



Annual pilot overview report 2021

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C-Roads annual pilot overview report 2021

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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. Since 2019 the scope was enlarged towards urban areas. Currently more than 50 cities are starting to implement C-ITS Use Cases.

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

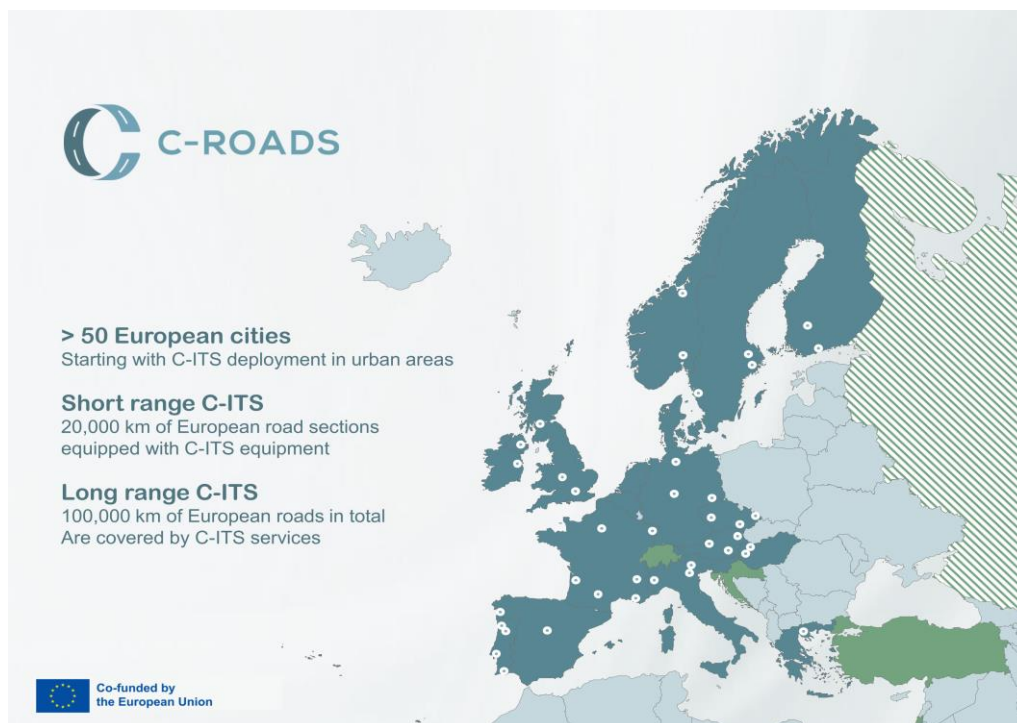


Figure 1: C-Roads overview

2. The Austrian Pilot site

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

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

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

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

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

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

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

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

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

Starting from 2022 further cities are planning to install roadside units and on-board units to transmit C-ITS services in urban areas. For example, the city of Linz already started to conceptualize their future installations. Other Austrian cities are expected to follow in future.

Involved partners

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

Location

Inter-urban

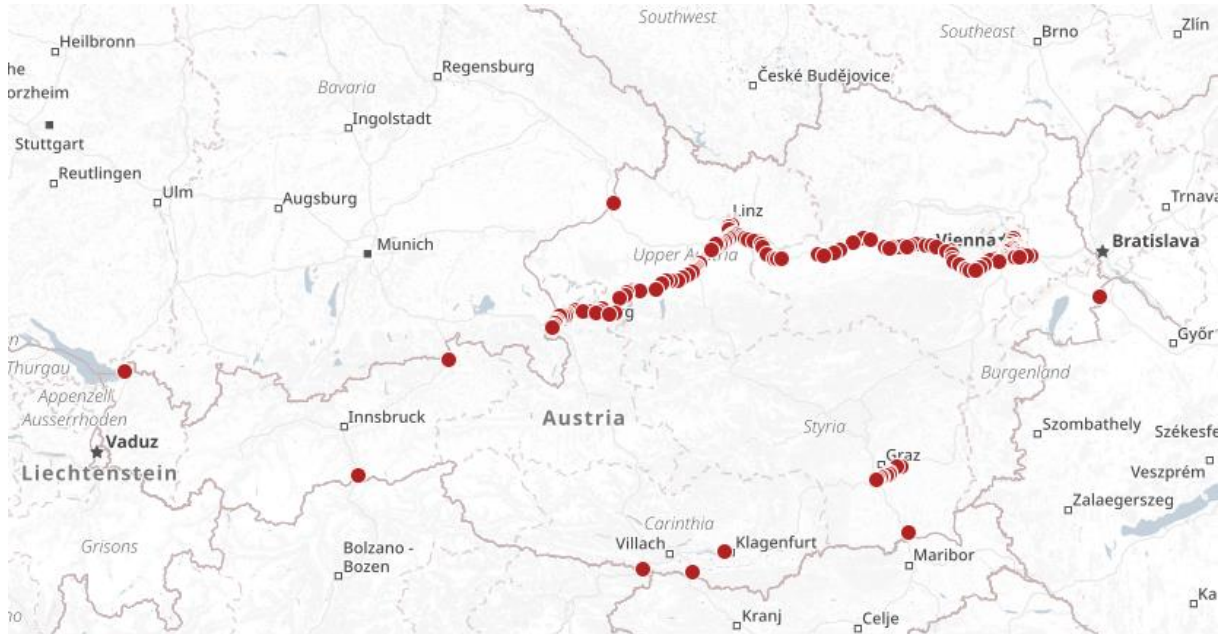


Figure 2: Initial operational deployment of 175 C-ITS roadside stations in Austria in 2021

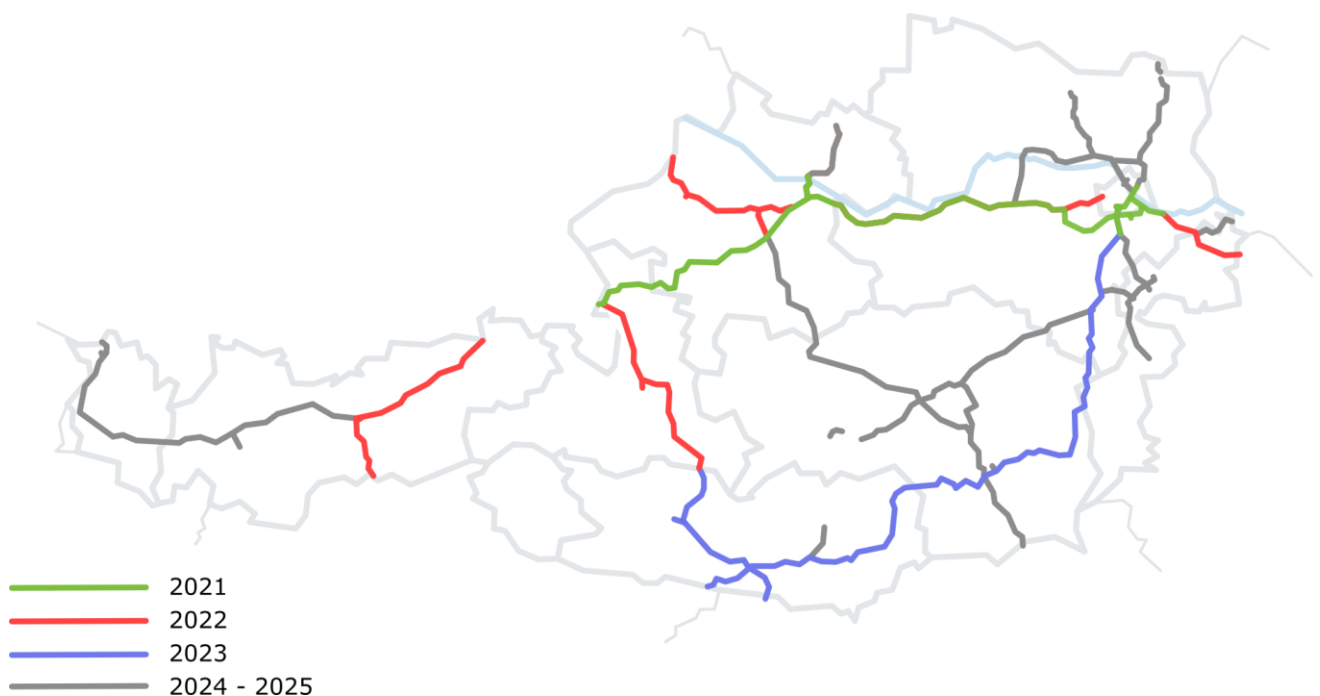


Figure 3: Initial operational deployment of C-ITS roadside stations in Austria in 2021 and further deployment plans for 2022 and 2023

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 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 until 2025 onwards.

Urban

Pilot Graz

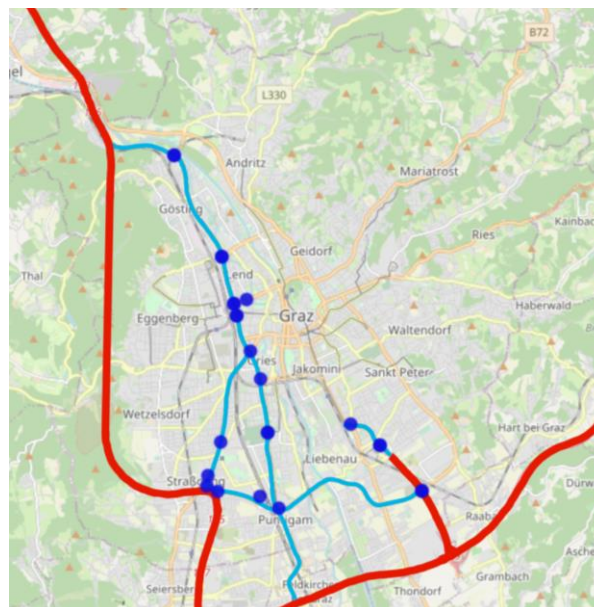


Figure 4: Map of C-ITS pilot in Graz

The two motorways A9 in the West and A2 in the South (red routes in the Figure 4), are both important connections for the city and at the same time, the city area of Graz is a common bypass

in the event of incidents on one of the motorways. Therefore, these roads are regularly congested and the city is facing a high additional traffic volume. The most common bypass routes are the B67 and the B70 (blue routes in the Figure 4), which are also the segments for the pilot in Graz.

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

- Purchase of necessary equipment and necessary replacements for existing traffic light equipment (central traffic computer, etc.)
- Purchase of testing equipment to independently validate installed road side units and to generate scenarios
- 16 road side units installed at signalized intersections on the above mentioned routes B67 and B70. All of those send SPAT/MAP information.
- 1 road side unit installed at an intersection with a parallel bike lane. This location is used to test a VRU use case by detecting cyclists on the bike lane.
- 4 busses equipped with onboard units, which are used to compare the PT prioritization and test other use cases.
- 1 vehicle equipped with onboard unit, which is used to test a RWW use case for the urban area.
- Equipment of a city tunnel with road side units which are supposed to send out the information of the variable message signs
- Design of an application to display messages in vehicles which are retrofitted with onboard units.

Pilot Wien

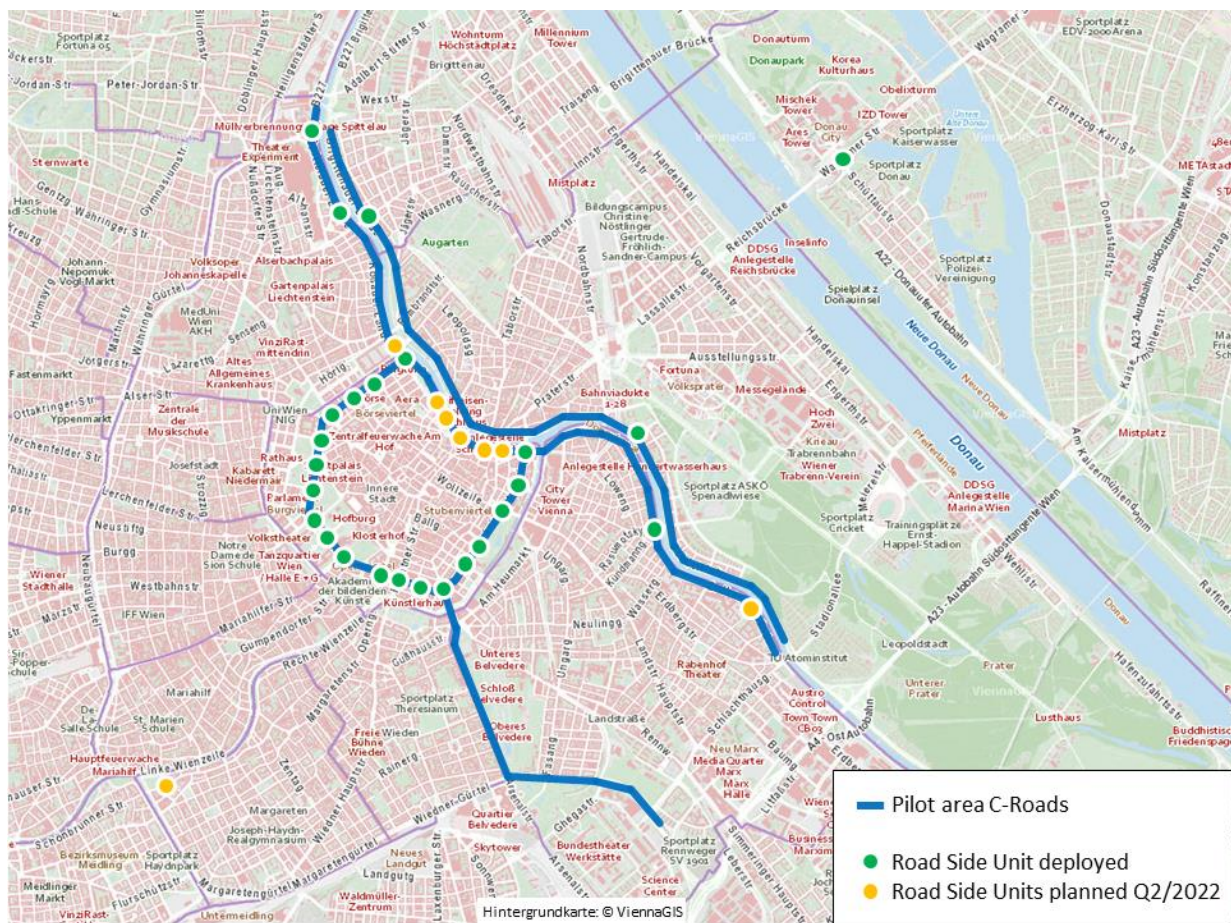


Figure 5: Map of C-ITS pilot in Vienna

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

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

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

- Purchase of necessary equipment and necessary replacements for existing traffic light equipment
- 24 road side units are already installed at signalized intersection across the above mentioned routes. All of those send SPAT/MAP information. More will come in the following months.
- 2 tramways equipped with onboard units, as preparation for the PT prioritization.
- 1 vehicle will be equipped with an onboard unit in 2022, which is used to test several use cases for the urban area.

