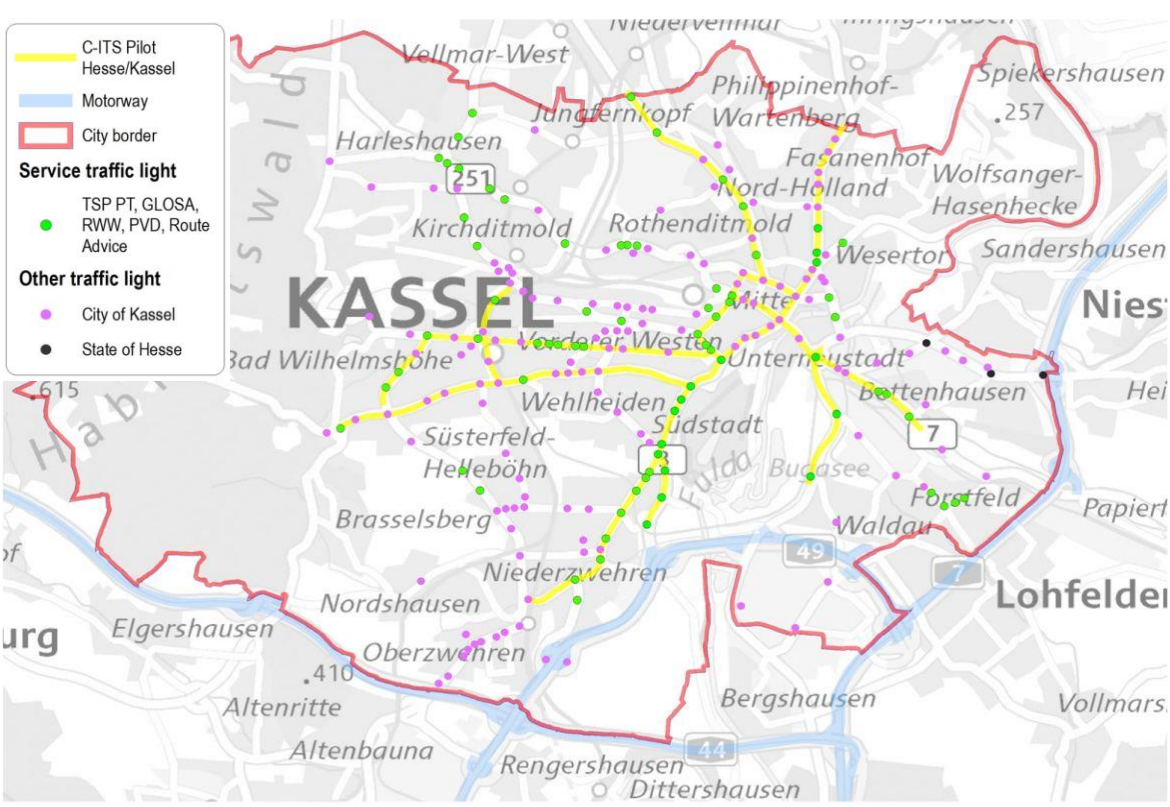


Figure 16: Overview of the equipped routes in the city of Kassel

The digital test site for connected driving Kassel covers modern technical equipment in the traffic management center of the city of Kassel and already more than 30 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. By end of 2023, the test site in Kassel will comprise 75 C-ITS capable traffic lights (by 12/2020 36 R-ITS-S are already in operation).

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.

5 C-ROADS R-ITS-S went into operation in 2020 (see **Fehler! Verweisquelle konnte nicht gefunden werden.** – blue layered corridor). Up to 30 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

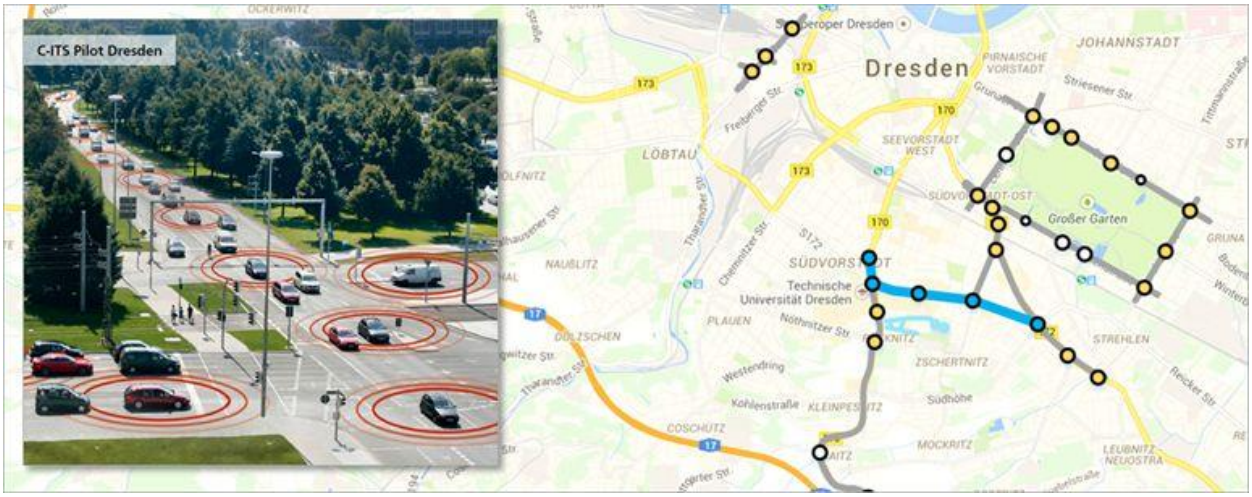


Figure 17: Overview on the Dresden pilot. Source: maps.google.de

Overview of progress by End of 2020

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 has maintained the corresponding structures for aligning the German C-ITS pilot sites and the work has become routine. The Urban Nodes pilot sides have been integrated into the daily harmonisation activities.

The harmonisation of the German activities (Activity 2) within the C-Roads Germany Coordination Group and the established Expert Groups has been continuously refined and consolidated, involving now the Urban Nodes pilot sides, too. In 2020, two Steering Committee meetings took place to discuss results and urgent topics. An amendment to the Grant Agreement was requested in 2020 to extend the project duration by one year until 31.12.2021. It was required due to systematic delays caused by the COVID-19 pandemic situation and included mainly those tasks that involve partners from several C-Roads projects on Platform level (cross-border tests, C-ITS roadshow). The preparation of further intra-pilot tests and the international cross-border tests planned for 2020 were assisted.

Pilot site Hessen (CRG Activity 3) focussed on fulfilling Milestone 45 “Hessian final demonstration event of all services”. The last intensive test phase has been carried out in 2020 as a preparation for the cross-border tests which took place in September 2020. Due to COVID-19 only German members of the CAR 2 CAR Communication Consortium participated. The tender and implementation of the EVA service had to be postponed. The V-ITS-S was tendered twice in 2020.

End of 2020 the contract was awarded as a direct award and the service will be implemented in Q1/2021.

In Pilot site Niedersachsen (CRG Activity 4) Milestone 50 was successfully reached, that is the deployment and testing of the services In-Vehicle Signage (IVS) and Probe Vehicle Data (PVD). Due to the COVID-19 pandemic the supply chain was temporarily broken and caused the postponement of both activities. Three R-ITS-S for the IVS and PVD services were installed on three gantries. To collect the vehicle data for the PVD service, ten test vehicles are equipped with V-ITS-S for sending CAMs. Milestone 51, the Niedersachsen final demonstration event of all services, was successfully held on 9.09.2020 in Braunschweig. Regarding Traffic Management Centre Integration, the data converter system was verified and implemented. The development activities for achieving data exchange between C-ITS-S and TMC within the framework of the project were presented and demonstrated at the Niedersachsen Final Demonstration Event. Moreover, an amendment to the Grant Agreement was agreed in 2019 as the service deployment area is extended from A2 (E34) near Braunschweig to include the A39 between Wolfsburg and Braunschweig. The required infrastructure including R-ITS-S was discussed and planned. However, owing to the ongoing COVID-19 crisis, the acquisition and installation of the hardware for the infrastructure was delayed. Therefore, deployment of the infrastructure as well as the provision of these additional services will be implemented in 2021.

By the end of 2020 36 intersection within the Pilot Hamburg (CRG-UN Activity 3) were equipped with C-ITS hardware. Additionally, 5 intersections of the HEAT project which are already sheeted with R-ITS-S could be augmented with additional hardware in order to provide GLOSA service as described in the System Architecture and service Specification (M38). With minor restrictions the GLOSA service is already in operation at 15 intersections, 13 intersections are already equipped with the necessary hardware but are afflicted by software defects caused by one of our distributors. In March, the pilot organised an online workshop where the CRG-UN members came to a common understanding of forecasts and different questions concerning MAPs. One agreement pertains details of the so-called MAP-layering which is already in use at one intersection in the Hamburg pilot. By the end of 2020 feedback from test track users was still open which is needed for a general roll-out.

In 2020 Hessen Mobil and the city of Kassel (CRG-UN Activity 4) fulfilled the milestones M43, M44. The system architecture documents of Hessen Mobil and Kassel as well as the service specifications (M43) have been prepared. It defines the overall system architecture as basis for the service specifications; the service specifications contain the requirements to the envisaged C-ITS service implementations. Furthermore, in order to get an overview of available research studies, the Feasibility Study on vulnerable road user protection (M44) was also carried out. Within the test site of the city of Kassel the traffic light infrastructure of the main roads leading into the city centre of Kassel, is upgraded towards an ETSI ITS G5 I2V- and V2I-communication. The city of Kassel installed 14 C-ITS capable traffic light systems equipped with R-ITS-S (by now 36 C-ITS capable traffic light systems). During the operation periods, the R-ITS-S send the ETSI ITS G5 messages MAP, CAM and SPaT. Since Q4 of 2020, the message type DENM is implemented additionally. Moreover, the expansion of broadband connections between the

several signalised intersections and the TLCC proceeded. In 2020, 6.3 kilometres of fibre optic cable was installed (by now in total 7.8 kilometres).

In 2020 Fraunhofer fulfilled six of seven planned milestones in the Dresden pilot (CRG-UN Activity 5). With the preparation of the Pilot Organisation Plan the organisation and deployment of all services in the C-ITS Pilot Dresden are defined. The services GLOSA, PVD, TSP and VRU were specified (M55 and M60). The C-ITS services GLOSA (M56) and PVD (M57) went operational. The services serve as the basis for further deployment in 2021. Moreover, Fraunhofer installed 5 R-ITS-S with ITS G5 and connected to traffic lights for GLOSA, PVD and TSP. One intersection is defined and planned to be equipped with camera-/sensor systems for the service VRU. HD-map for automated and connected driving were contract for a corridor.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
725	1 493	2 091	2 508	1 590	1 524

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
1 510	7 758	12 116	9 401	8 570	

10. The Greek Pilot site

C-Roads Greece is a newcomer within 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 ADVANXCED 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 3 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 5 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 18: 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, meteo & smoke sensors) will be utilized alongside the C-ITS field equipment that will be installed in the course of the pilot.

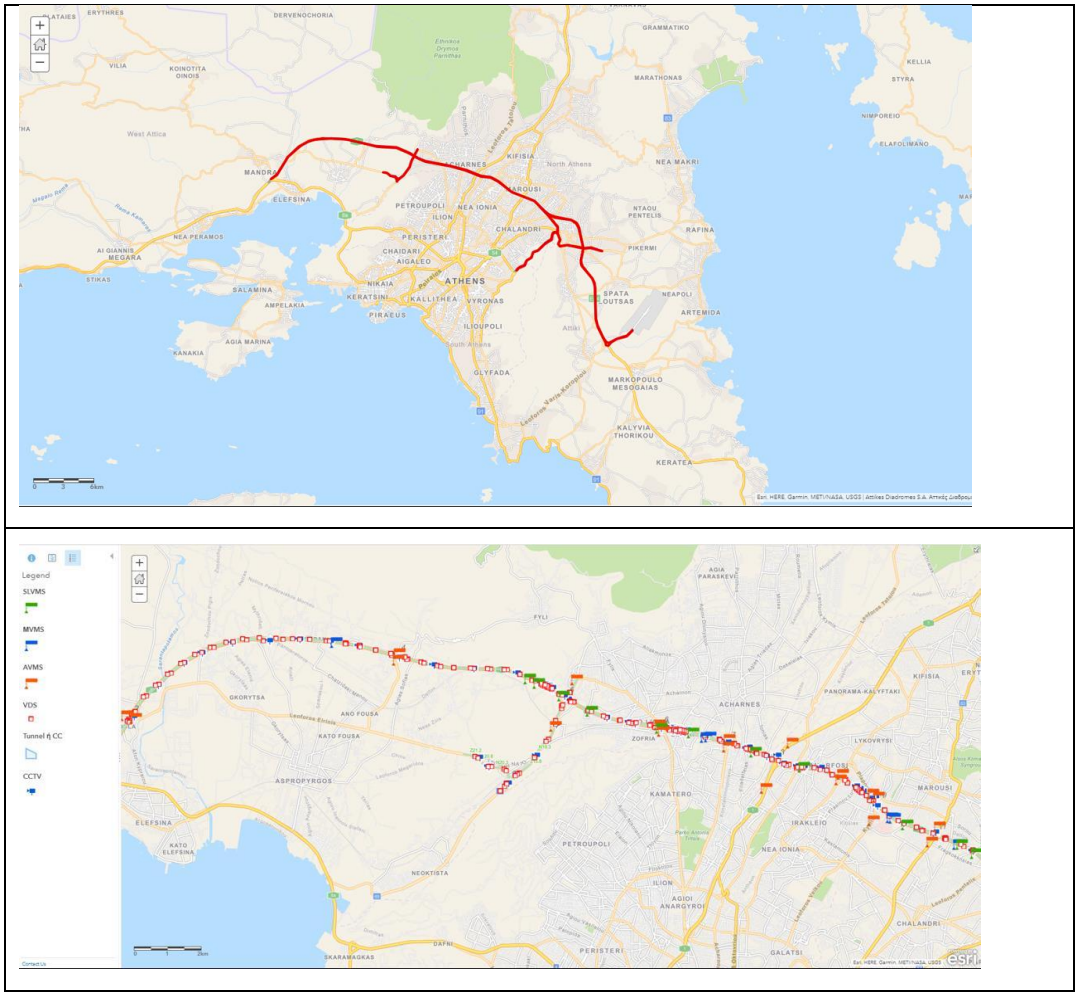


Figure 19: Location of the "Attica Tollway" Greek pilot site

Overview of progress by End of 2020

C-Roads Greece is implemented according to the timetable set in the Grant Agreement work plan. In total, 11 out of 43 milestones have been achieved, i.e. approximately 25% of the overall progress in terms of absolute milestones completed.

- Activity 1: "C-Roads Platform"

During 2020, the planned milestones in Activity 1 were achieved. Four C-Roads Steering Committee Meetings were held virtually (due to the pandemic) with the participation of Greece. 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 in 2020. Best practices on technical and administrative issues are followed.

- Activity 2: "Greek Pilot Management"

C-Roads Greece organised a very fruitful virtual stakeholder workshop (MS29) on 14th of December 2020. The highly successful event welcomed many notable speakers and organisations initiating the dialogue about Cooperative Intelligent Transport Systems (C-ITS) deployment in Europe, issues and recommendations. Two key note speakers were invited, including C-Roads Platform coordinator Mr Martin Boehm and WG2 leader Mrs Marie-Christine Esposito, while 281 people attended it.

- Activity 3: “Pilot Design and Specification of the C-ITS Services”

Preparatory work for the upcoming design of the C-ITS architecture at the two pilot sites has been done in Q1-2020. Various physical and functional architectures from other projects like SCOOP, C-Roads Platform (NL, AT) were analyzed and possible roles and responsibilities between involved parties in C-Roads Greece were defined. An initial discussion and planning for the Network Architecture, services and use cases per Greek Pilot Site, has also taken place. The activity has been concluded within this period (MS33).

- Activity 4: “Procurement and Components development”.

The start of the procurement procedures (MS34) took place as planned, in June 2020. The specifications that fit the needs of the 2 Greek Pilots were defined. All the procurement and tender procedures and steps per pilot site were described.

Concerning the Egnatia Odos Pilot an open international tender is under preparation following the provisions of the national law N.4412/2016 (in conformance to Directive 2014/24/EU and 2014/25/EU) for public tenders.

Concerning the supplier of Attiki Odos Pilot, a shortlist of candidate vendors was formed and a round of web meetings was arranged with them. One key criterion of including a vendor in the shortlist was to have experience in other C-ROADS projects, as a technology provider. The “Request for Proposals” (RFP) round followed with its participants posing a subset of those that participated in the RFI (Request for Information) round. Finally, the preferred bidder was NeoGIs.

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
27	228	1 453	731	130	

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. 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' 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, too.

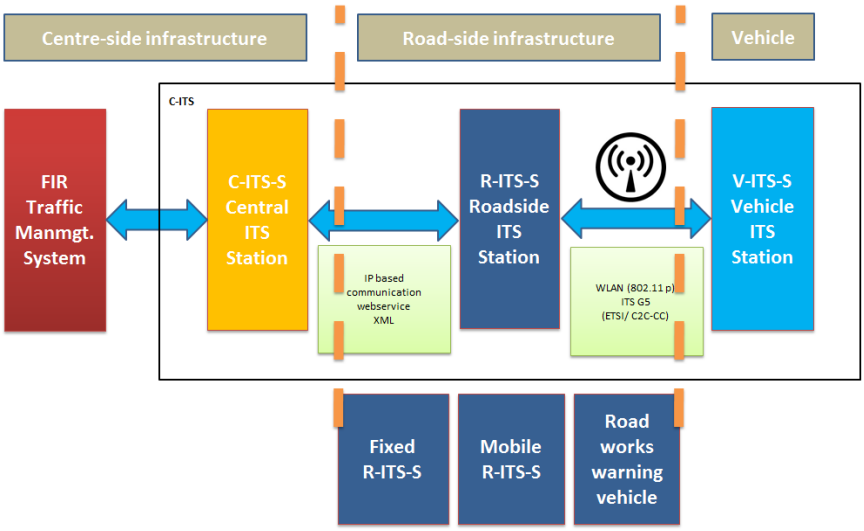


Figure 20: System architecture

In the framework of CROCODILE 2.0_HU project, additional 26 fixed road side units, at 13 locations were deployed along M0 Budapest Ring Road till May 2019. 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 plan 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, too, 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 Automative 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 plans 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 vehicle equipped with OBUs

Involved partners

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

Partners planned to be involved:

- 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) will be covered, and urban deployment will be 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 and other devices will be 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.

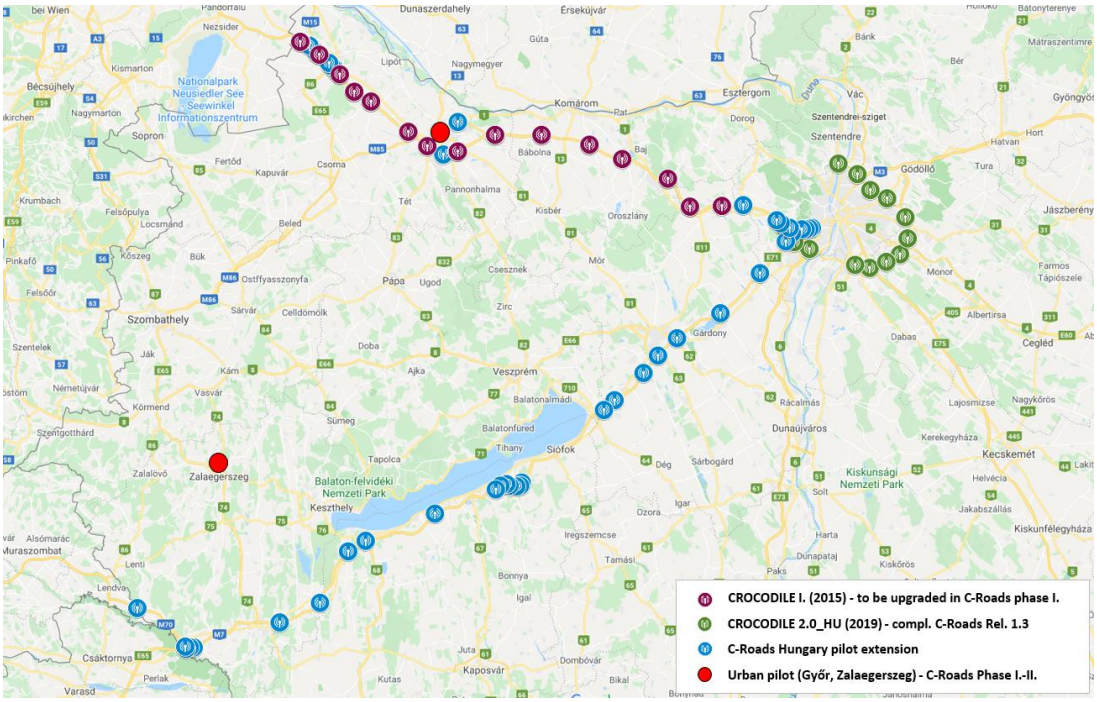


Figure 21: Location of the Hungarian pilot site

Figure 22: Urban pilot site, Győr

Co-financed by the European Union
Connecting Europe Facility

Overview of progress by End of 2020

The four main parts of C-Roads Hungary pilot deployment were completed by the end of 2020, these parts were the following:

1) Upgrading existing pilot (motorway M1)

In this part , the main goal was to fully upgrade, the pilot system along motorway M1 installed in 2015, in order to be compliant with the C-Roads Release 1.6 specifications, and to introduce new use cases, and to introduce a two way (I2V and V2I/V2X) and hybrid (ETSI ITS-G5 and cellular) communication. The provided services /the names of their sub-cases are as follows: IVS-DSLI, IVS-EVFT, IVS-DLM, IVS-OSI, HLN-AZ, HLN-TJA, HLN-WCW, HLN-TSR, HLN-OR, RWW-LC, RWW-RC and RWW-RM. The figures of the deployment:

- 20 mobile units mounted on maintenance vehicle, and VMS trailers
- 27 fixed units mounted on VMS gantries, and emergency poles (between km 34 and 170 of motorway M1)

2) Purchase of test OBUs (V-ITS-S)

Purchase of at least 20 V-ITS-S unit for testing. The use cases to be tested are the following: IVS-DSLI, IVS-EVFT, IVS-DLM, IVS-OSI, HLN-AZ, HLN-TJA, HLN-WCW, HLN-TSR, HLN-OR, RWW-LC, RWW-RC, RWW-RM, 'SI-GLOSA', 'SI-SPTI', 'SI-ISVW' and 'PVD' (as in C-ROADS Harmonised Communication Profiles Rel. 1.6).

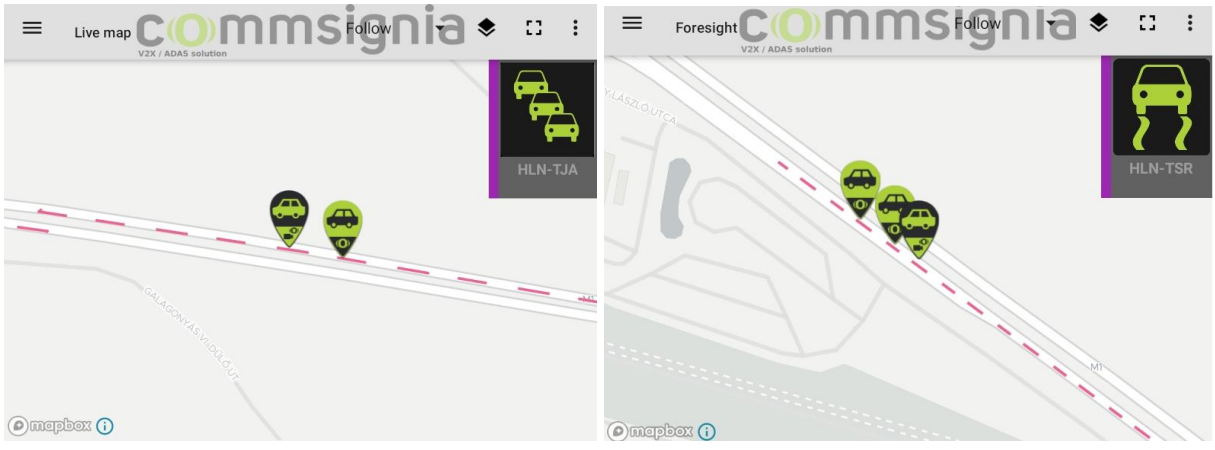


Figure 23: OBU visualization (Foresight Application by Commsignia)

3) Urban Pilot (Municipality of Győr)

The aim of this part was to build up a cooperative system based on signalised junctions in the town of Győr, by implementing the elements of the "Roadside Infrastructure" (R-ITS-S), as well as implementing new functionalities and message types (eg. SPATEM, MAPEM). The urban

pilot covered 10 consecutive junctions along the main transport corridor of Győr passing through the city centre. The provided urban C-ITS functions are the following:

- SI-GLOSA (Green Light Optimal Speed Advisory)
- SI-SPTI (Signal Phase and Timing Information)
- SI-ISVW (Imminent Signal Violation Warning)

(as in C-ROADS Harmonised Communication Profiles Rel. 1.6).

Figure 24: Installation works at H002 intersection in Győr

Besides urban use cases, the RSUs the following use cases are included, too: IVS-DSLI, IVS-EVFT, IVS-DLM, IVS-OSI, HLN-AZ, HLN-TJA, HLN-WCW, HLN-TSR, HLN-OR, RWW-LC, RWW-RC és RWW-RM, and PVD.

4) Pilot extension (fixed RSUs along TEN-T motorway sections)

The objective of this part was to cover new sections with C-ITS services by installing 43 new fixed road side units (R-ITS-S), along motorway M1 and M7. The services or services or their sub-cases to be provided are as follows: IVS-DSLI, IVS-EVFT, IVS-DLM, IVS-OSI, HLN-AZ, HLN-TJA, HLN-WCW, HLN-TSR, HLN-OR, RWW-LC, RWW-RC and RWW-RM and PVD as in C-ROADS Harmonized Communication Profiles Rel. 1.6.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	2	5	26	585	1

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
10	100	1 785	1 187	10	

12. The Italian Pilot site

The main goal of the C-Roads ITALY project is to implement and test, in real traffic conditions, 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.

That implies the infrastructure upgrade and the integration of V2I C-ITS service and V2V information with vehicle control strategies.