Pilot Salzburg

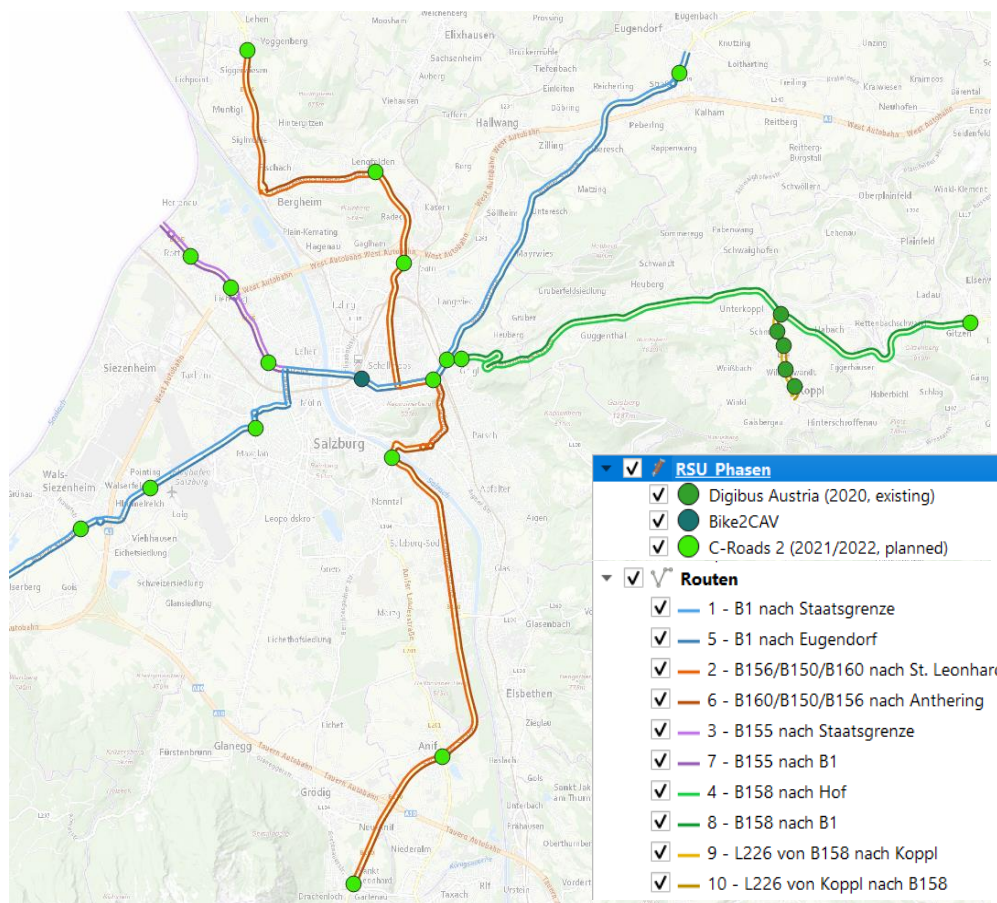


Figure 6: Existing and planned road corridors and RSU locations in and around the City of Salzburg

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

possible to create a continuous ETSI ITS-G5 infrastructure between the motorways and the peri-urban and urban road networks.

Planned deployment:

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

Overview of progress by End of 2021

Inter-urban

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operational status on the ECTL have become available (which only happened at the end of 2021) and can be implemented (which will not happen before the end of 2022). Nevertheless, these deployments have supplanted the pilot installations from Q2 / 2021 onwards for additional C-ROADS test activities.

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

Urban

Pilot Graz

In 2021, the installation of 17 road-side-units within the city has been finished. 16 road-side-units are currently transmitting SPAT and MAP messages.

One road-side-unit is being used to test a VRU use case. An artificial intelligence camera is detecting fast cyclists, which are arriving to the intersection in the blind spot of right-turning cars. The detection triggers a DENM (cause code and sub cause code for "dangerous situation") which is sent to cars on the according lane.

In parallel to the two above mentioned use cases, different public transport use cases are in preparation. For example, the prioritisation message for busses has been evaluated with internal tests.

Furthermore, testing equipment for the C-ITS systems was purchased. It enables the city of Graz to do acceptance tests at the final technical handover independently from the delivering company.

For the planned internal use cases, a visualisation tool is necessary. In 2021, a first concept for such a tool was elaborated and the first steps of the implementation were accomplished.

Pilot Vienna

In 2021, Wien Leuchtet equipped most of the signal-controlled intersections within the pilot area on Ringstraße with C-ITS infrastructure (Road Side Units). These 16 Road Side Units (RSU) are connected with the already existing traffic lights at the various intersections and serve in a first step the use cases Signal Phase and Timing Information (SI-SPTI, SPAT and MAP messages).

During 2021, AustriaTech, Kapsch and Virtual Vehicle carried out test drives by car on the pilot site Vienna.

Furthermore, Wiener Linien equipped two tramways with On Board Units (OBU) in 2021. End of 2021 there was a test drive with Wiener Linien and Wien Leuchtet to test the implementation of Signal Phase and Timing Information for the specific tramway signals.



Figure 7: On Board Unit with tramway signaling

Pilot Salzburg

By the end of 2021, the central C-ITS station (C-ITS-S) including a connection to the existing ITS system has been deployed. Moreover, four roadside ITS stations (R-ITS-S) have been successfully rolled out and connected to the C-ITS-S.

Concerning the C-ITS-S, the system concept (s. Figure) is connected to the already existing ITS system as well as the existing traffic control centre of the City and Federal State of Salzburg. The ITS system is further connected to the national data exchange platform EVIS.AT, through which the C-ITS system is supplied with traffic messages.

The C-ITS-S is based on an open source message broker (Apache ActiveMQ® Artemis) and has been deployed in the middle of 2021. The C-ITS-S is connected to the ITS system as well as to the traffic control centre for exchanging data (e.g. traffic data or signal information). The R-ITS-S from Kapsch TrafficCom are connected via the Kapsch V2X Integration Interface. In due course during the further deployment, it is also planned to support the C-Roads Hybrid Interface via AMQP.

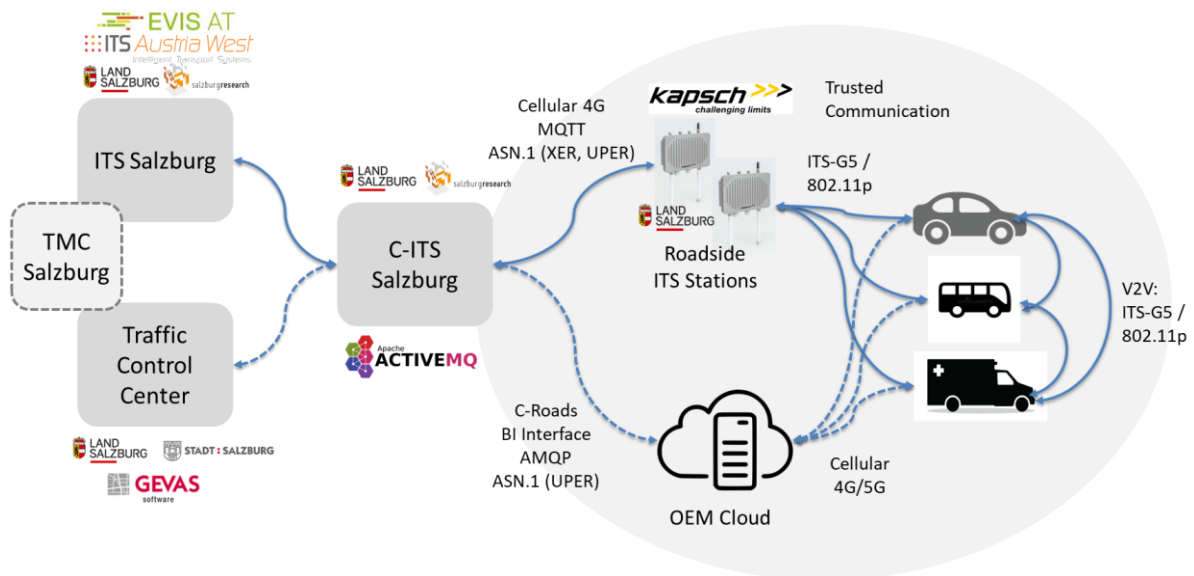


Figure 8: C-ITS system architecture of the pilot site Salzburg

In addition to the deployment of the C-ITS-S, the procurement of 17 R-ITS-S was carried out and completed in 2021. In December 2021, the first four R-ITS-S in the city of Salzburg were rolled out and the functionality of the C-ITS-R was successfully tested with the RWW use case. The roll-out of the remaining 13 R-ITS-S will be continued in the first quarter of 2022. For the further planned use cases (IVS, SI, HLN), a technical concept was developed with the partners involved so that the use cases can be implemented in due course during 2022. The procurement of 10 V-ITS-S required for the HLN use cases was also started in 2021 and will be completed in 2022.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
335	1266	1919	1062	5054	2452

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

2019	2020	2021	2022	2023
88	617	1166	6319	5710

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 9: 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 2021

Our project ended 30th of June 2021.

The only activities were a

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

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

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

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

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

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

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

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

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

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

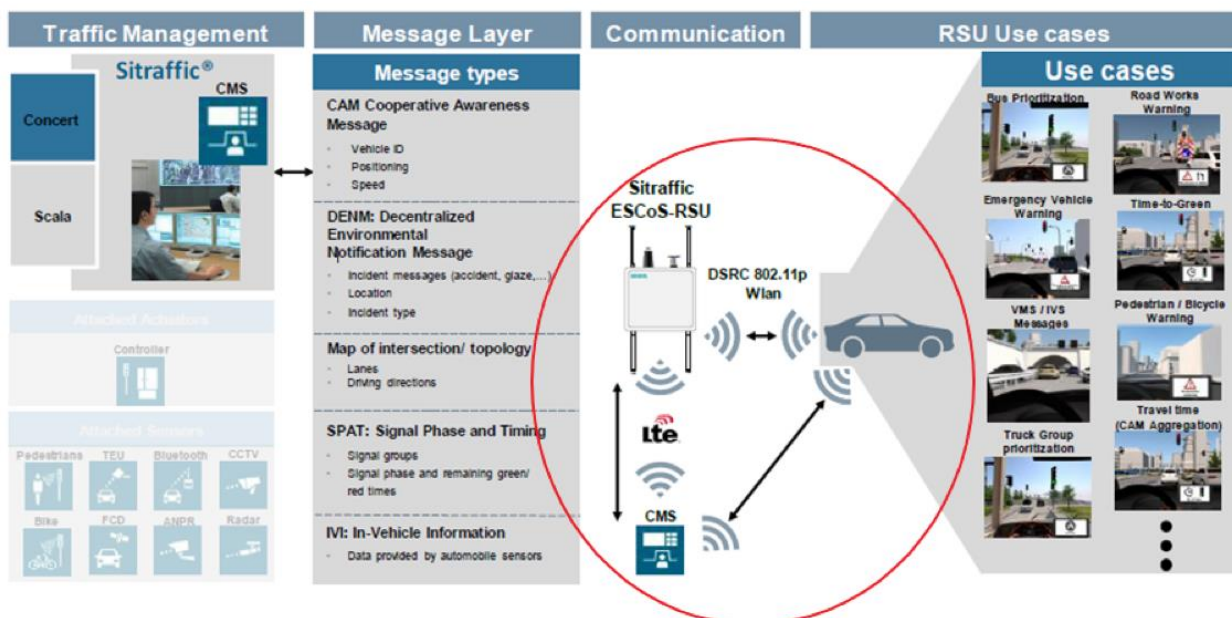


Figure 10: Data flow in the C-Roads Wallonia pilot site (image: V2Wal)

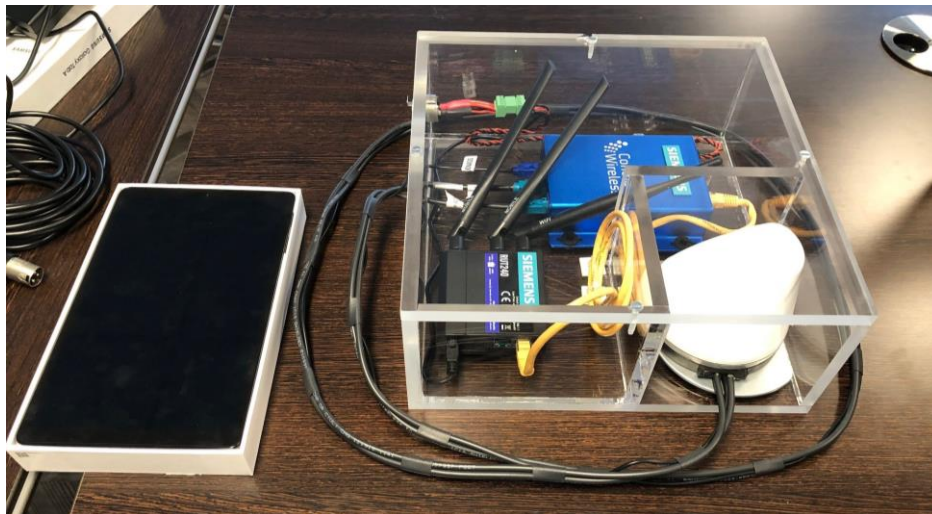


Figure 11: Pilot On Board Unit (photo : Tractebel)

- 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.

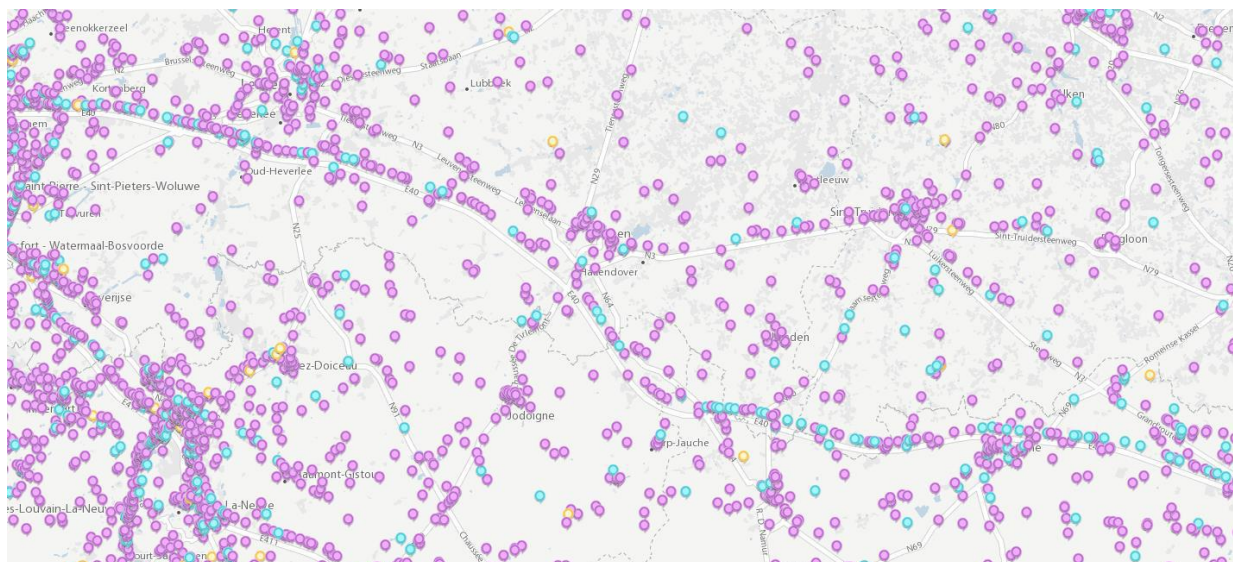


Figure 12: Coyote Community coverage in Wallonia (Zoom on E40 between Brussels and Liège, Image: Coyote)

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.

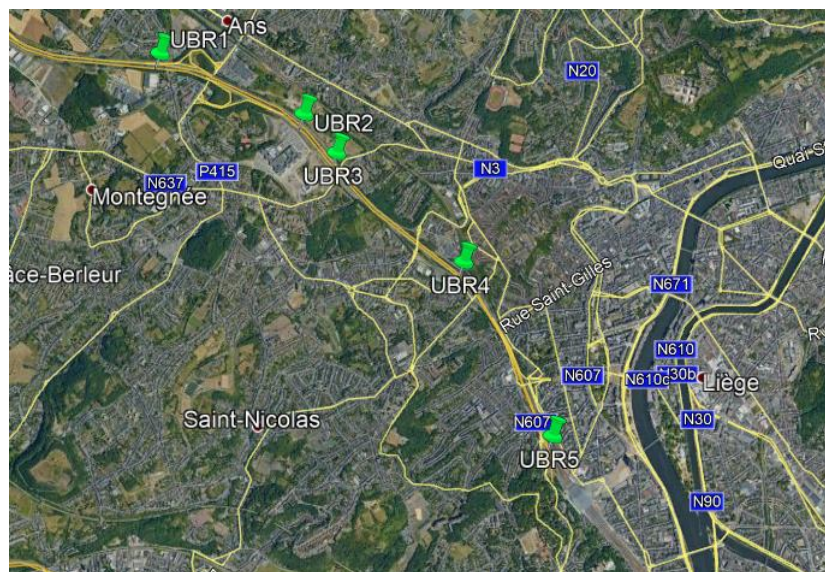


Figure 13: Localisation of the RSU's near Liège (Background: Google Maps)

- **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 2021

RSU (ITS-G5)

- The foreseen RSU were installed.
- The Siemens mainframe linked up with the TCC via a DATEX II interface.
- The data communication chain from the TCC until RSU's was tested and commissioned.
- The foreseen use case services were tested and validated (reception of the traffic information on the OBU via the RSU('s)).
- Tablets with a developed app were used as an OBU.
- Due to Covid, no physical cross border tests took place on the Walloon pilot site.
- Instead, PCAP files were logged for virtual cross border tests.
- Other member states replayed our PCAP files and provided us with their test report.
- Remarks such as missing traces, missing 'à la carte container' were not added afterwards.
- All performed test were used for the evaluation.

Cellular: Coyote (4G)

- The Coyote mainframe linked up with the TCC via a DATEX II interface.
- The data communication chain from the TCC until Coyote mainframe was tested and commissioned.
- The Coyote app which serves as an OBU was modified to receive the foreseen use case services.
- The updated app was tested and validated on the pilot site (E42 highway).
- 1000 app users received the updated app and tested in for further evaluation. These tests also served as cross border tests.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
n.a.	23	204	778	840	2483

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 Czech Republic pilot sites are located on:

- the Rhine-Danube Core Network Corridor, from Rozvadov at the Czech/German border to Praha
- the Orient-East Med Core Network Corridor, section Praha – Brno
- the urban nodes Plzeň, Brno and Ostrava. Plzeň and Ostrava are situated on the Rhine-Danube Core Network Corridor. Ostrava and Brno are situated on the Baltic-Adriatic Core Network Corridor.
- In case of railway level crossings in Pardubice region and In Ústí n. L. region

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

- **DT1 Brno agglomeration** covers the southern sector of the city of Brno, in particular the following roads / motorways:
 - Part of motorway D1 in the length of 30 km between km 180 and km 210
 - Part of motorway D2
- **DT2 Brno city**, this pilot took place on the 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.

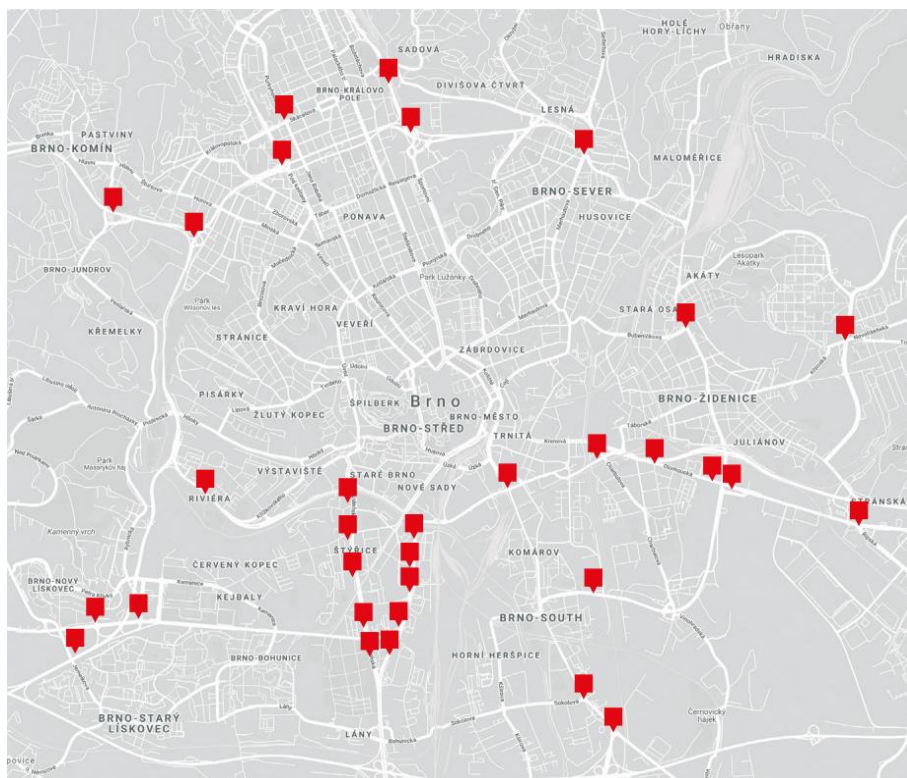


Figure 14: Deployment in Brno

- **DT3 – Motorways D1, D5, D11 and I/52 / D52** C-ITS equipment and services were deployed on the D1 motorway between Prague and Brno, D5 motorway between Prague and Rozvadov (German border), on the D11 motorway between Prague and Hradec Králové, and on the D52/I52 connection road between Brno and the Austrian border. Total length amounts to more than 360 km. This pilot site includes both cross-border locations – on the D5 motorway with Germany, and on the D52/I52 motorway/road with Austria.

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

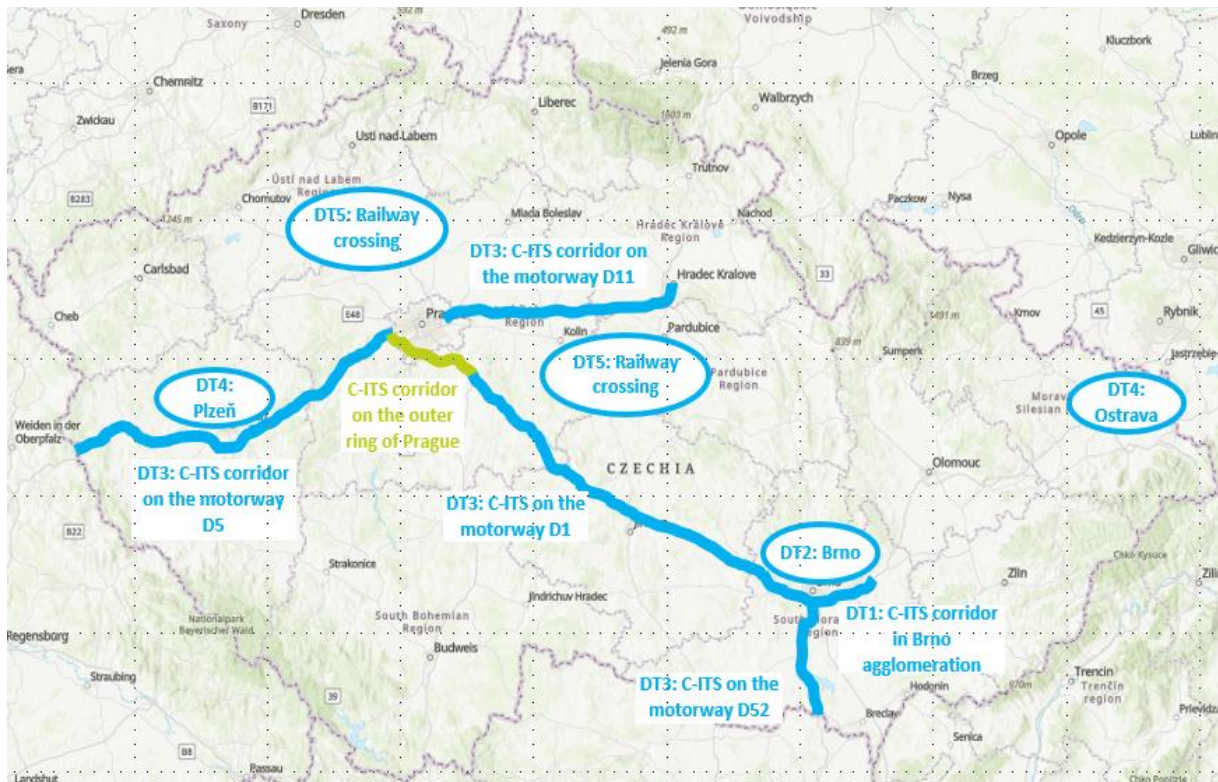


Figure 15: Location of the Czech pilot site

Overview of progress by End of 2021

By the end of 2021, all activities planned within the project C-Roads Czech Republic were successfully completed. In overall, C-Roads Czech Republic activities were divided as follows:

- Activity 1: C-Roads Platform
- Sub-Activity 2.1: Czech pilot sites, Studies & system specification
- Sub-Activity 2.2: Czech pilot sites, Deployment & field tests
- Sub-Activity 2.3: Czech pilot sites, Evaluation & standardization
- Activity 3: Horizontal activities

Within the activity 1 C-Roads Czech Republic contributed to C-Roads Platform deliverables and activities, the key contribution was related to deep involvement in PKI implementation and definition of European security specifications based on experiences of real operations, major inputs for the common harmonized specification in specific topics like C-ITS for public transport, railway crossings, signalized intersections and hybrid communication, because the very first deployment of these concepts and technologies took place at the Czech pilot sites. Moreover, the Czech Republic came up with the draft of hybrid architecture, principles and interfaces leading to the overall concept of IP-based C-ITS message exchange and held the key role during hybrid testing.

The main goal of sub-activity 2.1, to prepare technical documents in order to enable deployment and subsequent testing of C-ITS systems within C-Roads Czech Republic pilot sites and services in an interoperable way (nationally as well as cross-border), was achieved. Therefore, use cases, common system architecture, functional and technical requirements for C-ITS deployments and test plans and scenarios were defined. All technical specifications fully reflected the latest C-Roads Platform specifications (Release 2.0) as well as national and cross-border testing results. These documents will be used as a technical corner stone for all future C-ITS deployments in the Czech Republic to maintain interoperability within the country as well as abroad.