C- Roads ITALY planned to pilot a set of “Day1” and “Day1,5” C-ITS services as recommended by the EC C-ITS Platform.

The expected impact to be demonstrated is mostly on mobility, considered in terms of:

- Safety – to demonstrate the reduction of risk related to cooperative/automated technology in truck and passenger cars scenarios, and also in combined scenarios
- Traffic fluidity – to show the potential for efficient use of the infrastructure with Platooning technology and Highway Chauffeur technology
- Energy efficiency – to measure in real life conditions the potential for fuel consumption and related emission reduction.

The Italian implementing bodies (Road concessionaires, OEMs, telecom operator, research centre, etc…) will invest in their infrastructure and the industry will use that pilot test infrastructure to test components and services.

All Italian implementing bodies, according to their technical expertise, will be involved in the different WGs and Task Forces established by the C-Roads Platform; reporting about the status of national pilots, contributing to the harmonization of the different technical issues that will be discussed within the C-Roads Platform.

The results and lessons learned from C- Roads ITALY will be fully shared across Europe through the cooperation in the C-Roads Platform.

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

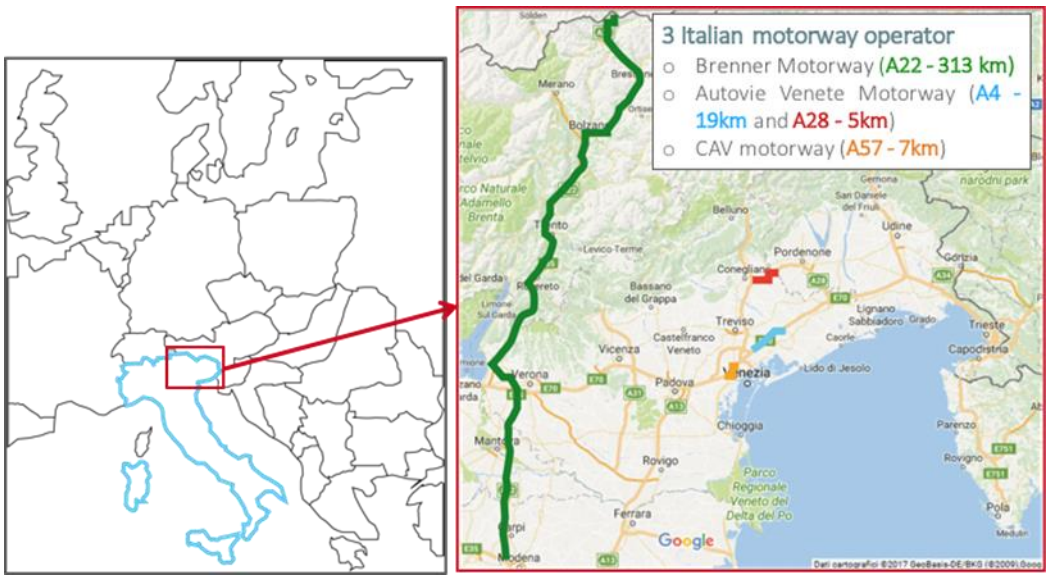


Figure 25: Location of the Italian pilot site

Overview of progress by End of 2020

- 82 RSUs installed along the 367Km of road sections involved in the first pilot
- Trucks Platooning - 4 Trucks have been updated and completed with innovative HW and the last SW available to support Platooning and its interaction with the C-ITS Day1 services implemented within the project. At the end of 2020 an extensive driving activity started that will go on in 2021; more than 300.000 km will be travelled with active platooning technology. The goal is to collect elements useful for its improvement to ensure the most effective application in real conditions of use. On the same occasion, the Vehicle communication will be 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) - Three vehicles have been set-up with the Highway Chauffeur functionality and equipped with C-ITS and are currently operational along the Brenner corridor motorway. The set-up concerned the adaptation/substitution of the hardware and software components. The main components which have been adapted for the project are the V2X communication firmware and the vehicle control/actuation software. The on-board equipment installed includes modules both for connectivity and for the processing of the V2X information. In particular, vehicle connectivity regards V2X communication via ETSI ITS G5 and 4G cloud connectivity in order to exchange messages with other vehicles and to receive messages from the RSUs installed along the infrastructure test site.

Within C-Roads Italy two specific Milestones have been set and will be finalized in 2021: a cross-site test session between Italy and Austria, both for passenger cars and for trucks equipped during the life time of the C-Roads Italy project. The cross-site test will be organized with the goal to verify the full interoperability of the C-ITS services as requested by the C-Roads Platform. In agreement with the Austrian motorway operator Asfinag, the pilot test will stretch to the Austrian road network, in the Brenner area, in order to have data and results also in a cross-border environment.

Moreover, it is important to highlight the evaluation activity performed in order to demonstrate the expected impact on mobility. A first difficulty faced in defining the evaluation methodology adopted is constituted by the limited percentage of vehicles experimental or capable of receiving C-ITS with respect to traffic total circulating that will be recorded during the tests on field. To overcome the limitations imposed by this condition, the evaluation methodology was designed for evaluate how the systems tested affect the driver behavior. The hypothesis that determined this approach is as follows: to identify changes of the individual driver behavior, and then to project these variations on a percentage of traffic higher, in order to estimate the different impacts for different market penetration percentages, which can be associated with different time horizons. National Implementing Bodies were involved in the identification and investigation of the set of data needed/useful to be collected during the actual deployment of the field tests in order to perform the modelling exercises and the ex-post evaluation.

C-Roads Italy 2

The main goal of the 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

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	2 244	3 752	4 437	2 803	5 406

Indicative budget overview C-Roads 2 (in k€)

2018	2019	2020	2021	2022	2023
116	1 320	1 915	4 005	3 756	2 625

13. 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 both V2V and V2I communications. Figure 26 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 will be tested on this section together with tests to demonstrate interoperability and harmonised services across a simulated border.
- **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 and along a corridor that connects to the TEN-T network.
- **Section 5: M7 and N18 between Limerick and the M8 intersection** - a range of services are to be piloted on this section, which are likely to include adverse weather warnings (both via V2V and V2I).

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 responsbile for the development and growth of Irish enterprises
- **IDA** – (Indiustrial Development Authority) a semi-state organisation promoting overseas direct investment into Ireland
- **Kapsch** – A partner to provide C-ITS central station support and services
- **Dynniq** - A partner to supply and install RSUs and OBUs together with the provision of C-ITS service application software

Discussions about potential partnering opportunities are currently being held with a number of organisations under the following categories:

- **Mobile network operators** – the three main MNOs in Ireland (Vodafone, Three and Eir);
- **Car manufacturers** – Jaguar Land Rover;
- **Road operators** – PPP concessionaires (M50CL, Celtic Roads Group and Direct Group).

Location

Figure 26: Location of the Irish pilot site

Overview of progress by End of 2020

Having completed the outline design of the pilot, covering both system design and roadside infrastructure design, specifications were prepared that were subsequently tendered. This

procurement process covered the development of the central station (C-ITS-S), roadside and in-vehicle C-ITS equipment together with use-case software application development. The procurement process made use of two existing contracts that Transport Infrastructure Ireland (the implementing body) were using to procure a replacement traffic management system and the necessary road side equipment/support to deliver variable speed limit functionality on the M50 (part of the pilot corridor).

By August 2020, contracts were signed with Kapsch to provide the C-ITS-S and Dynniq to provide roadside and in-vehicle equipment together with software application development. This is five months later than the indicative completion date set out in the grant agreement and in the first ASR. There were numerous reasons for this slight delay, such as extended tender period being granted, a longer than anticipated evaluation period and issues around the outbreak of COVID-19.

This delay in appointment of C-ITS contractors has had the knock on effect of not being able to install RSUs in the timescale that was originally envisaged. The milestone to complete and approve the installation of ITS G5 infrastructure has therefore not been achieved within 2020. RSUs will be deployed in phases (to mirror the deployment of other ITS infrastructure), with the first phase expected to be completed by Q3 2021, with site acceptance sites completed by the end of 2021. The last section of motorway to be equipped with RSUs is the M50 between junctions 3 and 4, which is scheduled for Q2 2022, with testing scheduled to be completed by Q3 2022.

To support the RSU deployment activity, ITS-G5 radio modelling has been undertaken to help identify optimal locations for deployment, in terms of radio coverage. The analysis has resulted in fewer locations being anticipated which will potentially result in a cost saving – discussions are on-going as to whether the RSU network could be extended in light of these findings.

Significant progress has been made to see how C-ITS can benefit Dublin City Council. Numerous workshops have been held with DCC, to initially understand their aspirations and then to help assess/define their technical feasibility in line with C-Roads specifications. A series of use-cases have been identified. Work continues to develop the implementation plan.

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
593	717	2 277	3 248	2 612	

Costs are exclusive of VAT and relate to the national pilot only and not C-Roads platform support. The profile of forecast costs is based on a procurement strategy as of March 2021

14. The Dutch Pilot site

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 meaning full 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 takes place there. Next to that also the Core network section on the A2 around the Leidsche Rijn Tunnel is added. The total network stretches out for 268km of which 60km or 22% is 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 will be piloted and implemented. Combining the Brabant Corridor initiatives with the services proposed within the InterCor project, the region will benefit even more.

Involved partners

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

Location

The services will be 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.

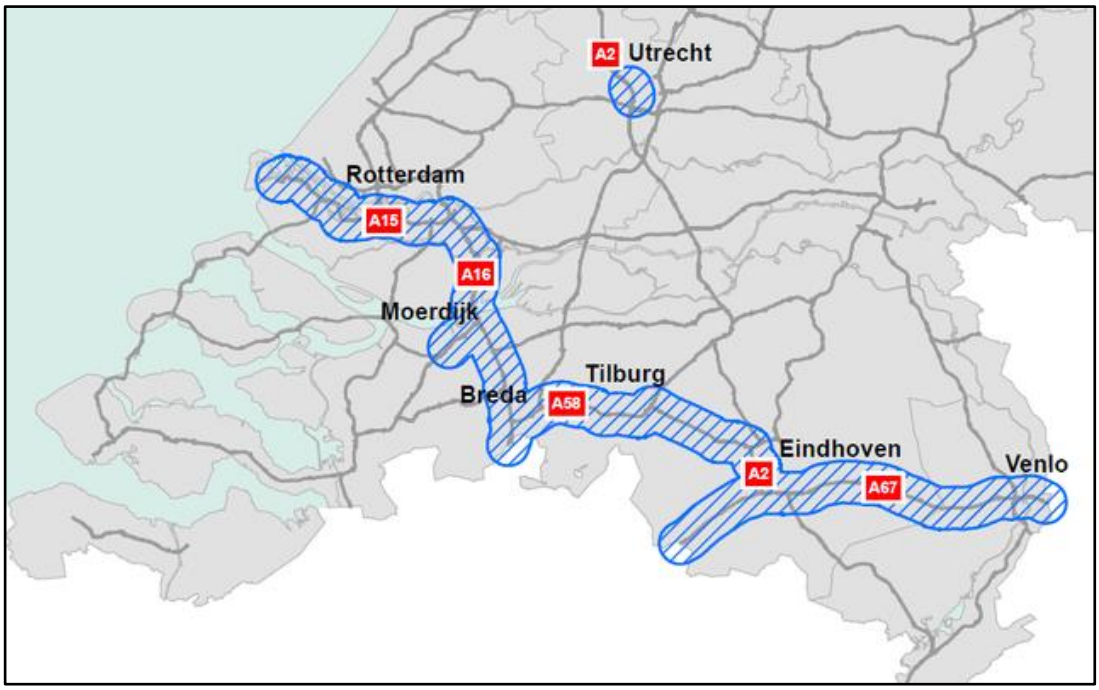


Figure 27: Location of the Dutch pilot site

Overview of progress by End of 2020

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 adaptions 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 Drechttunnel closed for roadworks), May 10, 11 and 12 (60 test drivers – roadworks on the Van Brienenoord 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 date 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.

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.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
1 100	3 700	5 200	3 300	n.a.	n.a.

15. The Norwegian Pilot site

The Norwegian pilot was part of the NordicWay 2 project (2017-2020) and currently 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 2 project (2017-2020):

- Contributed to the harmonisation and interoperability of the C-ITS services in Europe with requirements agreed by the C-Roads Platform.
- Supported the deployment of new "Day-1" and "Day-1,5" C-ITS services in Nordic countries and extend its use in vital road freight transport routes subject to extreme weather conditions and in urban and interurban environments.
- Supported the infrastructure readiness for connected and automated driving in Nordic countries in snowy and icy arctic conditions.
- Evaluation results (2020) include technical feasibility, ecosystem and business models, socio-economic impacts of the piloted Day-1 and Day-1.5 C-ITS services as well as the effect on user´s mobility and traffic behaviours and on public acceptance. Final evaluation results are available at www.nordicway.net.

NordicWay 2 project was successfully completed in 2020 and the project's evaluation results as well as the knowledge gained in C-roads TF2 Service definition and TF4 Hybrid communication were addressed in the planning of the new NordicWay 3 project. The full NordicWay 2 (2020) and in future NordicWay 3 results and reports can be viewed in the www.nordicway.net webpage.

From 2021 forward the NordicWay 3 – Urban connection project, with more cities involved, will continue to harmonise and build European C-Roads specifications for hybrid communication. 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 board tests with other pilots in European countries who has implemented the C-Roads hybrid communication specification.

Norwegian national pilots

The two Norwegian pilots include (1) use cases of Day 1 and Day 1.5 C-ITS services on the peripheral networks and (2) mapping of infrastructure readiness for connected and automated driving on major freight routes of the comprehensive network in Norway.

(1) Use cases of Day 1 and Day 1.5 C-ITS services on the peripheral networks

The pilot will design, and implement, test and evaluate use cases of Day-1 and Day-1.5 C-ITS services on the peripheral networks, to allow for smooth transitions between the networks.

Testing on the comprehensive and peripheral networks ensures a broader test of functionality than on the core network. If tests are successful on the peripheral or comprehensive network, the Day-1 and Day-1,5 C-ITS services tested will be applicable under extreme weather conditions on the core network.

In particular, the pilot will explore the feasibility of the following Day-1 and Day-1,5 services on these rural routes with poor cellular connectivity and without full access to power mains:

Day 1 services:

- Hazardous location notifications:
  - Slow or stationary vehicle(s) & Traffic ahead warning
  - Weather and road conditions
  - Emergency brake light
- Road works warning
  - Road and lane closure
  - Mobile road works
- In vehicle signals
  - In-vehicle speed limits
- Signalized intersection
  - Signal violation/ intersection safety
  - Green light optimal speed advisory
- Probe vehicle data
  - Single vehicle data

Day 1.5 services:

- Information on fuelling & charging stations for alternative fuel vehicles
- On street parking information and management
- Traffic information & Smart routing
- Cooperative collision risk warning

The interoperability of the following C-ITS services will be tested throughout the whole NordicWay2 network:

- Slow or stationary vehicle(s) & Traffic ahead warning
- Weather conditions
- Traffic information & Smart routing

The service “Weather conditions” will include slippery road detection since this is an important functionality to ensure traffic safety and traffic ability on rural roads in wintertime. Moreover, the “Green light optimal speed advisory” test will be oriented to test the use of the virtual “traffic lights” focus on bottle necks, narrow bridges and tunnels.

The communication technology tested under this pilot will be cellular communication. Selected roadside infrastructure and vehicles may also be equipped with ETSI ITS-G5 when needed to ensure interoperability.

Pilot result are available at Nordicway2: Final report Norwegian Pilot 1

(2) Mapping infrastructure readiness for connected and automated driving on major freight routes of the comprehensive network in Norway

The pilot will map and assess the infrastructure readiness for connected and automated driving on major freight routes of the comprehensive network in Norway.

The pilot will aim at identifying what parts of the network are hard to read for the vehicle sensors and exploring the potential for communicating information from the road authorities' backend instead of rebuilding the infrastructure using C-ITS.

Figure 28: The pilot was extended and covered main roads in all four Nordic countries, see map. The inclusion of the other countries that are partners in the NordicWay project gave the NPRA a unique chance to create a dataset for direct comparison between the Nordic countries.

Recording of data into three groups.

- Mobile network coverage and quality
- GNSS availability and quality
- The vehicles understanding of the infrastructure

Pilot result are available at Nordicway2: Final report Norwegian Pilot 2

The Norwegian NordicWay 3 C-ITS pilots in main road network and urban environment, using cellular network and C-Roads hybrid communication Interchange Node architecture, will be implemented between 2021-2023.

Involved partners

Norwegian Public Roads Administration and public sector and private sector partners through open tendering processes. The following actors has been involved:

- Aventi
- Bouvet
- ITS perception
- NORCE
- OneTraffic
- PSI
- Q-Free
- Triona

Location

The C-ITS pilot were on the corridor from Tromsø to the Finnish border. The main pilot stretch will be from Skibotn to Kilpisjärvi, but other road sections on E8 and connecting roads can be included in pilot activities if it is appropriate to cover specific issues. In addition, C-ITS pilots were testet on E6, Patterø junction.

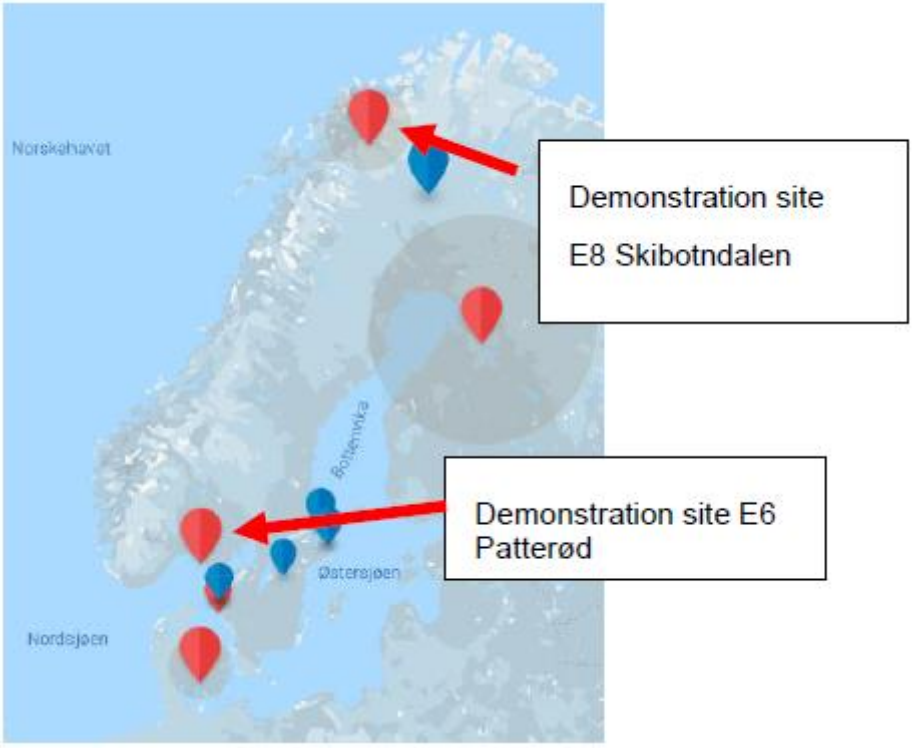


Figure 29: Norwegian pilots.

Overview of progress by End of 2020

NordicWay 2 pilots were completed in 2020 and results published in www.nordicway.net

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	1 900	1 800	1 500	1 100	0

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
320	840	1 010	1 030	1 030	

16. The Portuguese Pilot site

C-Roads Phase 1

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.

Pilot 1 – Single Access Point – SPA and SPApp usage app for SPA Services

This activity consists on the design of the National Single Point of Access (SPA) prototype designed in compliance with the Commission Delegated Regulation (EU) 2015/962 and the Commission Delegated Regulation 886/2013 and covering information of around 3390 km (20%) of the network. In addition, a mobile application (SPApp) that will provide added value services on the basis of the information provided by the SPA will be also tested together with the SPA prototype. This pilot will pave the way for the future implementation of the SPA in Portugal.

Currently, in Portugal, there are several traffic data producers, namely the different road operators such as BRISA, ASCENDI or NORSCUT, that send information to distinct entities (already) in DATEXII format. This means that, although already using an open UE standard for traffic data exchange, there is no official Portuguese National Access Point.

The pilot will consist of the following two sub-activities:

Sub-activity 1.1: The first sub-activity will identify the technical and financial requirements, both in terms of hardware and software, to establish the SPA on the basis of the existing traffic data communication network. In particular, the following aspects will be analysed and defined:

- specific requirements to set up the SPA in compliance with the Commission Delegated Regulation (EU) 2015/962 and the Commission Delegated Regulation (EU) No 886 / 2013;
- system modelling including the data interfaces according to the DATEXII model; normalization of the data frames sent by each road operator;
- the "discovery/search and browse" functionality

Moreover, a prototype to validate the approach and analyse the different required functionalities will be developed and piloted. This prototype will be tested (i.e. pilot operation) before the major deployments of other pilots carried out under the other activities are taken place, enabling its usage as the data sharing point for the different collaborative services in test.

Sub-activity 1.2: This sub-activity covers the design and development of a SPA mobile application (SPAapp) based on an existing technological platform that will enable interactive added-value services between the driver and the highway operator. In particular the app will cover the following Day-1 C-ITS services:

Day-1 C-ITS services:

- Slow or stationary vehicles;
- Traffic Jam ahead warning;
- Other hazardous location notification;
- Road works warning;
- Weather conditions.

This app looks to demonstrate the potential of the SPA based services. In particular this Activity will design and develop an application layer for static road data, dynamic road status data and traffic data provided by the data sharing backbone system delivered under sub-activity 1.1 (i.e. the basis for the future SPA in Portugal). The system will compile transportation data from the nodes provided by SPA to be used by a consumer-facing app. The SPA app will be tested together with the SPA prototype as a part of the pilots delivered under other activities.

This Activity will cover the procurement tasks, i.e. the preparation of procurement documents and contracts, which are necessary to implement the above sub-activities.

Pilot 2 – Portuguese network for C-ITS

This activity consists on the deployment of a pilot to test Day 1 and Day 1.5 services over 460 km of the core and comprehensive network, including cross-border sections in Valença and Caia, and roads giving access to urban nodes of Lisbon and Porto.

This activity will test these services in different kind of roads (metropolitan areas, interurban roads, streets and highways) using hybrid communication system (ITS G5 and Cellular).

The activity is desegregated in the following sub-activities

Sub-activity 2.1: Demonstration of C-ITS services in the core (A1, A2, A3, A6 and A12) and comprehensive (A2, A22, A27 and A28) network, including cross-border sections in Valença (A3 and A28) and Caia (A6), and roads giving access to urban nodes of Lisbon (IC 17 and IC 19) and Porto (A4 and A20 — VCI).

This sub-activity will expand the network of cooperative systems on the basis of the results of a CEF funded Action 2014-EU-TA-0669-S- SCOOP@F Part 2 with the deployment of around 88 RSU, 29 OBU and 29 vehicles testing the following Day-1 and Day -1.5 C-ITS services:

Day-1 C-ITS services:

- Emergency electronic brake light;
- Emergency vehicle approaching;

- Slow or stationary vehicles;
- Traffic Jam Ahead warning;
- Other hazardous location notification;
- Roads works warning;
- Weather conditions;
- In-vehicle signage;
- In-vehicle speed limits;
- Probe vehicle data;
- Shockwave damping.

Day-1.5 C-ITS services:

- Off street parking information;
- Park and Ride information;
- Information on alternative fuel vehicles and charging stations;
- Traffic information and smart routing;
- Zone access control for urban areas;
- Wrong way driving.

Sub-activity 2.2: Development and testing of an in-vehicle app that will provide C-ITS services to the users on the highway A25 and urban node of Lisbon (entrance through the N6 road).

This sub-activity will develop and test an In-Vehicle App, using a hybrid communication system (ITS G5 + cellular), that will be able to provide the following Day-1 and Day -1.5 C-ITS services on the highway A25 and on the access to the urban node of Lisbon through the N6 road:

Day-1 C-ITS services:

- Slow or stationary vehicles;
- Traffic Jam Ahead warning;
- Other hazardous location notification;
- Roads works warning;
- Weather conditions.

Day-1.5 C-ITS services:

- Off street parking information;
- Traffic information;
- Smart routing.

The sub-activity will cover the following task:

- Development of the in-vehicle App;
- Installation of 24 RSU on two roads: A25 and N6 (access to urban node of Lisbon);

- Installation of 20 OBU in 20 vehicles;
- Connection of the in-vehicle App with the server(s) that will receive and process the information received from the installed RSUs and OBUs,
- Piloting of the In-vehicle App: the provision of all C-ITS services by the in-vehicle App will be tested and monitored during a period of at least 12 months.

Sub-activity 2.3: Development of C-ITS services in tunnels: Túnel da Gardunha (A23)

This sub-activity will pilot the provision of Day-1 C-ITS services inside and in the surroundings of the "Gardunha tunnel" located in the A23 road using a hybrid communication system (ITS G5 + cellular).

Day-1 C-ITS services:

- Emergency vehicle approaching;
- Slow or stationary vehicles;
- Traffic Jam Ahead warning;
- Other hazardous location notification;
- Roads works warning;
- Weather conditions;
- In-vehicle signage;
- In-vehicle speed limits.

The sub-activity will cover the following task:

- Installation of 6 RSUs in 20 km of the A23, inside and outside the "Gardunha tunnel;
- Equipment of 10 vehicles with 10 OBUs,
- Testing and monitoring of the provision of the Day-1 C-ITS services inside and in the surroundings of the tunnel during a period of 12 months.

This Activity will cover the necessary adaptation of the vehicles to perform the pilots and will cover the procurement tasks, i.e. the preparation of procurement documents and contracts, which are necessary to implement the above sub-activities.

Pilot 3 – Network preparation for Connected and Autonomous Vehicles

This activity consists on the deployment of a pilot that will prepare TEN-T network for Connected and Autonomous Vehicles with levels of automation 2 and 3, also using hybrid communication system (ITS G5 and Cellular).

This activity covers three sub-activities that will carry out the following pilots in real environment.

Sub-activity 3.1: Pilot of Connected and autonomous vehicles in open roads

Under this sub-activity, around 6 RSU will be installed over around 24.7 km of the A27 highway (Viana do Castelo - Ponte de Lima), 88.6 km of A28 (Porto-Caminha) and 40 km of the A3 (Porto-Braga).