As concerns deployment and testing of pilot sites, within sub-activity 2.2 were completed cross-sectional activities, pilot sites and new technologies. Cross-sectional activities included deployment and testing of central elements - security layer (PKI) and so called Integration platform (the hybrid element that ensures a guaranteed C-ITS messages exchanges between C-ITS Back Offices and serves as the national interconnection point). Moreover, 6 pilot sites defined by Grant agreement were also successfully deployed and tested. In total, 230 km of motorways are covered by ITS-G5 technology, approximately 360 km of motorways are covered also by LTE technology, 3 cities were involved, 115 RSUs at all pilot sites and 25 urban intersections were equipped with RSU, more than 240 vehicles and VMS warning trailers were equipped. Furthermore, the Czech Republic implemented and tested LTE-V technology, hybrid On-board Unit and mobile application. The testing took place on the national as well as international level. Moreover, Czech Republic actively participated at international testing organized by 8 Member States (Austria, Belgium/ Wallonia, France, Germany, Hungary, Italy, Slovenia, Spain).

Pilot sites were thoroughly evaluated within the sub-activity 2.3.

Last but not least, the Czech Republic was active with dissemination activities – e.g. conferences, leaflets, workshops.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
124	808	2052	5164	4590	2102

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

2019	2020	2021	2022	2023
0	0	0	60	60

6. The Danish Pilot site

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

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

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

NordicWay 3 project (2019-2023):

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

The results of NordicWay 3, as well as of the previous NordicWay projects, can be viewed in the www.nordicway.net webpage.

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

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 2021

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

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

NordicWay 3 project (2019-2023):

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

In 2021, no actual pilots took place in Finland, but the pilots were prepared to become operational in 2022. Several prestudies were performed, checking the readiness of Finnish actors and data sources to deploy C-ITS services over cellular communications, according to C-Roads specifications. These include:

- Pre-studies for the Tampere pilot for traffic light interoperability, in which a node will be developed which will publish traffic light signal status messages (SPATem and MAPem) according to C-Roads specification, from different traffic light providers, will

- Pre-study for a C-ITS Emergency vehicle approaching pilot, delivered over cellular communications.
- Demonstration of the use of 3D sensor and Lidar Edge AI edge intelligent solution for analysing traffic in intersections, and warning drivers on potential collisions with VRUs. This proof of concept was performed in Helsinki Jätkäsaari district.
- Pre-study of interactive and cooperative traffic management in the Helsinki region. The different steps to deploy a data platform, which can be used for the publication of C-ITS services, have been proposed.
- [Study on Automated driving on Motorways](#), addressing the readiness of the road network to support automated driving

Involved partners

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

Location

Currently, there is not yet a pilot in operation. The traffic light pilot will take place in the city of Tampere. The other prestudies relate to the national road network.

Overview of progress by End of 2021

At the end of 2021, the Tampere pilot is in the procurement phase. For the other pilots, no decisions were yet taken at the end of 2021.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	2300	1300	1400	800	0

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

2019	2020	2021	2022	2023
100	100	1000	1400	1500

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	<p>Ministry - public road operators</p> <ul style="list-style-type: none"> • Interdepartmental Directorate of Eastern Roads DIRE (deconcentrated state service) • Interdepartmental Directorate of Centre-East Roads DIRCE (deconcentrated state service) • Interdepartmental Directorate of Atlantic Roads DIRA (deconcentrated state service) • Interdepartmental Directorate of West Roads DIRO (deconcentrated state service) 	<p>Ministry -public road operators</p> <ul style="list-style-type: none"> • Interdepartmental Directorate of Eastern Roads, DIRE (deconcentrated state service) • Interdepartmental Directorate of Mediterranean Roads (deconcentrated state service) • Interdepartmental Directorate of Ile-de-France Roads (deconcentrated state service) • Interdepartmental Directorate of South west Roads (deconcentrated state service)

	C-Roads France	InDiD
Road operators	<p>Concessions companies and provider of road transport services</p> <ul style="list-style-type: none"> ASFA: The Association of French Motorway Companies APRR: Société des autoroutes du Nord et de l'Est de la France SANEF: French freeway concession company Vinci Autoroutes: French freeway concession company 	<ul style="list-style-type: none"> Interdepartmental Directorate of Centre-East Roads (deconcentrated state service) Interdepartmental Directorate of north Roads (deconcentrated state service) Interdepartmental Directorate of Atlantic Roads (deconcentrated state service) <p>Concessions companies and provider of road transport services</p> <ul style="list-style-type: none"> ASFA: The Association of French Motorway Company APRR: Société des autoroutes du Nord et de l'Est de la France SANEF: French freeway concession company Vinci Autoroutes: French freeway concession company
Cities / Public Entities	<ul style="list-style-type: none"> Eurometropolis of Strasbourg (EMS) Bordeaux Metropole 	<ul style="list-style-type: none"> City of Paris Aix-Marseille-Provence Metropole Département de l'Isère Bordeaux Metropole European Collectivity of Alsace (CEA) Eurometropolis of Strasbourg (EMS)
Car manufacturers	<ul style="list-style-type: none"> Renault PSA 	
Research institutes / Universities	<ul style="list-style-type: none"> CEREMA Université Gustave Eiffel Université Clermont-Auvergne Université de Reims Champagne-Ardennes 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> IDNomic 	<ul style="list-style-type: none"> IDNomic
Mobility Labs / Geography experts	<ul style="list-style-type: none"> Transpolis 	<ul style="list-style-type: none"> Institut Vedecom Le LAB IGN
Solution providers: C-ITS / Mobility / DIGITAL		<ul style="list-style-type: none"> Valeo TomTom Green communication Transdev Autonomous Transport Systems ATC France

Table 1: Involved partners of C-Roads France and InDiD

Use cases

A dedicated working group was set by Activity 2 – Studies. The WG worked from August 2019 till January 2020 to propose, discuss and select new use cases on which the partners were interested to work within InDiD project, including those already foreseen by the Grant Agreement. The WG established a list of use cases and functionally defined each of them. The French Use Case Catalog was thus updated with the new use cases and some already existing use cases were rewritten. The updated Use Case Catalog was approved by the Steering committee for Studies on February 6, 2020 and made public on internet on April 21, 2020. Thus the Milestone 28 –“Functional description of new use cases” was reached on February 6, 2020.

The numerous use cases functionally described above will not necessarily be developed in one of the quoted projects. Based on this list, each pilot site makes its implementation decision.

C-ITS Use Case			
A – Probe Vehicle Data (PVD)			
A1	Traffic data collection	A3	Probe vehicle data on manually declared events
A2	Probe vehicle data on detected events	A4	Detection of a vehicle in distress in a critical area
B – Road Works Warning (RWW)			
B1a	Alert closure of part of a lane, whole lane or several lanes	B2b	Alert operator vehicle in intervention
B1b	Alert planned closure of a road or a carriageway	B2c	Alert operator vehicle in patrol
B1c	Alert planned road works – mobile	B2d	Alert end of queue by a road operator vehicle
B2a	Alert operator vehicle approaching	B3a/b/c	Winter maintenance
C – Signage Applications			
C2	In-vehicle dynamic speed limit information (IVI)	C5	Toll Station Approaching: event information
C3	In-vehicle signage (Embedded VMS)	C6	Toll Station Approaching: orientation of automated vehicles
C4	Toll Station Approaching: orientation of drivers	C7	Toll Station Approaching: enhanced orientation of drivers
D – Hazardous Location Notifications (HLN)			
D1	Alert Temporary slippery road	D9a	Alert temporary mountain pass route closure

D2a/b	Alert animal or people on the road	D9b	Alert approaching a closed mountain pass route
D3	Alert obstacle on the road	D10	Alert emergency brake
D4	Alert stationary vehicle / breakdown	D11	Alert end of queue
D5	Alert accident area	D12	Emergency vehicle approaching
D6	Alert reduced visibility	D13	Longitudinal Collision Risk Warning
D7	Alert wrong way driving (WWD - Contre-sens)	D14	Alert slow vehicle
D8	Alert unmanaged blockage of a road		
E – Traffic Information and Smart Routing			
E1	Traffic information about snow on the road	E4	Smart POI
E2	Rerouting	E5	Travel Time of Heavy Goods Vehicle
E3	Smart routing	E6	Alert weather conditions
F – Parking, Park and Ride, Multimodality			
F1	Information on parking lots location, availability and services	F5	Modal transfer advice
F2	Parking lots location and availability : break time indication	F6	Reservation of a parking space released by a user
F3	Information about the schedule of the next public transport after parking at the station	F7	Information about a parking space released by a user
F4	Information about the schedule of the next public transport when approaching a station	F8	Car-sharing service between two specific stations
G – Intersection (SI)			
G1	GLOSA (Green Light Optimal Speed Advisory)	G5	In-vehicle signage at a merge for vehicles on the entry slip road
G2	Traffic signal priority request by designated vehicles	G6	In-vehicle signage at a merge for vehicles on the main road
G3	Intersection violation: Warning to the violator vehicle	G7	HD cartography extended services
G4	Intersection Violation: Warning to approaching vehicles		
H – Traffic management			

H1	Permanent Traffic Ban to Specific Vehicles	H5	Dynamic Lane Assignment
H2	Dynamic Traffic Ban to Specific Vehicles	H6	HGV overtaking ban
H3	Dynamic Lane Management – Reserved lane (I2V2I)	H7	Variable speed limit for automated vehicles
H4	Dynamic lane management – reserved lane (I2V)	H8	Vehicle entering a non-autonomous zone
I – Vulnerable users			
I1	Pedestrian at signalized intersection: warning to vehicles	I4	Pedestrian out of intersections and out of pedestrian crossings: warning to vehicles
I2	Pedestrian at signalized intersection: warning to pedestrian	I5	Vulnerable user at a public transport stop
I3	Road workers in the field		
J – Multimodal Cargo Transport Optimization			
J1	Estimated Time of Arrival (ETA) for terminal operators	J4	Information on the site's access conditions
J2	Dock reservation	J5	Optimal route advice for trucks
J3	Assigning a slot to a given vehicle for cross-channel traffic	J6	Guide the truck in the port (terminal or truck parking)
K - Level Crossing (Use cases SNCF - open level crossing)			
K1	Level Crossing out of order	K3	Level crossing in process of closing (level crossing in process of closure)
K2	Level Crossing approaching (open level crossing)	K4	Detection of a vehicle in distress in a critical area
L – Law Enforcement			
L1	Identification of vehicles reported by law enforcement agencies	L3	Automated driving system status
L2	Stationary law enforcement vehicle	L4	Location of vehicle particularly sought after by law enforcement agencies
M – Payment services			
M1	Payment service at a toll station		

Table 2: C-ITS French Use Cases Catalogue

Location

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

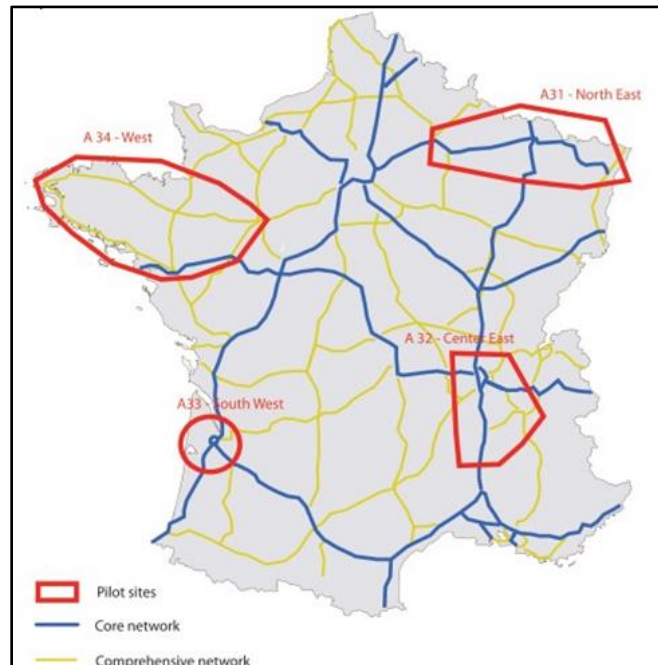


Figure 16: Location of the French pilot sites for C-Roads France

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

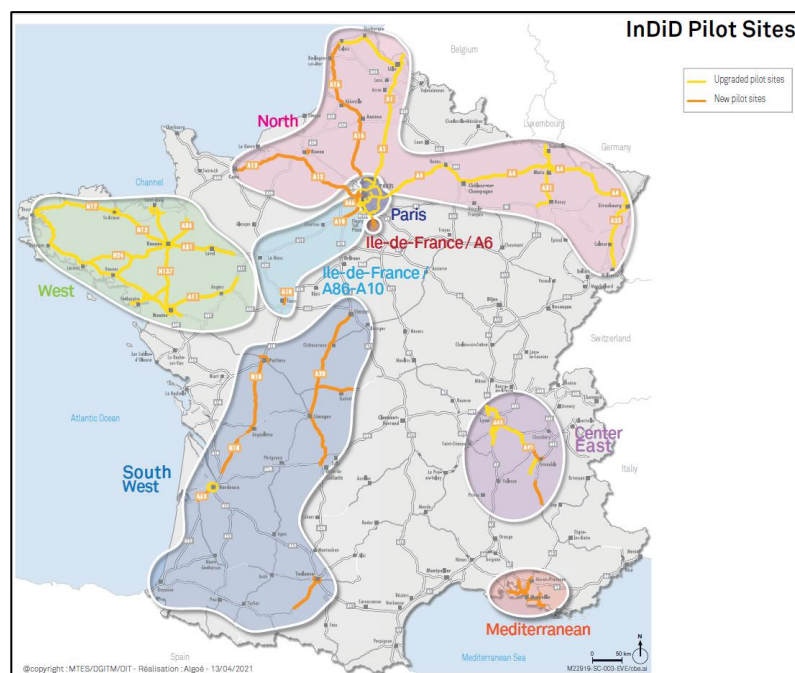


Figure 17: Location of the French pilot sites for InDiD

Overview of progress by End of 2021

C-ROADS_France

In 2021, 4 pilot sites (North-East, Centre-East, South-West and West) were configured as C-ITS living laboratories, on large scale, embedding both TEN-T Core Network and Urban Nodes networks and associated Traffic Management Centres. The project officially ended on 31/12/2021.