Moreover, one vehicle will be equipped with two different OBUs in order to test with two different levels of automation (level 2 and 3) the provision of the following Day-1 and Day-1.5 services:

Day-1 C-ITS services:

- Emergency electronic brake light;
- Slow or stationary vehicles;
- Traffic Jam Ahead warning;
- Other hazardous location notification;
- Roads works warning;
- Weather conditions;
- in-vehicle signage;
- in-vehicle speed limits;
- Signal violation/intersection safety.

Day-1.5 C-ITS services:

- Off street parking information;
- Park & ride information;
- Connected and cooperative navigation.

Sub-activity 3.2: Pilot on the A2, the "Holiday motorway"

This pilot will be implemented over 240km of the A2 network ("Intelligent Holliday Motorway" from Almada to Albufeira) and will involve some of the RSUs and OBUs installed under sub-activity 2.1 as well as around 50 additional RSUs that will be installed under this sub-activity. The pilot will test the provision of the following Day-1 and Day-1.5 services with around 30 vehicles (cars and trucks):

Day-1 C-ITS services:

- Emergency electronic brake light;
- Slow or stationary vehicles;
- Traffic Jam Ahead warning;
- Other hazardous location notification;
- Roads works warning;
- Weather conditions;
- In-vehicle signage;
- In-vehicle speed limits;
- Probe vehicle data.

Day-1.5 C-ITS services:

- Park & ride information;
- Information on alternative fuels & charging stations;
- Traffic information;
- Smart routing;
- Zone access control for urban areas;
- Wrong way driving;
- Connected and cooperative navigation.

Sub-activity 3.3: Pilot on Connected vehicles for advanced services.

This pilot will be implemented over 204 km of highways of the Core network and accesses to urban nodes (66 km of A1, 54 km of A2, 25 km of A5, 35 km of A9 and 24 km of A12) and will involve some of the RSUs and OBUs installed under sub-activity 2.1 as well as around 30 additional RSUs and 50 OBUs that will be deployed under this sub-activity. The pilot will be carried out with around 50 vehicles that will test the following Day 1 and Day 1.5 services:

Day-1 C-ITS services:

- Emergency electronic brake light;
- Slow or stationary vehicles;
- Traffic Jam Ahead warning;
- Other hazardous location notification;
- Roads works warning;
- Weather conditions;
- In-vehicle signage;
- In-vehicle speed limits;
- Probe vehicle data.

Day-1.5 C-ITS services:

- Park & ride information;
- Information on alternative fuels & charging stations;
- Traffic information;
- Park & ride information;
- Information on alternative fuels & charging stations;
- Traffic information;
- Smart routing;
- Zone access control for urban areas;
- Wrong way driving
- Connected and cooperative navigation.

Under this sub-activity in-vehicle/driver data will be analysed in order to feed data models to adequate traffic and guidance information. Additionally, this pilot will deploy a dynamic route pricing system that will calculate the price according to the distance travelled, type of roads and levels of congestion, usage-based insurance models and road usage charging models.

Pilot 4 – C-ITS Pilot in the Lisbon Urban Node

This activity consists in the deployment of a C-ITS Pilot in the Lisbon urban node.

The activity covers three sub-activities:

Sub-activity 4.1: Traffic service level monitoring and travel time prediction in Lisbon node to be tested along 10,5 km of A36 (2ª circular) using cellular communication.

This sub-activity will deliver and pilot an application that will provide the following Day-1 and Day 1.5 C-ITS services over the 10,5 km of A36 (2ª circular) using cellular communication:

Day-1 C-ITS services:

- Slow or stationary vehicles;
- Traffic Jam Ahead warning;

Day-1.5 C-ITS services:

- Traffic information;
- Smart routing;

This application will retrieve data on total vehicle volumes (with classes identification) to generate at least two O/D (origin/destination) pairs that will feed the municipal Traffic Management Centre. The RSUs deployed under activities 2.1. and 2.2. over the IP network IC 19/ CRIL/A36) will also be connected to this pilot case.

Sub-activity 4.2: Pilot of a Parking availability system in Lisbon node (Lisbon central axis - Entrecampos - Marques do Pombal, along 2,7 km)

This sub-activity will deliver and pilot with around 25 vehicles an integrated C-ITS application that will be able to provide the following Day-1,5 C-ITS services using cellular communication:

Day-1.5 C-ITS services:

- On-street parking;
- Off-street parking;
- Park & ride information;

- Information on alternative fuels & charging stations;
- Smart routing;

This C-ITS application will built on the existing EMEL Smart Parking Solution which is an integrated infrastructure-based sensor system that gives precise information on where available parking spaces in Lisbon can be found and how long each space has been occupied.

The EMEL Smart Parking Solution will be integrated with other technologies and improved in terms of the robustness of sensor devices, the stability and timeliness of sensor networks, the quality and agility of urban service, and user-centred considerations in order to be able to provide the services specified above.

Sub-activity 4.3: -Pilot of an In-Vehicle App that provides parking and traffic information in the Urban Node of Lisbon (Lisbon Node, 9.8 km of A36 (2ª circular) and N6)

This pilot will test an In-vehicle App that will provide information about parking availability inside the city (Day-1.5 service) and about traffic conditions and hazardous situations (Day-1 services) over 9.8 km of one of the most congested access road to Lisbon and main connection to the core airport (A36 – 2ª Circular) and over the N6 (one of the 5 main commuting entrances).

The test will involve 5 vehicles and will use hybrid technologies (ETSI G5 and Cellular).

Vehicles (cars, buses, trucks) shall be equipped with smartphones/tablets where the app prototype will be available along with the V2X-enabled In-Vehicle System (IVS) that allows the collection of data on the vehicle environment (like road conditions, driving conditions, traffic conditions and general environmental conditions) while at the same time acting as a receiver of information coming from other vehicles and/or the central C-ITS management system.

The app prototype will make use of state-of-the-art recommendations related to ensure safe driving while relaying the required information to the driver. Moreover, specifications already adopted by the C-Roads platform and technology neutrality and efficient use of radio spectrum will be key principles in order to ensure complementarity and co-existence with existing communication technologies.

Sub-activity 4.4: Signal corridors and bus corridors prioritization in Lisbon node

Endow the central corridor of Lisbon ("Campo Grande - Marques de Pombal" axis) with the suitable infrastructure capable of improving the efficiency of the public transport lanes by prioritising the emergency vehicles.

This solution will allow to implement a prioritization system (Green Light Optimal Speed Advisory (GLOSA) / Time To Green (TTG)) based on cellular communication technology through the adaptation of the existing OBUs and communication server and via the upgrade of the central traffic management and the development of middleware.

Sub-activity 4.5: Mobility hub in the Lisbon node

This pilot will cover some of the inter-urban highways that give access to Lisbon (A2, A5 and A9). Through this pilot test, the potential benefits of the integration of private car usage with other modes of transportation in the last mile of inter-urban motorway corridors will be studied and evaluated through the analysis of solutions such as carsharing, carpooling, park & ride or any other services which contributes to the implementation of the "mobility as service" (MAAS) concept.

Moreover, the pilot will also test the provision of the following Day-1 and Day 1.5 services using hybrid communication technologies (ETSI G5 and Cellular communications):

Day-1 C-ITS services:

- Emergency electronic brake light;
- Emergency vehicle approaching;
- Slow or stationary vehicles;
- Traffic Jam Ahead warning;
- Other hazardous location notification;
- Roads works warning;
- Weather conditions;
- In-vehicle signage;
- In-vehicle speed limits;
- Probe vehicle data;
- Shockwave damping.

Day-1.5 C-ITS services:

- Park & Ride information;
- Information on alternative fuel vehicles and charging stations;
- Traffic information;
- Smart routing;
- Zone access control for urban areas;
- Wrong way driving.

Pilot 5 – C-ITS Pilot in the Porto Urban Node

This activity consists in the deployment of a C-ITS Pilot in the Lisbon urban node.

Under this Pilot, the following two sub-activities will be tested:

Sub-activity 5.1: Pilot to test a Cooperative Intelligent Transport System (C-ITS) for short-medium term traffic predictions in Porto node

This sub-activity will test a Cooperative Intelligent Transport System that will provide traffic predictions in real time and in future-two-hour travel time using Cellular, Wifi and DATEX communication technologies.

This system will transfer real-time traffic information such as traffic flow, traffic speed, traffic concentration, accident occurrence, congestion, roadworks and public transport information to the traffic management centre (TMC) enabling the TMC to react and put in place contingency plans to tackle network bottlenecks and other traffic disruptions.

The pilot will monitor the traffic service level in real time and will predict the service level in 2 hours, in a total extension of about 24 km inside the Porto city.

The equipment deployed in sub-activity 2.1 will be connected to this pilot allowing to extend the area covered by the pilot (i.e. covering critical penetration roads in Porto such as commuting entrance/exits of the urban node).

The Day-1 and Day 1.5 C-ITS services that will be tested under this pilot are the following:

Day-1 C-ITS services:

- Traffic Jam Ahead warning;
- Roads works warning;
- Weather conditions;
- In-vehicle signage;
- Shockwave damping;
- Traffic signal priority request by designated vehicles.

Day-1.5 C-ITS services:

- On-street parking management;
- On-street parking information;
- Traffic information;
- Smart routing.

Sub-activity 5.2: V2I and I2V integration of an intelligent bus with the infrastructure in Porto node

This pilot will test the integration of an "intelligent bus" with the infrastructure in the city of Porto in a corridor of around 1,4 km for information and services sharing, using DATEXII communications protocol and cellular communication technologies. The pilot will require the installation of at least a RSU and the equipment of the intelligent bus with at least an OBU. This will allow the exchange of information between the infrastructure owner and the intelligent bus.

The following Day-1 and Day 1,5 C-ITS services will be tested:

Day-1 C-ITS services:

- Traffic Jam Ahead warning;

- Roads works warning;
- Weather conditions;
- In-vehicle signage;
- n-vehicle speed limits;
- Probe vehicle data;
- Shockwave damping;
- Traffic signal priority request by designated vehicles.

Day-1.5 C-ITS services:

- Traffic information;
- Smart routing;
- Connected and cooperative navigation.

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)

Pilots 1 to 5

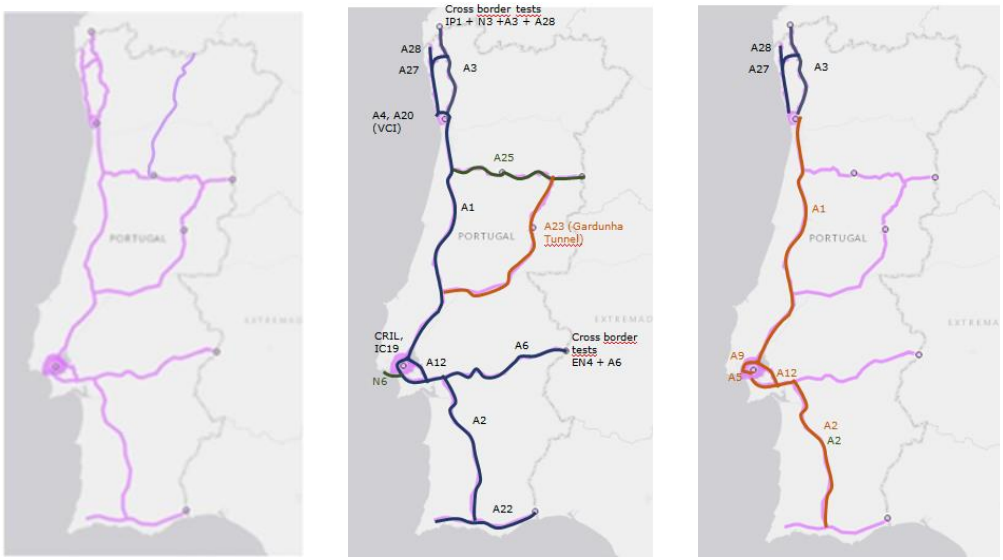


Figure 30: Location of the Portuguese pilot site 1 - 3

Figure 31: Location of the Portuguese pilot site 4-5

Overview of progress by End of 2020

By the end the reporting period, the Action had experienced an impressive progress, as a significant part of the delays were reabsorbed during 2020. Nevertheless. The pandemic situation led to some difficulties in the implementation of some of the projects included in the action, especially during lockdowns established in Portugal in the second and fourth quarters of 2020.

The COVID-19-crisis hit Europe heavily starting in February 2020 and led to a full lock-down in most of the C-Roads Platform Member States. The lock-down comprised the closure of borders, the closure of businesses, short-time working, travel restrictions, isolation measures and restrictions on outdoor activities.

The crisis did have some impacted in all the Action's activities, with several implementing bodies, suppliers and/or stakeholders actually having stopped all activities, slowing down hardware implementation, IT developments and any other deployment, also preventing partners to gather for any meetings.

Two types of constraints happened

1 – remote worked led to the delay in many of the processes, namely those related to administrative tasks. Many Implementing Bodies reported that having their teams working in separate locations in remote work conditions implied longer periods for processing information, reporting, decision making, procurement and implementation in general.

2 – all the public Implementing Bodies in the action reported a shift regarding public decision makers' priorities, that is, to the date, more focused on dealing with the public crisis. The implementation and execution of other planned projects (in which Cooperative can be included) was generically considered as non-priority.

Therefore, significant delays remained in 2020, although not transversal to all the projects or Activities within the Action. More details on the impact of the sanitary crisis are given in the description of each activity below.