In this project, all the pilot sites have agreed on the implementation of a **hybrid architecture**, schematically represented as follows:

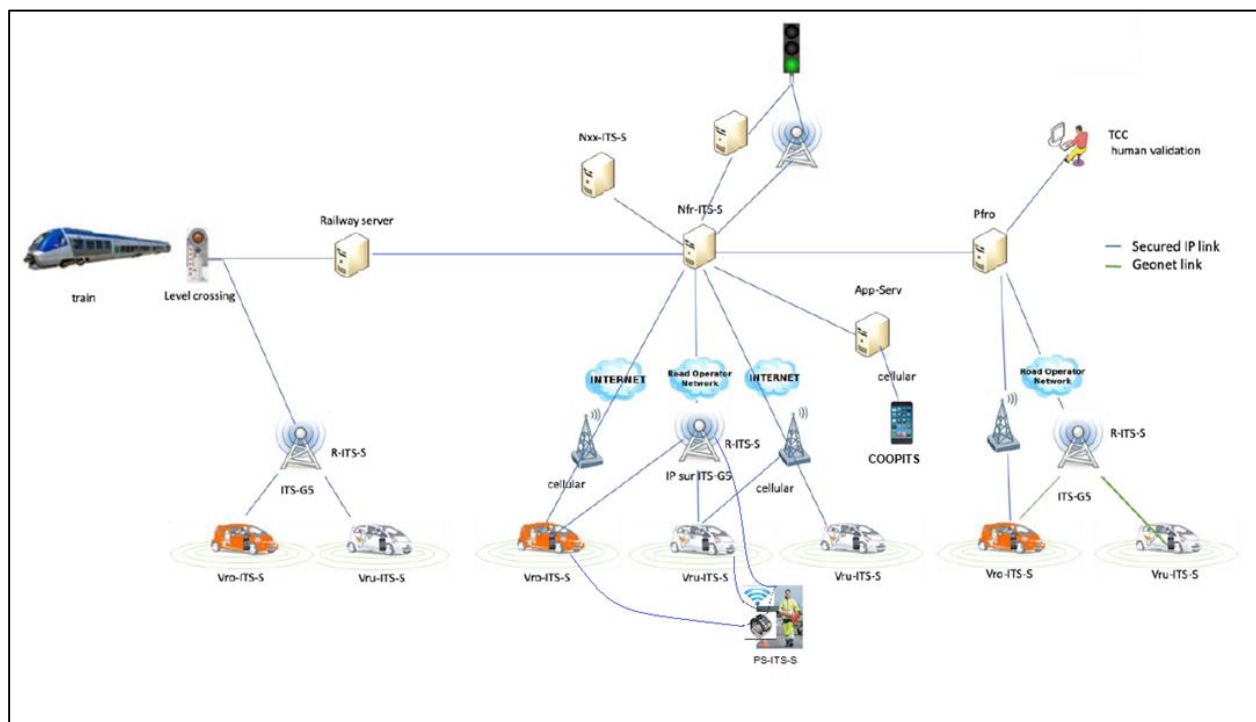


Figure 18: Schematic illustration of hybrid architecture for pilot sites in France

A3.1 : North-East

For this pilot site, the road operators were Interdepartmental Directorate of Eastern Roads (DIRE), deconcentrated state service, Société des autoroutes du Nord et de l'Est de la France (SANEF), motorway concession operator, Eurometropolis of Strasbourg (EMS) et the pilot was DIRE.

The road network of this pilot site was motorways 31 and 35 (operated by DIRE) and motorway 4 between Reims, Metz and Strasbourg (operated by SANEF).

DIRE installed the services according to its roadmap. All systems migrated to the latest European standards at the end of September 2020. In the scope of C-ROADS France project, Sanef integrated the required updates or software on servers, and on C-ITS equipment. The migrated use cases were available by the end of September 2020.

A3.2 : Centre-East

The road operators at this pilot site were Paris-Rhin-Rhône motorways (APRR), motorway concession operator, Motorways of the South of France (ASF), motorway concession operator, Interdepartmental.

Directorate of Centre-East (DIRCE), deconcentrated state service and the pilot was APRR. The road network of this pilot site was motorways 43 and 48 (operated by APRR), motorway 7 (operated by APRR), motorways 7, 9 and 46 (operated by ASF), motorways 42 et 43 et national routes 87,346, 481(operated by DIRCE).

A POC on Bluetooth communication protocols was realized. ITS G5 and cellular technologies are used by all road operators. Road operators have defined the list of services to be deployed on their perimeter. APRR deployed its local network architecture in a TMC test environment to facilitate testing and migration.

A3.3 : South-West

For this pilot site, the road operators were Interdepartmental Directorate of Atlantic Routes (DIRA), deconcentrated state service and Bordeaux Métropole. The pilot was DIRA. The road network of this pilot site was motorways 62 and 63 (operated by DIRA) and Bordeaux ring road covering in particular M1113 - Route de Toulouse and Bvd d'Aquitaine.

It was also on its perimeter that the smartphone application was firstly tested with public and including urban use cases. ITS G5 and cellular technologies are used both by DIRA and Bordeaux Métropole. The migration process was carried out by DIRA. Some development on the interfaces between the TMS and the Pfro were realized. Migration (new standards) has been developed by the French Ministry, and was tested fall 2020.

A3.4 : West

For this pilot site, the road operators were Interdepartmental Directorate of West Roads (DIRO), deconcentrated state service, and COFIROUTE (motorway concession operator) and the pilot of the activity was DIRO.

The road network of this pilot site was national roads 165,166 and 176 (operated by DIRO) and motorway 11 (operated by COFIROUTE). DIRO and COFIROUTE implemented communications technology ITS G5 and Cellular. The smartphone app can be used through WiFi delivered in Cofiroute's rest areas. A POC on Bluetooth communication protocols was realized. As in the other pilot sites, the operator's road have defined the list of services to be deployed on their perimeter.

A3.5 : Car manufacturers

PSA and Renault have both participated to Studies activities in order to define the list of C-Roads France use cases, and then specify, develop, and validate them.

Car manufacturers have defined the list of services to be deployed. Each car manufacturer has developed its own system architecture and provided the equipment for its vehicles.

During the course of the action, up to 2021, 162 RSU were installed.

INDID

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

The systems specified, developed and validated in the INDID action studies were deployed. In 2021, most of the work consisted of defining the requirements for contracts for the supply and installation of R-ITS-S and Vro-ITS equipment and IT contracts relating to IT development. These were either new contracts launched within the framework of the project or existing or previously awarded contracts that were reused. Due to the launch of the markets by all the pilot sites, the partners are now engaged in the installation of IT infrastructures and the development and deployment of use cases in the sites.

A3.1 Pilot 'Mediterranean

This pilot focuses on the experimentation in a high-density urban setting. The activities will take place within the metropolitan area of Marseille on the roads managed by Interdepartmental Directorate of Atlantic Roads (DIRMed), deconcentrated state service and the metropolitan government. The Metropole Aix-Marseille-Provence (MAMP) is working on the deployment of the use cases G1 Glosa, G2 Priority Fire, F1 Parking Information and Vulnerable Users. Tender to equip the buses will end in the second half of the year.

The consultations for the supply and installation of the R-ITS-S and Vro-ITS-S were launched in 2021.

The physical server was installed at the Traffic Engineering and Management Center (CIGT) and the SCOOP platform was installed in early November 2021.

A3.2 South West Pilot

The pilot will cover 3 different sites. Traffic management services will be developed in a first zone from Poitiers to Bordeaux and Spain. This site includes interurban and suburban roads and motorways. The road management is ensured by a unique traffic control centre based in the Bordeaux vicinity.

The second zone includes the Toulouse urban motorways (A620, A621, A624) under Interdepartmental Directorate of South west Roads (DIRSO), deconcentrated state service, responsibility and the main connected highway (A64) to the city ring-road. It also includes the A61 and a portion of A64 which is managed by ASF (motorway concession operator). Department road networks managed by Toulouse Métropole are part of it too.

A third zone aims to experiment C-ITS services on transit infrastructure usage on A20 between Toulouse and Limoges. Traffic of transit between Paris and Toulouse (and widely between South and North of Europe: E9) and between Lyon and Bordeaux (and widely between Atlantique and Centre of Europe: E62). The site includes interurban and peri-urban roads sections and a tunnel. The road management is ensured by a unique traffic control centre based in Limoges City.

Use cases have been defined at the South West pilot site and there will be few new use cases. The tenders for the supply and the installation of the R-ITS-S and Vro-ITS-S were launched in 2021.

A3.3.1 Pilot 'Ile-de-France / A6

The site is located on APRR (motorway concession operator) motorway A6, near Paris. The development of the interfaces with the toll information system is being completed. The process of supplying and installing the R-ITS-S and Vro-ITS-S and the procedure for reusing the existing public contracts for InDiD were launched.

A3.3.2 Paris pilot

The pilot site is part of a global approach set up by the City of Paris and the Urban Lab of Paris and Co, called 'Urban Innovation District'. This approach aims to focus on a limited number of territories, representative of a majority of complex urban situations. The identified territory is located in the 13th district and represents an area of approximately 188 hectares.

The uses cases G1 (GLOSA TimeToGreen) and G2 (traffic signal priority request by designated vehicles) were deployed and the tests were carried out. The operator installed the entire C-ITS infrastructure for the project, which has been in service since mid-February 2021.

A3.3.3 Pilot 'A86-A10

The site comprises two types of roads operated by COFIROUTE (motorway concession operator): motorway urban tunnel on the A86 a section of approximately 10 km and a motorway section of A1 near Paris. VINCI Autoroutes launched the tender for the supply and installation of the R-ITS-S. 16 R-ITS-S were installed, 10 of which are already operational and 6 are in the process of being put into service.

A3.3.4 Pilot 'North

The pilot site comprises a network of interurban motorways of approximately 1,500 km that connects Paris to the main regional capitals of Normandy, Hauts-de-France and Grand-Est regions. The main Cities are Caen, Boulogne-Sur-Mer, Lille, Reims, Metz and Strasbourg. Special focus will be given in InDiD to the deployment of C-ITS systems on the Western part of SANEF (motorway concession operator) network; these are the A13 and A14 motorways in Normandy.

Day1 and Day1.5 services were deployed. The procedures for reusing the existing contracts for the new R-ITS-S and Vro-ITS-S were initiated at the end of 2021. The PFRo platform was deployed.

A3.3.5 Pilot 'West

This pilot site aims to upgrade its equipment from SCOOP@F and C-Roads France projects with complementary use cases to improve drivers and workers security and enhance real-time traffic information availability and accuracy to road users. InDiD will provide equipment and C-ITS services towards Tours, through A10 motorway (Core Network / Atlantic Corridor). COFIROUTE (motorway concession operator): road operator will choose the services to be deployed.

The calls for tenders for the supply and the installation of R-ITS-S were launched. The pilot site participated in the production phase (top-down) on a first security level in mid-2021.

A3.4 : Centre East pilot

This pilot center was composed by AREA, METRO, SMTC, the city of Grenoble and the department of Isere. However, in 2020 METRO and SMTC dropped out of the project. The existing contracts in the framework of C-Roads_France for the supply and installation of R-ITS-S and Vro-ITS-S were taken over. The PFRo platform was installed and connected to the R-ITS-S.

During the course of the action, up to 2021, 60 RSU were installed.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
3332	947	1796	3803	4856	2675

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

2019	2020	2021	2022	2023
1837	5025	5938	5925	2806

9. The German Pilot sites

Germany as Member State will contribute to the C-Roads cooperation by the findings of the implementation and operation of in total 11 different C-ITS services, which will be deployed in 5 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 will not only be deployed but also delivered as a transferable C-ITS framework, harmonised on European level in cooperation with other pilot sites in the frame of the C-Roads Platform. This comprises:

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

The C-ITS Pilot Hessen contributes to the C-Roads cooperation by implementing and deploying the following C-ITS services:

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

The C-ITS pilot Niedersachsen contributes to the C-Roads cooperation by implementing and deploying the following three C-ITS services:

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

The C-Roads Germany – Urban Nodes pilot Hamburg 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 German motorway operator Autobahn GmbH.

In detail, in the Test Field Germany and Hessen interurban area, the service Emergency Vehicle Approaching (EVA) and Green Light Optimal Speed Advisory (GLOSA) will be extended. The following two new services will be implemented:

- Connected and cooperative navigation into and out of the city (route advice), and
- Traffic signal priority request (TSP) for emergency vehicles.

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 German motorway operator Autobahn GmbH. 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 sites were integrated in the C-Roads activities.

Consortium members C-Roads Germany (CRG):

- ITS mobility GmbH
- Federal Highway Research Institute (BAST)
- Continental Teves AG & Co. oHG
- SWARCO Traffic Systems GmbH
- GEVAS software GmbH
- Heusch/Boesefeldt GmbH
- Bayerische Medien Technik GmbH
- Niedersächsisches Ministerium für Wirtschaft, Arbeit, Verkehr und Digitalisierung
- Hessen Digital Radio GmbH
- Garmin Würzburg GmbH
- NORDSYS GmbH
- ESCRYPT GmbH
- Ingenieurgesellschaft für Auto und Verkehr GmbH
- e-Shuttle AG
- The German motorway operator Autobahn GmbH
- OECON Products & Services 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
- Magistrat der Stadt Kassel
- OECON Products & Services GmbH
- Fraunhofer-Institut für Verkehrs- und Infrastruktursysteme IVI
- SWARCO Traffic Systems GmbH
- GEVAS software GmbH
- The German motorway operator Autobahn GmbH

Location

The so-called Day 1 Services are trialled in the German testbeds.

The activities of the Hessen Pilot are realised on the Test Field Germany around Frankfurt in 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 Hessen state border including Frankfurt and Darmstadt
- A60, A67 and A671 in the whole Hessen area
- sections of the A661 near Frankfurt



Figure 19: Overview of the test field of the C-ITS Pilot Hessen

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

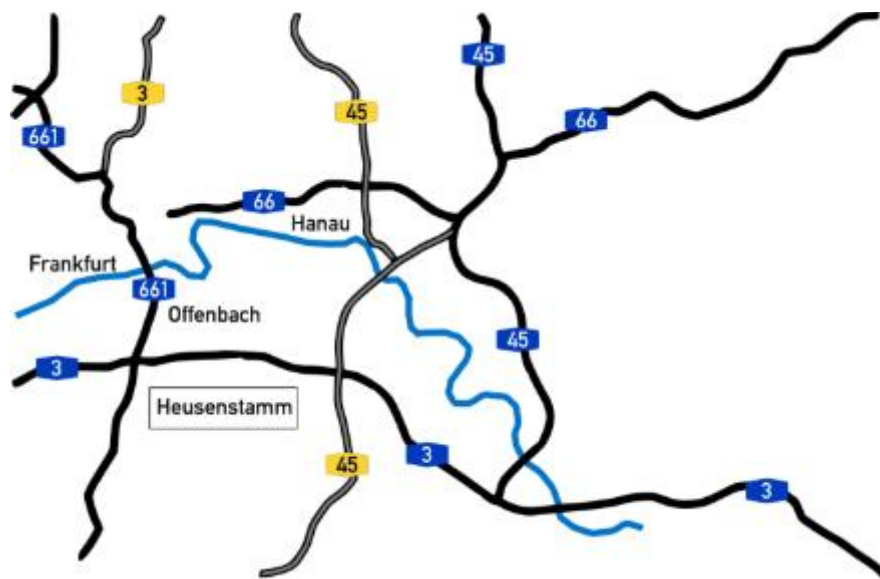


Figure 20: Test area of the GLOSA service in Hessen

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. 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, Braunschweig, and Wolfsburg. As part of this new Test Site Niedersachsen existing gantries on the motorway A2 were extended with Roadside ITS stations (R-ITS-S) to provide C-ITS services for testing and development activities via ITS-G5.

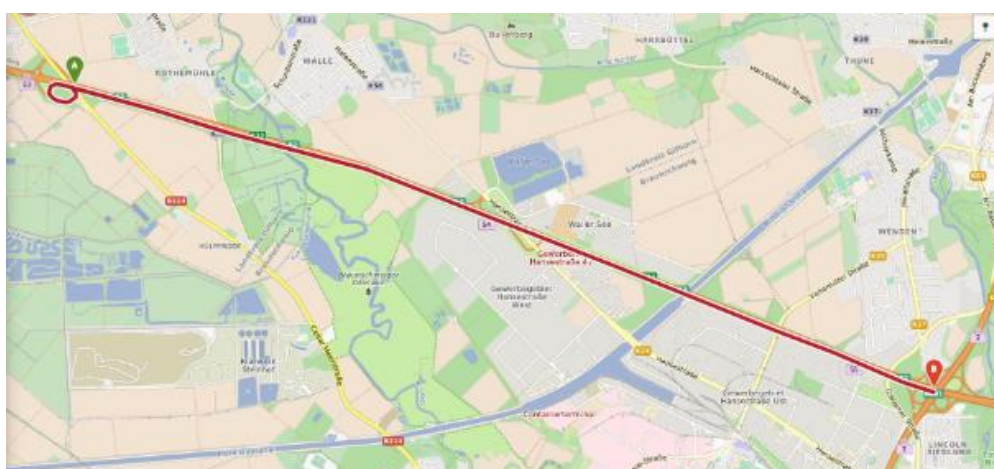


Figure 21: Niedersachsen pilot site stretch (Source: © OpenStreetMap)

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

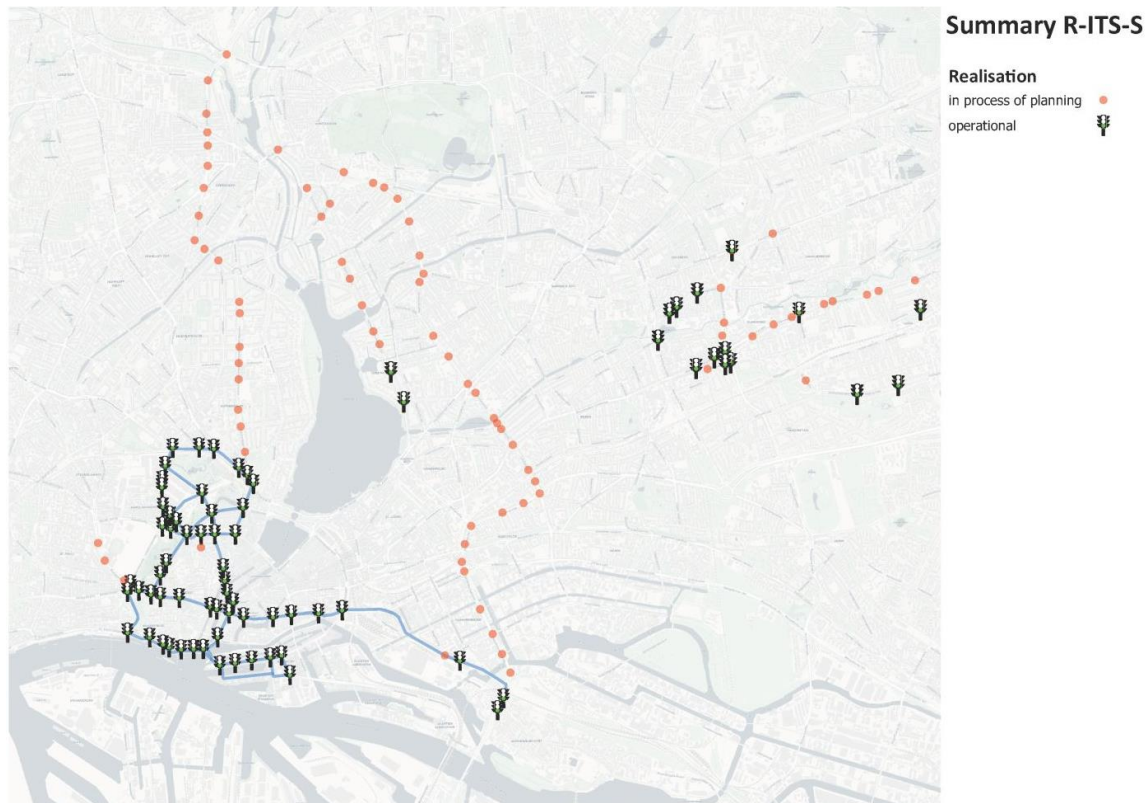


Figure 22: The Pilot Hamburg Site

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 (cf. Figure 19) 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.

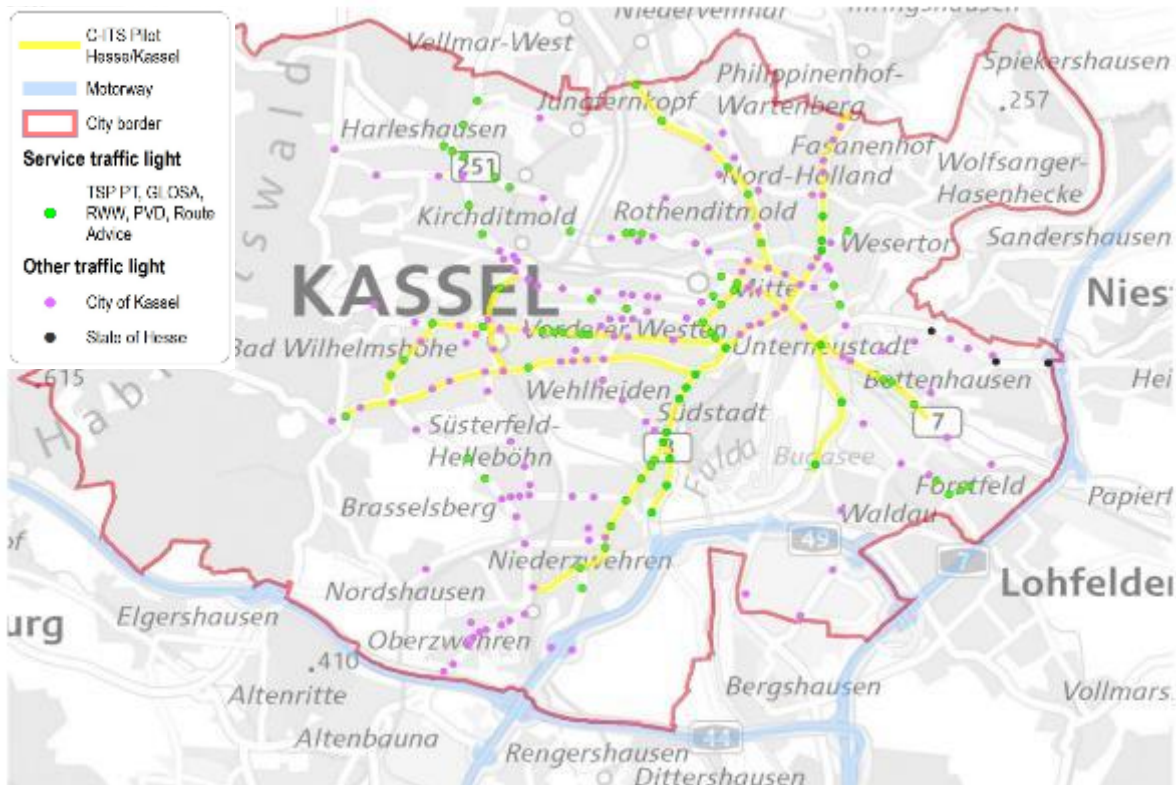


Figure 23: Overview of the equipped routes in the city of Kassel

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 50 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 12/2021 54 R-ITS-S are already in operation, including R-ITS-S from other projects).

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

5 additional C-Roads R-ITS-S went into operation in 2021 (see Figure 24 – green layered corridor), of which one for interoperability tests directly in pilot Hamburg as part of the ITS World Congress. 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 24: Overview on the Dresden pilot. Source: maps.google.de

Overview of progress by End of 2021

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 sites 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 sites, 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 the virtual Cross-border Tests which must have been shifted to 2021 due to COVID-19. Since the tender and implementation of the EVA service had to be postponed and the contract was awarded as a direct award in the end of 2020, the service was implemented in Q1/2021.

In Pilot site Niedersachsen (CRG Activity 4) milestone M48 Lower Saxony C-ITS preparation report was achieved in March 2021 by NORDSYS and OECON. Due to the COVID-19 pandemic, implementation of the IVS and PVD services were completed in November 2020 with a year delay. Therefore, this task can only be taken after the entire deployment activity of all services has been completed. The report was approved by the CRG Steering Committee. In addition, virtual cross-border testing was carried out. The original planned physical cross-border testing was scheduled for the summer of 2020. Due to the impact of the COVID-19 pandemic and the restrictions on entry in Niedersachsen at that time, it was postponed to 26. – 30. April 2021. Still, for the same reason, the colleague from member state France had to cancel the trip. Therefore, the C-ITS pilot Niedersachsen in Germany had to cancel the physical cross-border testing again and reschedule it to a virtual testing for two days. In fact, it only took one day to discuss all the issues which was successfully completed on 10th May 2021. All three implemented services (MVW/IVS/PVD) were tested with 13 participants from 5 member states (Austria, France, Hungary, Slovenia, and Spain). The extension of the service deployment area from A2 (E34) near Braunschweig to the A39 between Wolfsburg and Braunschweig is still ongoing. The deployment of the infrastructure as well as the provision of these additional services was temporarily implemented in 2021.

The Pilot Hamburg (CRG-UN Activity 3) fulfilled the milestone M39, which means that both GLOSA and PVD are operational. At the end of 2021, 73 intersections were equipped with ITS-G5 technology. This number includes five intersections of the HEAT project, which could be augmented with additional hardware to provide the GLOSA service. All intersections are sending MAP messages. A significant breakthrough in 2021 has been the successfully tested portioning into different layers of single MAPs, which is necessary at a plurality of large and intermediate intersections in the urban area due to size limitations in a specific MAPEM. The quality of the MAPs has been increased during the year, especially with respect to bicycle lane information. This is, amongst others, based on feedback from test track users, in particular in the run-up of the ITS World Congress. The C-ITS Pilot Hamburg has been a noteworthy feature of this congress and provided testing and demonstration facilities for multiple users. Due to legal and technical restrictions, only mobile stations involved in city internal projects can provide information for PVD so far. In March 2021, the pilot hosted the online workshop about PVD within CRG-UN where the German pilots shared their views on this topic which will influence further work on PVD improvements in Hamburg.

In 2021 the city of Kassel (CRG-UN Activity 4) fulfilled milestone M45. According to the defined milestone, the GLOSA service is operational in the digital test field for connected driving in Kassel. The specification documents for the PVD service were finished. In Q4/2021 the implementation of the PVD service started. The implementation of the RWW service was tendered and the implementation also started. In 2021 further traffic lights in Kassel were equipped with functions for the traffic signal priority request (TSP) of public transport vehicles.

In 2021, the city of Kassel installed 11 C-ITS capable traffic light systems equipped with R-ITS-S (by now 54 C-ITS capable traffic light systems). During the operation periods, the R-ITS-S transmit the ETSI ITS-G5 messages MAP, CAM and SPaT. The message type DENM is implemented additionally. Moreover, the expansion of broadband connections between several signalised intersections and the traffic light control centre proceeded. In 2021, 4,9 kilometres

civil engineering works were carried out for the broadband connection of the traffic lights with optical fibre (by now in total 19 km, including those from other projects). The German motorway operator Autobahn GmbH has discussed the internal interfaces for the implementations in 2021. In the process, the overall system architecture was adapted once again. For route advice exchanges with the city of Kassel and GEVAS occurred.