The pandemic situation led to the impossibility of recovering these delays, to which it must added the impossibility of performing the Actions adequate Impact Assessment (namely due to the lack of users for some of the pilots). In such a context, the Action's beneficiary joined the other members of C-Roads platform in a combined request for a one-year extension of the project. No additional funding was requested, but additional time to fulfil the Action's goals was imperative.

Most of the Activities within the Action have been progressing and recovering consistently. Without the pandemic situation, the Action would have most likely ended delivering all the outcomes that it is expected to.

Pilot 1 – Single Access Point – SPA and SPApp usage app for SPA Services

As the SPA governance model and property was finished, this activity experienced a very strong deployment along 2020.

The IT structure was fully functional by the end of 2020 and already includes real life data from some of the road operators in Portugal. The concessionaires are already supplying the NAP with traffic information that is now being aggregated and made available to the public through the aforementioned profiles.

Real-time information can be consulted on a Portal that serves as a web interface with the general public. Although the website is not fully available for undiscriminated users, a full life version is already available for licensed users. A user who wants to consume NAP information, must register on the portal, fill out a NAP information request and accept the terms and conditions associated with his request. This form will be reviewed and accepted / rejected by NAP managers.

The data available aims to comply with European regulations and directives in order to facilitate access, exchange and reuse of traffic data, thus contributing to a European network of interoperable transport services for the end user. All data is accessible in a non-discriminatory manner in accordance with the standards established for the exchange and reuse of information. The topics considered in this development of the NAP are those indicated in Delegated Regulations B, C and E.

Pilot 2 – Portuguese network for C-ITS

All the implementing bodies have finished the development planned for RSUs and OBUs, and have tested all the C-ITS services planned for this Activity.

During the 2nd quarter of 2020, the roadside equipment along the infrastructure was installed. During the third and last quarter several interoperability tests occurred in several different road sections, as planned in the GA, setting the way for the full implementation on a national. It was not possible to establish cross border tests due to the pandemic situation.

Pilot 3 – Network preparation for Connected and Autonomous Vehicles

In 2020 there was a significant increase of the pilot activity, mainly in the use case functional definition, Hybrid approach and Cross Testing. Multiple changes in specifications from the C-Roads Platform were analysed for convergence with national specifications, having been found minor variants to be corrected in future revisions. Nevertheless, the Pilot didn't have the expected developments due to the pandemic situation. However, it foresees the development and installations on the ground during the first months of 2021.

Pilot 4 – C-ITS Pilot in the Lisbon Urban Node

In the end of the year of 2020, new cameras were produced and sent for replacement and compatibility test were held. The manufacturing and shipping of these 16 cameras was delayed do to the Covid-19 pandemic.

2020 also marks changes in the architecture of the system (with the definition of the new server location, inside the municipality premises) and the implementation of SALTING (adding an extra

layer of data security). The relocation activity for the server is now pending on the purchase of a machine by CML.

The last steps to be concluded will be the integration of the travel time information to the mobile app and to the Variable Message Signs (VMS) panels. The tender for the VMS has been released, but the installation of the VMS is still pending. This will delay the integration of the information to these panels.

After the integration efforts are concluded and the information is available as expected, which is delayed when compared to initial plan, the final evaluation of the project can take place.

Pilot 5 – C-ITS Pilot in the Porto Urban Node

The implementing bodies continued to work in defining and testing the platform. They also worked in connection between traffic data (traffic counts and roadworks) and the platform. All the data integration and prediction models are ready for the evaluation phase.

The first RSU was installed in September 2020, later than expected, as road works were severely impaired. The IBs involved started to test the connection between OBU – RSU – traffic controller for bus priority; in terms of the connection with the VMS, the communication protocol and the messages templates have already been developed.)

C-Roads Phase 2 – Cooperative Streets

Cooperative Streets is a study with pilots, aimed to testbed 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 vehicles 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 on 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 backoffice 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"

1. 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 on 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.

2. 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.

3. 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.

4. 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.

5. 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 helps 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).

6. 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 insuring 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 transhipments, CO_2 emission ...).

This pilot will ensure the implementation of multi-modal multimodal 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:

- School Public transportation.
- 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
- ARMIS – Sistemas de informação, Lda.
- Associação Porto Digital
- Associação TRANSPORLIS - Associação para a Exploração e Gestão dos Serviços de Informação da Viagens Multimodais da Área Metropolitana de Lisboa
- A-To-Be Mobility Solutions, S.A.
- Brisa Gestão de Infraestruturas
- Brisa Concessão Rodoviária, SA

- Município de Cascais
- Município de Gondomar
- Município de Lisboa
- Município de Loulé
- Município de Matosinhos
- Município de Santo Tirso
- Município de Valongo
- Município de Vila Nova de Gaia
- Município de Viseu
- Município do Porto
- CEiiA - Centro de Engenharia e Desenvolvimento
- Companhia Carris de Ferro de Lisboa, E.M., S.A.
- EMEL – Empresa Municipal de Mobilidade e Estacionamento de Lisboa, E.M., S.A.
- GMVIS Skysoft, S.A.
- Infraestruturas de Portugal, S.A.
- Instituto da Mobilidade e dos Transportes, I.P. (IMT, I.P.)
- ISEL - Instituto Superior de Engenharia de Lisboa
- Loulé Concelho Global E.M.
- Município da Trofa
- Município de Lousada
- Quadrilátero - Associação de Municípios de Fins Específicos Quadrilátero Urbano
- Siemens Mobility, Unipessoal Lda.
- TISPT - Consultores em Transportes, Inovação e Sistemas S.A.,
- Via Verde Portugal, S.A.
- Via Verde Serviços, S.A.

Location

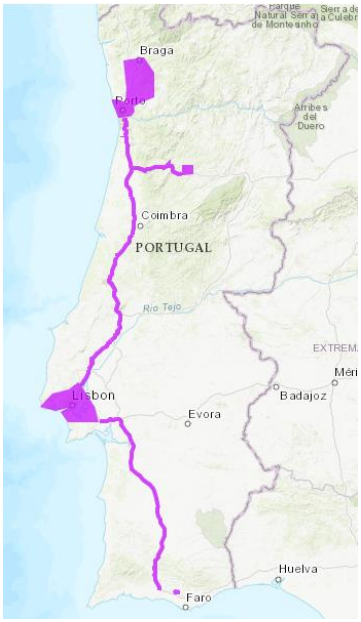


Figure 32: Pilots in Portugal.

Overview of progress by End of 2020

By the end of 2019, part of the deployments planned for that year was delayed. While some of the delays were reabsorbed during 2020, the pandemic situation led to severe difficulties in the implementation of many of the projects included in the action, especially during lockdowns established in Portugal in the second and fourth quarters of 2020. The crisis impacted all the Action's activities, with several implementing bodies, suppliers and/or stakeholders actually having stopped all activities, slowing down hardware implementation, IT developments and any other deployment, also preventing partners to gather for any meetings.

Two types of constraints happened

1 – remote worked led to the delay in many of the processes, namely those related to administrative tasks. Many Implementing Bodies reported that having their teams working in separate locations in remote work conditions implied longer periods for processing information, reporting, decision making, procurement and implementation in general.

2 – all the public Implementing Bodies in the action reported a shift regarding public decision makers' priorities, that is, to the date, more focused on dealing with the public crisis. The implementation and execution of other planned projects (in which Cooperative can be included) was generically considered as non-priority.

Therefore, significant delays remained in 2020, although not transversal to all the projects or Activities within the Action. More details on the impact of the sanitary crisis are given in the description of each activity below.

Pilot "Extended Multimodal National Access Point (NAP)"

This Pilot foresees the extension of the multimodal component of the Portuguese National Access Point since the current version does not yet allow the open upload of multimodal data. The intended development will be carried out during 2021, through a public tender. In 2020, IMT has prepared the technical and administrative documents that support the launch of the public tender. The work was concluded still during 2020, paving the way for an early public tender launch in 2021.

Pilot "From C-Roads to Cooperative Streets"

This Pilot experienced some delay. Still, this activity has made a strong recovery from the delays of 2019 and is now at a stage that. Due to the pandemic crisis, several initiatives were delayed, but the pilots that were developed provided essential results for the development of the next steps.

This activity included the deployment of an upgraded telecommunications network to support communication with vehicles in integration with the core business securely and efficiently. This upgrade took into account the compatibility with cybersecurity standards for vehicular communications, following European standards. Also, Activity 3 included the deployment and

testing of a private blockchain network, designing smart contracts to deploy the tolling system on top of the blockchain infrastructure, studies, and implementation of a pilot for the automatic detection of accidents and anomalies in the infrastructure in a tunnel in Lisbon's urban node.

Pilot "Cooperative Streets"

In 2019 this pilot was the one that within the Action experienced a higher deployment rate, but was one of those with the highest impacts of the pandemic situation, namely due to the big number of local public entities involved.

Some of the projects did proceed almost in line with planning, though. On-street and off-street parking location, information and payment systems have been deployed; EV charging points information integration has been concluded. Several bike-sharing network studies have issued recommendations for the systems to be implemented, with app releases in android and iOS with bike-sharing and bike parking services for the designated 50 test users.

There has also been an effort in the enhancement of the C-ITS solutions to accommodate new use cases to be deployed under the scope of Pilot Cooperative Streets. This includes the design and start of prototyping of a control centre for C-ITS urban applications from which operators will have access to all mobility information and use case functionalities.

The activities in this pilot case "e-Bikesharing Data Analytics" have started in 2019. During this year, a platform was and still is under development and will allow managing the fleet, the existing demand, as well as all the inherent operation and maintenance. The project team is also developing a centralized charging management tool to manage the electrical charges and current charge status of each vehicle. This is being done through a BMS (Battery Management System), based on an overview of the system, held by the central system, combined with the necessary electrical equipment on the infrastructure to allow electrical commuting capabilities.

Also, the activities in the pilot case "Bikesharing solutions" are ongoing. It was developed a solution for the infrastructure and the on-board part (IoT, battery and BMS). Regarding the infrastructure, developments were made on the electronic control board for the Totem and the docking station. Additionally, the hardware was already designed and prototyped having in focus good and easy maintainability.

It was necessary to provide the infrastructure with electrical equipment that allows the control of the charging in a centralized and point-to-point way so that, in the future, it is possible to proceed with the integration of an artificial intelligence component, so that, at the moment of decision-making regarding the type of charge to be applied, the system can make an adequate survey of the observed state between the supply and demand for vehicles and to act accordingly in the faced situation: in cases where the supply is higher than the demand, the type of charging to be applied should be done slowly, to extend the battery life without comprising the demand; in reverse situations, charging should be done faster, to optimize the user's waiting time.

Additionally, developments are still ongoing to test the implementation of a “bike-centric” system, which consists of transporting all the intelligence implemented in the stations, to the bicycles. With this, the vehicles can communicate directly with the central system, with the expectation of obtaining significant advantages, compared to the previous system of “station centric”, and with a view to the applicability of the free-float aspect and reducing costs of infrastructure side (typically more expensive - in systems with stations there are usually more docks than bicycles). Significant progress was made in this regard, the IoT device to be incorporated inside the bike was developed and prototyped successfully.

The activities in the pilot case “Central Management System for C-ITS and RSU trial” are ongoing, in specific several configurations and testes were done in the laboratory and already on a test site. An important activity that is still ongoing in this pilot case is the transfer of knowledge that is coming from the C-Roads project to mitigate risks and errors and move forward with a faster and successful implementation of this pilot case in 2021/2022.

The activities in the pilot case “Prioritization of Autonomous Vehicle using C-ITS” started this year with a more detailed setup of the scope of the project for each partner and the definition of the project team and the collection of all the technical info that will be needed to start working.

Finally, a very relevant project with Activity 4 implies integrating data from different sources into the Data Platform, in cooperation with one of the largest Municipalities in Portugal. The project has already defined the overall architecture of the Mobility Platform and all its components, required to support the pilots, but also the integration between the Data Platform and the Mobility Platform. It also developed components to provide real-time data about the location and ETA of the Bus services in the city and provide data about light mobility usage and availability (namely, scooters).

Pilot "MMTIS"

This pilot was one of those with the highest impacts of the pandemic situation, namely due to the big number of local public entities involved. Nevertheless, some projects are undergoing as planned.

Several improvements were made in the design of the future platforms of public transport services and to prepare the Netex Catalogue that several of the public entities will share. A combined work between the two main Portuguese Metropolitan Area, together with their municipalities gave special emphasis to the mandatory requirements of ITS Directive 2010/40/EU and Commission Delegated Regulation (EU) 2017/1926, namely the availability soon of public national and European ITS platforms (ex-NAP) were PTOs data, will easy the process of making data available, with minimum costs for operators. This also allows trip planning platforms being feed with correct and updated data, offering information about trips, schedules, real-time location, etc. to the public, enabling transport solutions optimized to the preference of users, and minimizing waiting times.

On a not so wide scope, several municipalities were involved in projects that in 2020 hired services related to a virtual accommodation infrastructure necessary for the pilots that deal with the Municipal Passenger Transport Information Production System (InfoPub).

Also, some projects included the comparative assessment of possible technological options for the implementation of the Integrated Ticketing System and functional characterization of a regional Access Point (MAP) platform which includes management support, technical and technological monitoring, administrative and financial reporting and the technical-economic Feasibility Study and Business Model Associated with an Integrated Mobility Information System in the Quadrilátero Urbano, Definition of the pilot's architecture, at the level of the integrating platform, legacy systems and applications, IT infrastructures and physical mobility systems.

For the main public bus operator in Portugal, activities during the last year were strongly affected by the COVID-19 pandemic, which has different but substantial impacts across all five 'pilots' that are being deployed in the framework of C-STREETS. As a Public Transport Operator CARRIS develops an essential function and accordingly, it did not stop its operations during any point of the pandemic. However, priorities and teams' capacity were strongly affected. For example, operations' teams had to focus on revised planning and scheduling to adapt to new constraints and mobility patterns; procurement teams had to shift attention to immediate needs, such as the acquisition of individual protection equipment; all communication resources had to be concentrated on messages about the safety rules and restrictions. In any case, several activities were developed throughout the year and progress was made in some of the pilots, namely in the Pilot 'Bus on-demand, the Pilot "Passenger Counting Systems"

Pilot "Urban testbed - Zone to free test technology"

This Pilot started with a delay but within this reporting period, it was able to recover to some extent. ZLT – Matosinhos Free Technological Zone was created by CEiiA, formally in April 2019, in partnership with the Municipality and NOS. It is a geographically delimited space in an urban environment for demonstrating, experimenting, and testing innovative technologies, products and services aimed at decarbonizing the municipality. Since that date, three tests have been carried out:

• AYR sustainability platform (CEiiA) - Since April 2019, CEiiA has been testing a reward system for citizens using sustainable mobility modes, through a platform that allows quantifying, value and exchange avoided carbon emissions credits.

• 5G technology (NOS) - In June 2019, NOS carried out a 5G technology test, to assess the potential of applying new generation communications for coastal surveillance and security.

• Technology for detecting abusive parking (VisionWare) - In January 2020, within the scope of a European project supported by Horizon2020, VisionWare carried out a test on an intelligent system for detecting abusive parking within which the potential of this technology in cities management and data privacy aspects were analysed.

On March 4, 2020, as part of the Digital Week promoted by the Government, the official launch session of the ZLT was held at CEiiA, attended by the Minister of State, Economy and Digital Transition and the Secretary of State for Digital Transition. In sequence, the Council of Ministers Resolution 22/2020 was published, establishing the general principles for the creation and regulation of Free Technological Zones.

CEiiA is now working on technical, operational, regulatory and communication documents associated with Matosinhos ZLT, to formalize the process for carrying out tests on ITS solutions in the real context.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
	792	1 688	2 136	2 264	1 766

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
1 559	3 875	14 468	5 906	3 602	

17. The Slovenian Pilot site

The objective of the “The C-Roads Slovenia” pilot is to improve real time traffic information on pilot section and to test communication solutions for C-ITS day 1 services related to motorways.

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

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 the second phase roadside ITS-G5 infrastructure will be extended to the pilot length of 300 km on selected locations on complete motorway A1, A3 and H4 and at critical points of A2 with the central ITS-G5 server real-time platform located at Traffic Management Centre Dragomelj. Roadside ITS-G5 stations will also be installed at motorways cross-border areas to ensure coexistence of cooperative ITS-G5 with RTTT DSRC tolling system.

3G/4G/LTE Cellular Connected Vehicle with the Cloud Information Services were deployed on complete motorway network in 2019. Mobile traffic information application with the location awareness was launched, successfully tested and evaluated.

National assessment plan will be drafted and harmonised with the C-Roads Platform assessment and evaluation plans and findings and a final C-Roads Pilot Slovenia evaluation will be delivered at the end.

Involved partners

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

Location

The C-Roads Slovenia Pilot first phase (ITS-G5 and cellular) is planned along 30 km of TEN-T core network (Baltic-Adriatic and Mediterranean Corridor) in Slovenia and is located on the A1 highway (section Ljubljana – Koper) between Postojna and Divača.

Figure 33: Location of the Slovenian pilot site

On the C-ITS Slovenia pilot site the “C-Roads Slovenia 2” roadside ITS-G5 infrastructure will be extended to pilot length of 300 km on selected locations on complete motorway A1, A3 and H4 and at critical points of A2.

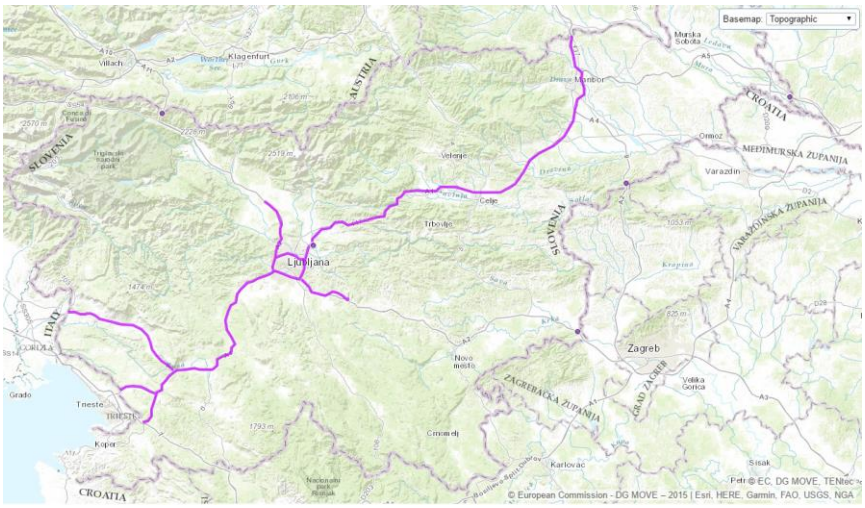


Figure 34: Location of the Slovenian pilot site (second phase)

Overview of progress by End of 2020

The next steps of the C-ITS services deployment in Slovenia within C-Roads 2 have been in progress in 2020. The pilot implementation of automatic transfer of traffic events from tunnel monitor and control systems into Information cloud and C-ITS was successfully implemented. Due to the positive results, preparations of extension of the project to the other regional Traffic control centres including automatic transfer of traffic events from other traffic management and control systems already started. ITS-G5 roadside infrastructure was upgraded and equipped with the PKI to ensure secure C-ITS communications. A second set of C-ITS Day-1 services was implemented end of 2020 as well.

Implementation of C-ITS services using 3g/4g/LTE cellular networks and hybrid solutions has been in progress in 2020. Within this project DARS (Motorway Company in the Republic of Slovenia) has developed the 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 measurements of information flow have been made indicating that the average time to send and receive the message via 3g/4g/LTE network takes 2/10 of the second.

The system was designed to perform as a hybrid. For this purpose the proper interchange node named C-ITS Middleware was created. It acts as a filter to prevent message duplication and confusion created by different protocols of connected devices within current and future C-ITS system in Slovenia. The system, for example enables the probe vehicle data that come from OBUs to become a single message of traffic congestion. It also enables to receive and push forward CAM messages, etc.

Also C-ITS Basic Interface was developed to the extent the confirmed specifications within WG2/TF4 make it possible.

The project includes the research on user experience and user acceptance of the solutions. The user interface of the app was developed on the basis of live testing on driving simulator which includes devices such as eye tracking system, simulator of different driving conditions, the copy of real road network etc.

Only minor adjustments of the systems are necessary and the project will be concluded by the end of March 2021.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
152	170	553	1 129	1 560	2 077

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
0	830	1 730	2 700	0	

18. The Spanish pilot site

The pilot report is meant to introduce the pilot sites foreseen in C-Roads Spain, as well as their services and technologies. C-Roads consists of different C-Roads pilots operated in different national environments, being Spain one of their pilot sites' locations.

The Spanish pilot is made out of 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 – Ministry of Interior (DGT).
  - Dirección General de Carreteras - Ministerio de Fomento (DGC).
  - 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).
- Private companies:
  - Transport Simulation Systems SL (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.
  - SEOPAN, Asociación de empresas constructoras y concesionarias de infraestructuras.
- Universities:
  - Universidad Politécnica de Madrid (UPM).
  - Universitat Politècnica de Catalunya (UPC).

- Universitat de Valencia – Estudi General (UVEG).
- Research Centres:
  - Fundación para la Promoción de la Innovación, Investigación y Desarrollo Tecnológico en la Industria 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 will be 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 will span 150 Km.
- **Madrid Calle 30**, located along the road "Calle 30" in Madrid, with approximately 32 km. C-ITS services will be 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.

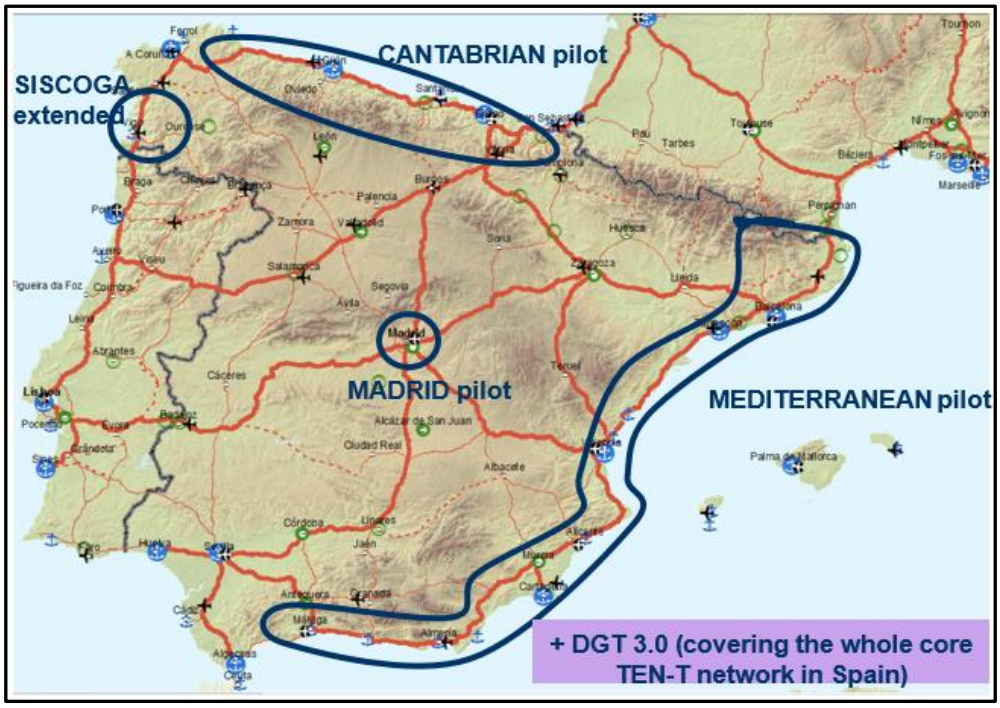


Figure 35: Location of the Spanish pilot site

Overview of progress by End of 2020

C-Roads Spain has held a number of physical and virtual Steering Committee and General Assembly meetings (12 February, 8 May, 23 September, 26 November) where governance and technical involvement have been endorsed according to the course of action and the latest activities carried out by the C-Roads Platform. Indeed, the constant revision and refinements of the internal organisation of the Action had already been foreseen since the very beginning. These meetings have resulted in an improved collaboration, a coordinated effort, and a unified position towards the C-Roads Platform. As a result of these coordination meetings, and endorsing the C-Roads Platform's SCOM decisions, it was agreed to start an amendment process to request INEA a formal extension of the project to mitigate the adverse consequences and delays of the pandemic on the planning. The amendment foresees a 6-month extension to the Spanish pilot, which would conclude on 30/06/2021. As a result, some pilot milestones (M41, M42, M43) have been re-scheduled, adding up to those corresponding to the C-Roads Platform (M24, M26, M30) which have also been moved with SCOM agreement. Indeed, modifying the schedule is necessary to accomplish the goals of the Spanish pilot, whose planning has been severely impacted by the pandemic, and achieve meaningful results.

From the technical standpoint, in these meetings the technical setup, operation, progress, and results of the Spanish local pilots has been followed in close detail, addressing both common and specific problems. In this regard, 2020 has witnessed the completion of the deployment of all the infrastructure elements of the pilot involving ITS-G5, as part of the foreseen activities of the

second phase. Despite de inevitable delay in the piloting activities due to the pandemic, after the preliminary results obtained in the first phase of the pilot and provided that the C-Roads Platform's TF2-3 have finally delivered some set of functional and technical specifications for the ITS-G5 communication scenario of all Day-1 services, the piloting phase has yielded to the following results and achievements:

- The DGT 3.0 pilot has witnessed the successful integration into the DGT 3.0 platform of four use cases ("V-16", "Planned Roadworks", "Virtual Variable Message Panel", "Semaphore Information"). Events have been mapped to ETSI codes and sub-codes to reach the convergence with the use cases defined by the C-Roads Platform. A group of 10 volunteers has been recruited for the tests, and a dedicated HMI mobile app has been prepared. Finally, stress and security tests of the backend infrastructure have been defined and started.
- During 2020 the deployment of equipment for the SISCOGA Extended pilot has been further extended with additional RSUs, adding up to the already available ones. Overall, 95 RSUs are deployed at the urban area of Vigo, 6 at the urban area of Porriño, and 21 at interurban road sections. Accordingly, the fleet has been increased to 99 vehicles after the private fleet was reinforced after a volunteering campaign. The C-ITS centre has also been updated integrating the Spanish PKI. The 6-month update will allow to extend both the data acquisition and evaluation of the pilot.

Figure 36: Operation of Time To Green in the SISCOGA Extended pilot.