In 2021 Fraunhofer fulfilled two planned and one previously delayed milestones in the Dresden pilot (CRG-UN Activity 5). The delayed service TSP (M59) was operational by end of March 2021. The C-ITS service VRU went operational (M61) on one specific intersection equipped with camera-/sensor systems for the service. The service EVA was specified (M62), which is the final service in Dresden within this project. It is planned to be implemented in 2022, allowing the final demonstration event of all services in 2023. In 2021 Fraunhofer installed 5 R-ITS-S with ITS-G5 and connected to traffic lights for the services GLOSA, PVD, TSP and VRU.

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

2016	2017	2018	2019	2020	2021
725	1493	2091	2508	1590	1524

R-ITS-S installed based on funding by CINEA in C-Roads Germany

Pilot Hessen	Pilot Niedersachsen
42	3

Indicative budget overview C-Roads Germany – Urban Nodes (in k€)

2019	2020	2021	2022	2023
1510	6860	7373	12411	11199

R-ITS-S installed based on funding by CINEA in C-Roads Germany – Urban Nodes

Pilot Hamburg	Pilot Hessen/Kassel	Pilot Dresden
73	39	11

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 ADVANCED TELEMATIC AND INFORMATION TECHNOLOGY SERVICES AND PRODUCTS (G4S TELEMATIX)
- TELENAVIS S.A. (TELENAVIS)
- HELLENIC ASSOCIATION OF TOLL ROAD NETWORK - HELLASTRON (HELLASTRON)
- Attikes Diadromes S.A. Operation and Maintenance Company for the Elefsina Stavros Spata Airport Free Motorway and Imitos Western Peripheral Motorway (Attikes)
- INTRACOM S.A. TELECOM SOLUTIONS (INTRACOM)

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

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

Location

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

- A. The Egnatia Odos Motorway is a motorway extending along 660 km and is part of the TEN-T Core Network Corridors, which crosses Greece from its westernmost edge (Igoumenitsa port) to its easternmost borders with Turkey (Kipoi, Evros). It has two separate directional carriageways, each consisting of two lanes (in few sections 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.

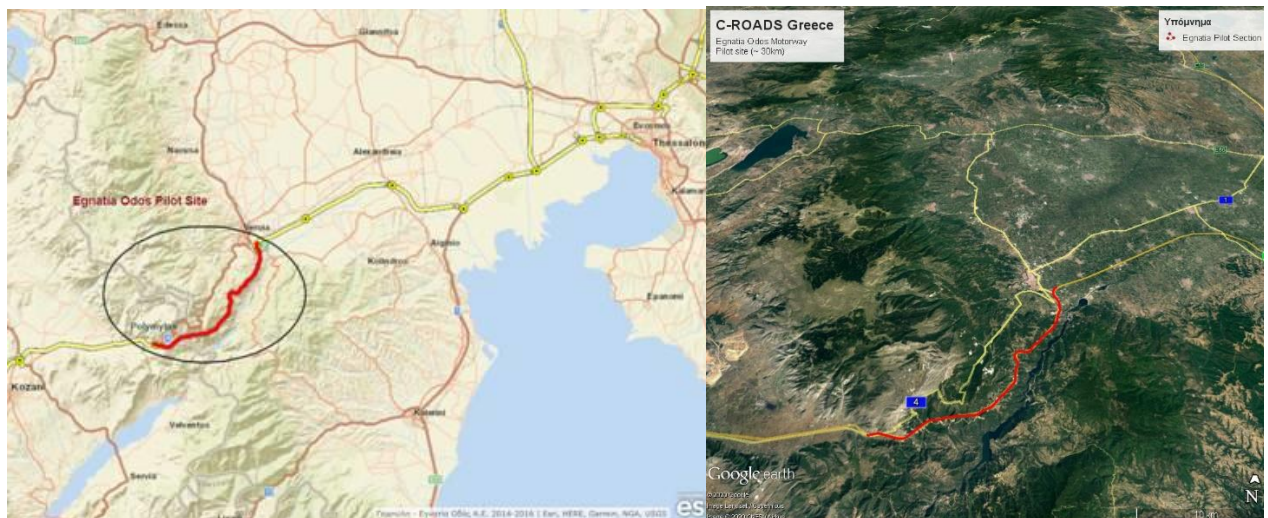


Figure 25: Location of the “Egnatia Odos” Greek pilot site

- 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.

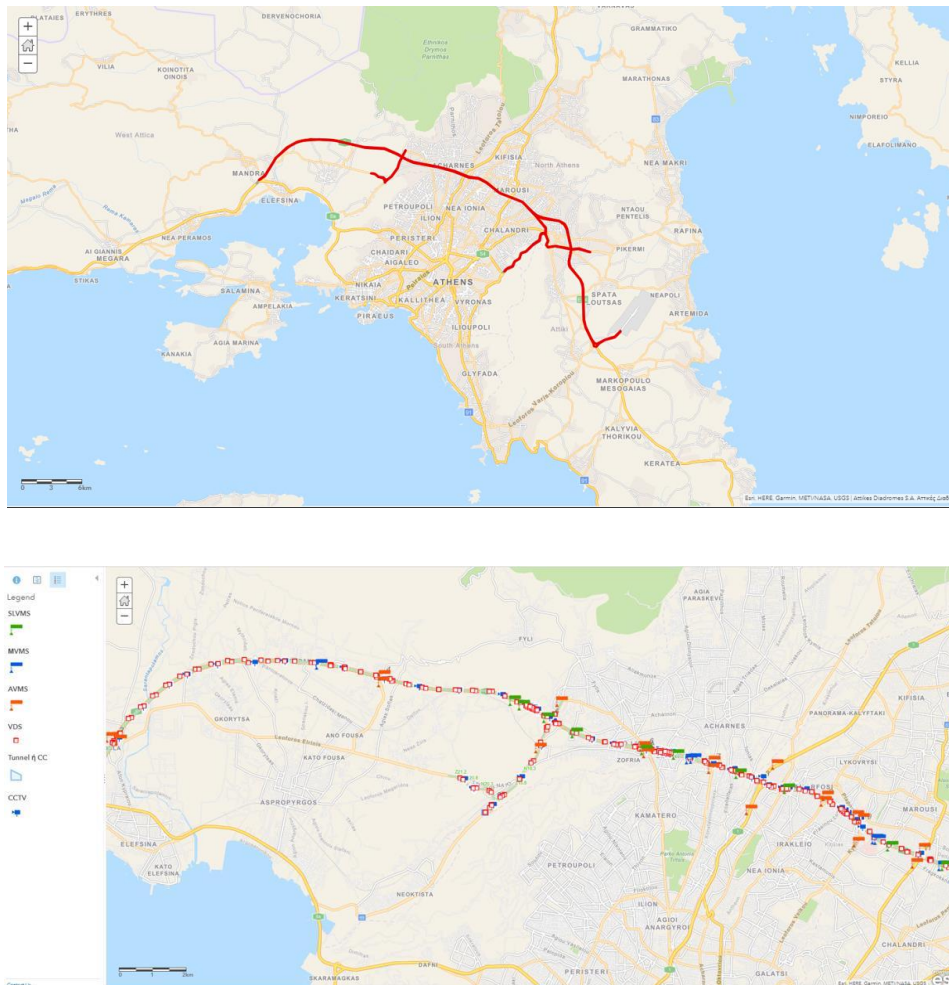


Figure 26: Location of the “Attica Tollway” Greek pilot site

10 RSUs and 1 mobile unit have been installed in Attica Tollway. As far as Egnatia Odos Motorway is concerned, 25 RSUs and 1 mobile unit have already been procured and are planned to be installed by mid-2022.

Overview of progress by End of 2021

C-Roads Greece is implemented according to the timetable set in the Grant Agreement work plan. In total, 26 out of 43 milestones have been achieved, i.e. approximately 61% of the overall progress in terms of absolute milestones completed.

Activity 1: “C-Roads Platform”. During 2021, the planned milestones in Activity 1 were achieved. 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 2021. Best practices on technical and administrative issues are followed.

Activity 2: “Greek Pilot Management”. C-Roads Greece organised a very fruitful virtual stakeholder workshop (MS30) on the 8th of December 2021. The highly successful event welcomed many notable speakers and organisations during the 7th ITS Hellas Conference, showcasing the progress of the two Greek pilots and attracting 48 individuals.

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

Activity 4: “Procurement and Components development”. All equipment was purchased by the two pilots, adhering to the schedule of the relevant MS35 (All equipment and components purchased). Attiki Odos had selected the supplier since 2020 (NeoGLS), buying and receiving all the equipment. Egnatia Odos, followed public laws and the relevant procedures for the public procurement of equipment and services (EU Directives 2014/24 & 25 and their transposition into national legislation as Law 4412/2016, 4782/2021). Two tenders were submitted electronically on the ESIDIS platform for public procurement tenders and both were accepted as compatible with the tender selection requirements. The chosen Bidder was the company "MOUSTAFERIS SA", having in the selected form the support of an experienced Czech company under the name "Cross Zlin.as" (www.cross-traffic.com). The agreement with the company-Supplier was finally signed on December 14, 2021, when all the equipment is expected to be received in early 2022.

Activity 5: “Pilot Integration”. In MS36 (Launch and verification of the 1st set of services of the Greek Pilot), the first set of services for the two pilots of C-Roads Greece relied on mobile (LTE/4G) long-range communication, which through the GeoMessaging server implements direct C-ITS services without the need for infrastructure (RSU / OBU equipment). This decision was in line with the implementation schedule of C-Roads Greece. The results of the verification were presented both to back-end and front-end for this first set of services. DENM and IVIM messages were verified to be sent correctly by the back-end to front-end application. In MS37 (All services of the Greek Pilot launched), the other implemented services were presented, using both the long- and short-range communication channels (Attiki Odos) and the long range (Egnatia Odos).

Activity 6: “Pilot Execution and Evaluation”. In MS39 (Completion of the Pilot execution plan and impact assessment methodology) the methodology for the assessment of impact areas was developed. The data to be collected during the execution of the work and the links between this data and the research questions were presented. The approach was to be based on the common basis for the evaluation of the C-Roads pilots of the Member States, and to be adapted to the particularities of the Greek pilot. The main goal was to better understand the impact of the provision of C-ITS services on the Greek pilot. This requires an impact assessment approach that can compare the observed pattern of behavior with some "hypothetical" of what would have happened without intervention, i.e., the impact of C-ITS Services is the result of a comparison between a framework and C- ITS Services that operate or are activated on equipped vehicles / devices and other vehicles that do not have C-ITS services or have them disabled. Parameters and key performance indicators (KPIs) were defined as the comparison between the metrics revealed with C-ITS and the baseline which is the current framework without C-ITS services.

Activity 7: “Roadmap for Large-scale Implementation of C-ITS in Greece”. To be started in 2022.

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

2019	2020	2021	2022	2023
27	242	928	1134	235

11. The Hungarian Pilot site

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

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

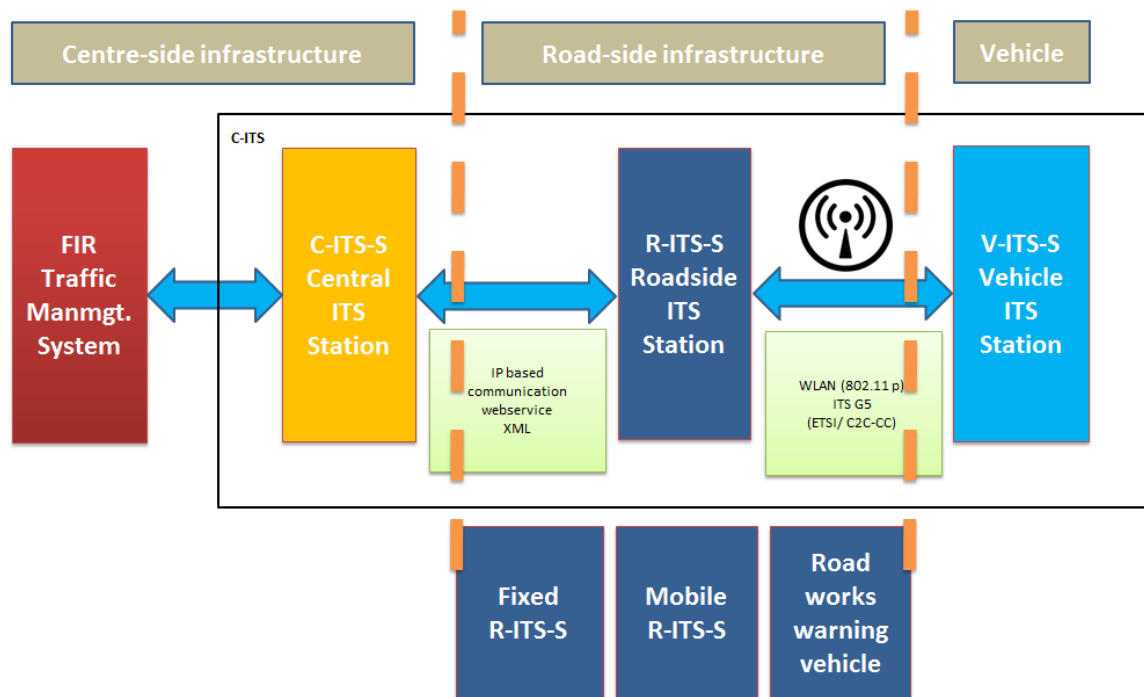


Figure 27: System architecture

These ITS G5 transceivers are compliant with the C-Roads specifications Release 1.3, and they are operational, ready for testing. In the third phase of CROCODILE we 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, in particular GLOSA/Time-to-green as well as intersection safety (signal violation). The communication technology is planned to be upgraded, too – deployment of hybrid DSRC and preparation of cellular technology that is envisaged in near future.

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

All together: 123 RSU's have been installed so far, and 23 are planned for installation in the upcoming years.