- In 2020, the Madrid Calle 30 has completed the development, testing, and deployment of the C-ITS hub. This central system allows to collect, parse, filter, format, and transmit traffic information in real time to interested drivers of Madrid Calle 30. Communication tests have concluded successfully, and the data collection proceeded as expected. Some

RSUs had to be de-installed, updated with new security certificates, and re-installed again in order to support its interaction with the Spanish PKI.

- The Cantabrian pilot has witnessed several achievements along its three test sites. The Basque sub-pilot intensified the data-collection process during Q2 2020 thanks to the participation of 27 real users. In parallel, several improvements to the HMI have been made, including general corrections, the connectivity to the server, and its compatibility with Android Auto. A preliminary evaluation report has also been prepared. The Galician sub-pilot increased the number of installed RSUs to 30 and the number of OBUs to 7. Additionally, it has been working on software tools for the automatic identification of fog and triggering of events to the drivers. Tests of the Emergency Brake Light have started in a controlled environment, and pre-tests questionnaires have been sent to the final users. Finally, the Asturias sub-pilot has finalised the deployment of the Traffic Jam Ahead and Park & Ride services. As they are Day-1,5 services, tailored KPIs had to be defined as there are no harmonised references from the C-Roads Platform. The baseline includes pre- and post-covid data, and therefore a ML algorithm has been developed to normalise them.
- The continued work in the Mediterranean pilot has led to significant progress in 2020. The 7 C-ITS services foreseen for the Catalonian sub-pilot and their visualisation are already available. Several complex cases, such as the detection of slow vehicles on the road, are being worked at simulation level. In fact, for the simulation part values for the KPIs and the evaluation result are already available. Overall, the test site has 35 Km, involving 10 RSUs, 10 OBUs, and a C-ITS hub integrating external data sources (INRIX, AEMet). Likewise, in 2020 the Andalusian sub-pilot has increased the number of deployed RSUs to 10, as well as 9 OBUs at maintenance vehicles, and a microwave emitter to detect the presence of vehicles. Altogether, 9 use cases are already working related to the RWW and HLN services, as well as the Day-1,5 service Smart Slip Road. The logic of the architecture is provided through a C-ITS hub developed specifically for the pilot. The collection of data is currently ongoing, with its completion and the beginning of the evaluation phase during Q1 2021.

To mitigate the delays caused by the pandemic, some of the tasks established for the development of the pilot have been assumed by different partners than those initially planned. This reassignment of tasks also involves the transfer of the budget associated with those tasks, which was also detailed in the amendment request.

Periodical follow-up conference calls have been organised among the representatives of the several pilots in order to follow a harmonised evaluation and assessment methodology, foster the exchange of knowledge and data among the participants, and highlight important results. During the reported period, calls have been held on 31/01, 06/03, 03/04, 07/05, 05/06, 03/07, 07/08, 18/09, and 27/11. The evaluation phase is supported by the results obtained by the Working Group 3 of the Platform concerning the selected KPIs and evaluation methodology for each investigation area, which have been endorsed and implemented by the Spanish pilot.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	1 546	7 751	5 428	4 858	2 196

19. The Swedish Pilot site

The Swedish pilot was part of the NordicWay 2 project (2017-2020) and currently 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 2 project (2017-2020):

- Contributed to the harmonisation and interoperability of the C-ITS services in Europe with requirements agreed by the C-Roads Platform.
- Supported the deployment of new "Day-1" and "Day-1,5" C-ITS services in Nordic countries and extend its use in vital road freight transport routes subject to extreme weather conditions and in urban and interurban environments.
- Supported the infrastructure readiness for connected and automated driving in Nordic countries in snowy and icy arctic conditions.
- Evaluation results (2020) include technical feasibility, ecosystem and business models, socio-economic impacts of the piloted Day-1 and Day-1.5 C-ITS services as well as the effect on user´s mobility and traffic behaviours and on public acceptance. Final evaluation results are available at www.nordicway.net.

NordicWay 2 project was successfully completed in 2020 and the project's evaluation results as well as the knowledge gained in C-roads TF2 Service definition and TF4 Hybrid communication were addressed in the planning of the new NordicWay 3 project. The full NordicWay 2 (2020) and in future NordicWay 3 results and reports can be viewed in the www.nordicway.net webpage.

From 2021 forward the NordicWay 3 – Urban connection project, with more cities involved, will continue to harmonise and build European C-Roads specifications for hybrid communication. 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 board tests with other pilots in European countries who has implemented the C-Roads hybrid communication specification.

Swedish national pilot

The Swedish NordicWay 2 Pilot covered 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 had the possibility to assess the viability of different applications on different types of road networks.

The pilot was 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 was 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)
- Hazardous Location notification (HLW): Roads works warning, emergency brake light, Emergency vehicle approaching and other hazards.

C-ITS Day-1,5 services:

- Traffic information and smart routing (TISR)
- Dynamic environmental zones

The NordicWay 3 pilot will build on NordicWay 2 and scale up the services to be implemented or close to implementation. The Swedish pilots will be carried out in close coordination with the other countries within NordicWay 3.

Involved partners

The Swedish Transport Administration and the following public and private organisations:

- Telefonaktiebolaget LM Ericsson
- Scania CV AB
- Volvo Car Corporation
- City of Gothenburg
- City of Stockholm
- VOLVO AB
- Kapsch TrafficCom AB
- Myndigheten för samhällsskydd och beredskap
- Uppsala kommun
- Södertälje kommun
- Zenuity AB
- IBM Svenska AB
- Swarco Sverige AB

- Technolution AB
- Springworks AB
- Carmenta AB
- DB Schenker
- Veridict AB
- Statens Väg och Transportforskningsinstitut
- Mindconnect AB
- Chalmers University of Technology
- KTH - Integrated Transport Research Lab (ITRL)
- Combitech AB
- Triona AB
- RISE Interactive Institute AB

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, Södertälje 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.

Overview of progress by End of 2020

NordicWay 2 was finalised and closed and the evaluation from the project and the knowledge gained in C-roads TF2 and TF4 were addressed in the planning of the new Nordic Way 3. The full results report can be viewed from in the www.nordicway.net webpage under year 2020.

In 2021 we will focus our efforts on aligning our new Nordic Way project (Nordic Way 3) with c-roads specifications for Hybrid communication. We are trying to close the gaps regarding messages and security. This will put requirements on our new pilots who will take place in 2022 to 2023. The goal is to be able to do cross board testing with other pilots in European countries who has implemented the hybrid communication specification.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	140	1 500	2 400	2 200	0

Indicative budget overview C-Roads 2 (in k€)

2019	2020	2021	2022	2023	
100	300	3 200	3 200	3 100	

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).

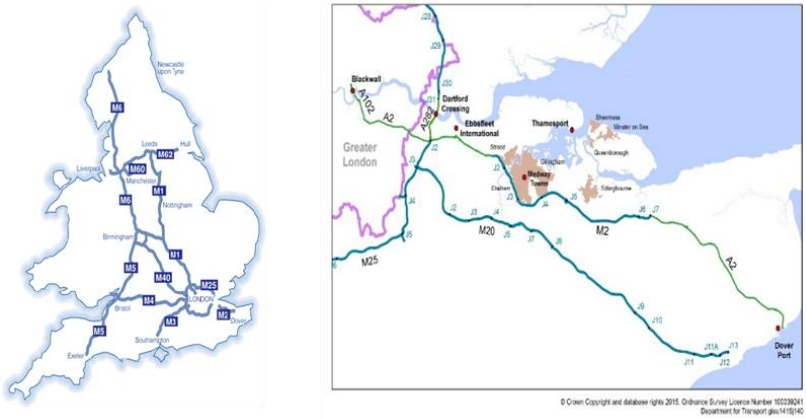
The Corridor will be a pathfinder for future investment and the blueprint for the wider roll-out of connectivity across the UK road network. Importantly, when it is fully operational in 2019, it will provide an open test-bed where the UK motor manufacturing sector and after-market companies can develop 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



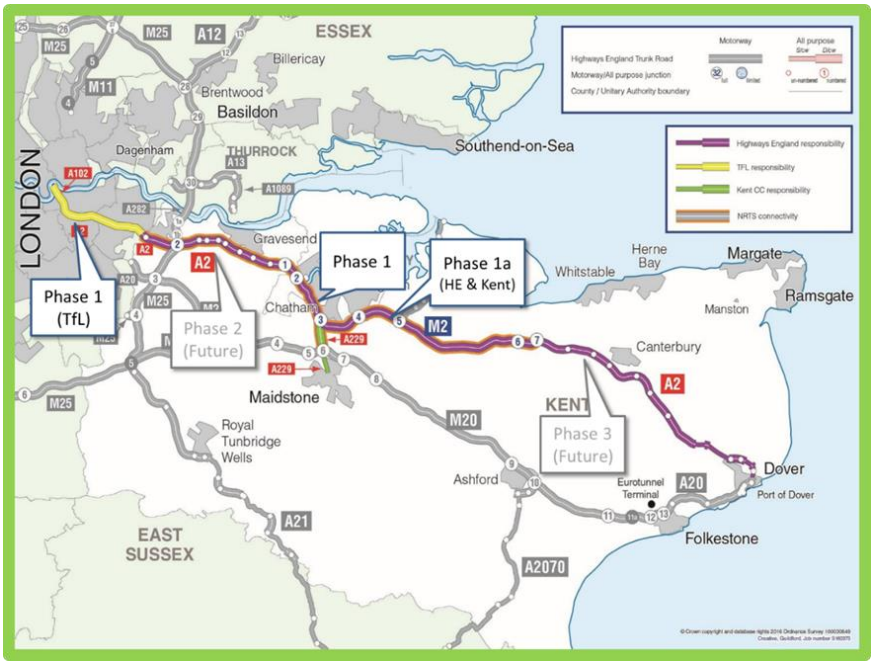


Figure 37: Location of the UK pilot site (Phases 1 & 1a deployed)

Overview of progress by End of 2020

The initial aim of InterCor was to achieve 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.

The implementation of the Action through 4 main Activities has been fulfilled, with definitive NL/FR/BEL/UK evaluations documented in Milestone 13 and submitted to INEA at the end of February 2020.

A further report detailing the UK specific results from the InterCor project were prepared in the common reporting template agreed within the C-Roads Evaluation Working Group (WG3) and were submitted to the chair of WG3 on 9th September 2020.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
39,8	1 190,8	4 397,0	5 972,7	423,3	0

21. Summary

Based on the basic technical specifications, developed from 2017 on, and the supporting common test specifications, pilot sites have defined their use cases to deploy, and the precise sections to be equipped on their networks. Active participation of dedicated platform partners on national and international preparatory works for public procurement tenders, single deployments and integration of C-ITS system have been carried out. Tenders for ITS-G5-based C-ITS roll-out on European roads as well as for cellular systems have been issued.

To ensure interoperability of services in Europe, it is important to carry out cross-border tests. Due to the pandemic situation in 2020 physical cross-border tests could not be conducted. Instead, virtual testing has been successfully carried out across different sites and countries, demonstrating the interoperability of C-ITS across Europe.

C-Roads						
Member State	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Austria	335	1 266	1 919	1 100	4 099	700
Belgium/Flanders	20	560	1 670	1 510	340	123
Belgium/Wallonia	-	24	204	778	840	2 400
Czech Republic	122	821	1 970	5 498	4 524	1 973
Denmark	-	50	130	170	180	-
Finland	-	2 300	1 300	1 400	800	-
France	167	474	894	1 894	2 428	1 351
Germany	725	1 493	2 091	2 508	1 590	1 524
Greece	-	-	-	-	-	-
Hungary	-	2	5	26	585	1
Ireland	-	-	-	-	-	-
Italy	2 244	3 752	4 437	2 803	5 406	-
Netherlands	1 100	3 700	5 200	3 300	n.a.	n.a.
Norway	-	1 900	1 800	1 500	1 100	-
Portugal	-	792	1 688	2 136	2 264	1 766
Slovenia	152	170	553	1 129	1 560	2 077
Spain	-	1 546	7 751	5 428	4 858	2 196
Sweden	-	140	1 500	2 400	2 200	-
UK	40	1 191	4 397	5 973	423	-
Sum (k€)	4 905	20 181	37 509	39 553	33 198	14 111

Table 1: Indicative budget overview (in k€)

C-Roads 2						
Member State	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Austria	-	105	597	826	5 208	6 262
Belgium/Flanders	-	-	-	-	-	-
Belgium/Wallonia	-	-	-	-	-	-
Czech Republic	-	-	-	-	60	60
Denmark	-	5	40	200	170	170
Finland	-	100	100	1 000	1 400	1 500
France	-	642	2 610	7 074	7 196	4 386
Germany	-	1 510	7 758	12 116	9 401	8 570
Greece	-	27	228	1 453	731	130
Hungary	-	10	100	1 785	1 187	10
Ireland	-	593	717	2 277	3 248	2 612
Italy	116	1 320	1 915	4 005	3 756	2 625
Netherlands	-	-	-	-	-	-
Norway	-	320	840	1 010	1 030	1 030
Portugal	-	1 559	3 875	14 468	5 906	3 602
Slovenia	-	-	830	1 730	2 700	-
Spain	-	-	-	-	-	-
Sweden	-	100	300	3 200	3 200	3 100
UK	-	-	-	-	-	-
Sum (k€)	116	6 292	19 911	51 144	45 192	34 057

Table 2: Indicative budget C-Roads 2 overview (in k€)