Involved partners

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

Other stakeholders:

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

Location

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

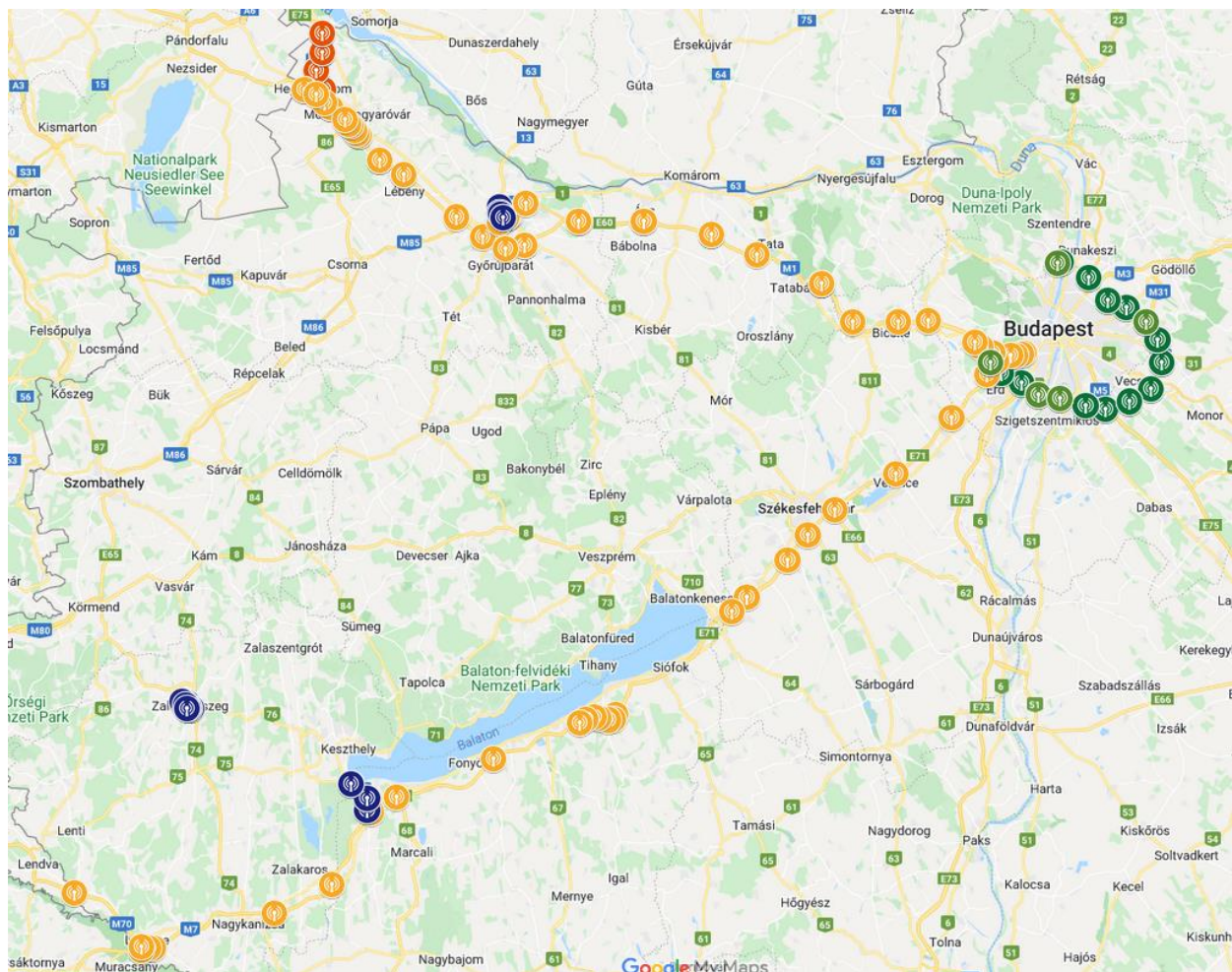


Figure 28: Location of the Hungarian RSU Positions

Overview of progress by End of 2021

The first phase of C-Roads was successfully closed in 2021 and the preparation of the second phase has begun. In accordance with the Steering Committee, the closure of the first phase was prerequisite of the start of the second phase. The public procurement documents were prepared

and submitted to the procurement department. Due to external reasons the technical documentation had to be recalled and some parts had to be changed and the procedure restarted. This caused a minor delay in the start of the planned work.

Planned progress of the Action

The new locations and use cases have been defined according to the following table.

D	G	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO		
Pilot site	Road Name	Status (installed/ planned by (incl. Date MM/YY))	C-Roads Release (1.0 - 1.4, 1.5, 1.6 or 1.6+)	Security Implemente d (Y/N)	ITS-TS	ITS-FT	HUN-ADR	HUN-AWWD	HLV-2E	HUK-ERT1	HUK-OR	HUK-PTC	HUK-PTYS	HUK-RBX	HLV-SV	HUN-LA	HUN-TSR	HUK-UBR	HUK-UCV	RWW-LC	RWW-RC	RWW-RM1	RWW-RM2	SIGLOSA	SF-LP	SF-SP1	SF-SPW	SF-ETP	AVG-SABG	AVG-PSI	PID-UDC	PID-EDC	Others		
5	Zalaegerszeg/ZalaZONE	762	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
6	Zalaegerszeg/ZalaZONE	762	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
7	Zalaegerszeg/ZalaZONE	762	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
8	Zalaegerszeg/ZalaZONE	7401	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
9	Zalaegerszeg/ZalaZONE	7401	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
0	Zalaegerszeg/ZalaZONE	7401	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
1	Zalaegerszeg/ZalaZONE	7401	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
2	Zalaegerszeg/ZalaZONE	Platán sor	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
3	Zalaegerszeg/ZalaZONE	Platán sor	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
4	Zalaegerszeg/ZalaZONE	Platán sor	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
5	Zalaegerszeg/ZalaZONE	74013	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
6	Zalaegerszeg/ZalaZONE	7401	planned by 12/22	1.6 +	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	VRU use case pilot
7	Zalaegerszeg/ZalaZONE	M76	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	N	
8	Zalaegerszeg/ZalaZONE	M76	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	N	
9	Zalaegerszeg/ZalaZONE	M76	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	N	
0	Zalaegerszeg/ZalaZONE	M76	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N	N	
1	Zalaegerszeg/ZalaZONE	M76	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N	N	
2	Zalaegerszeg/ZalaZONE	M76	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N	N	
3	Győr	14	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
4	Győr	14	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
5	Győr	14	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
6	Győr	14	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
7	Győr	14	planned by 12/22	1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	
8				1.6 +	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	

Table 3: Overview of planned progress

In Győr, due to the success of the first step, we plan to extend with a North-South corridor the C-ITS coverage.

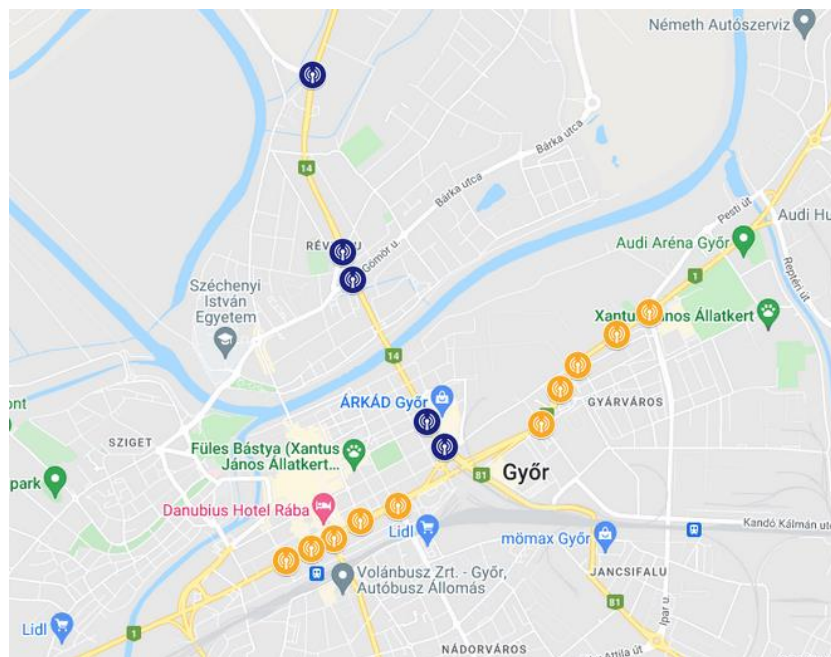


Figure 29: Location Győr

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



Figure 30: Location Zalaegerszeg

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

2019	2020	2021	2022	2023
0	0	10	1400	610

12. The Irish Pilot site

The Irish C-ITS pilot will test and evaluate a range of day 1 and day 1.5 C-ITS services on both Transport Infrastructure Ireland's road network (i.e. the TEN-T road network) and within the urban centre of Dublin using V2V, I2V and V2I communications. Figure 31 shows the location of the pilot corridors, which have been divided into the following sections where specific services will be piloted:

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

Involved partners

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

- **DoT** (Department of Transport) – the beneficiary of the Grant Agreement
- **Dublin City Council** – the urban centre where urban based C-ITS services will be piloted
- **Road Safety Authority** – Ireland's primary road safety organisation and an official statutory body charged with reducing the number of fatalities and injuries on Irish roads
- **Enterprise Ireland** – a government organisation responsible for the development and growth of Irish enterprises
- **IDA** – (Industrial Development Authority) a semi-state organisation promoting overseas direct investment into Ireland
- **Kapsch** – A partner to provide C-ITS central station support and services
- **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:

- **Academic institutions** – Trinity College Dublin, Maynooth University and University College Cork;
- **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

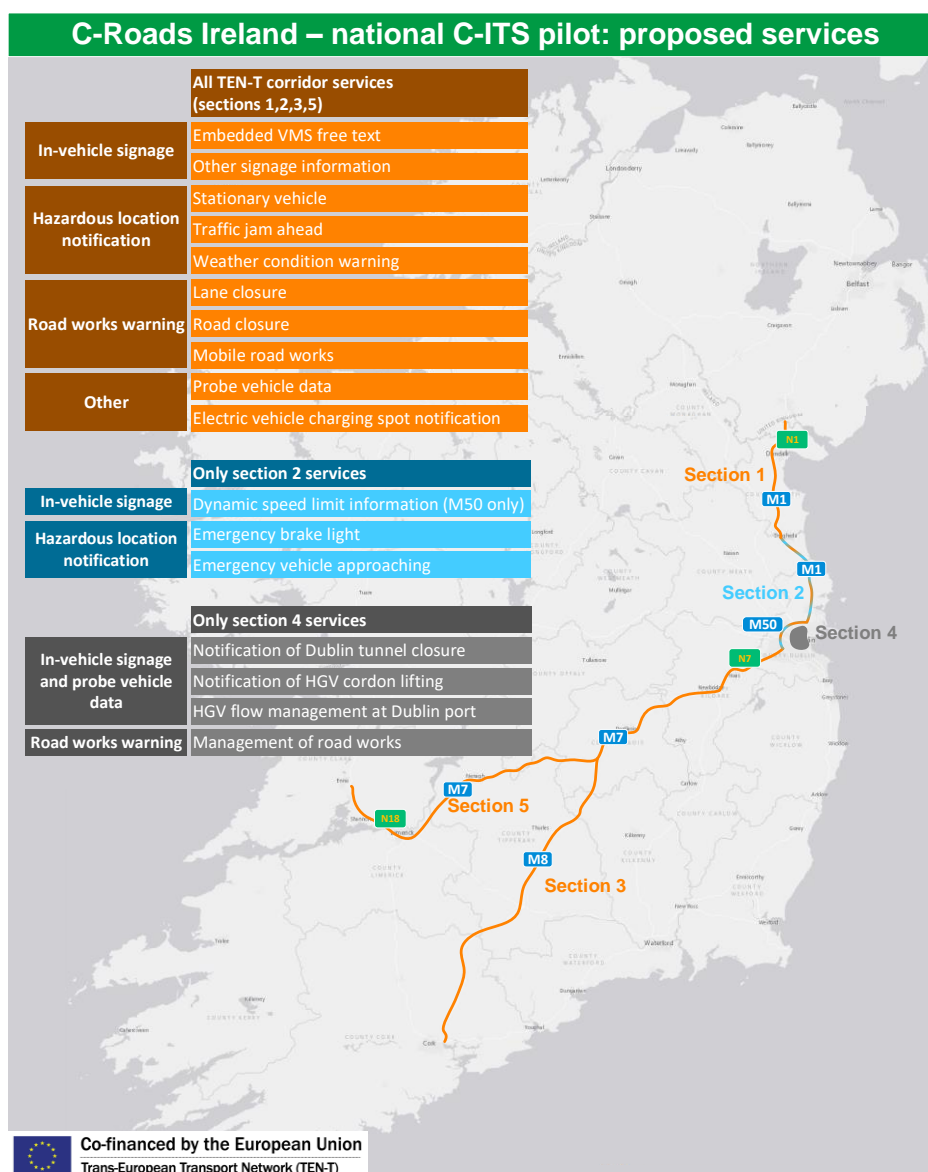


Figure 31: Location of the Irish pilot site and use cases

Overview of progress by End of 2021

Progress to date on the national pilot is described against the pilot milestones (milestones Ref No. 28-37) contained in the grant agreement. Early on in the pilot, key project management and procurement planning documents were either completed early or by the indicative due date (milestones 28-31).

Significant work was undertaken to prepare an outline design of the pilot, covering both system and roadside infrastructure design in order to issue specifications as part of the suite of tender documents. The pilot components were then procured via two contracts that TII used to procure a replacement traffic management system (NIMS) and the necessary roadside equipment/support to deliver variable speed limit functionality on the M50 (MTFO ITS DC). The C-ITS programme therefore became linked to the NIMS and MTFO ITS DC programmes. By August 2020, Kapsch was appointed to provide the central C-ITS control station (a component of NIMS) and Dynniq was appointed to provide roadside equipment and in-vehicle equipment together with software application development, thereby completing milestone 32.

Since contractors were appointed, a series of technical workshops were completed with both Kapsch and Dynniq during which a number of system-based design outcomes were achieved, e.g. agreeing interface solutions between the different vendors' equipment, agreeing which version of C-ITS standards are to be adopted, system security parameters, implementation plans for use-cases to be piloted, etc. The core features of the C-ITS design have been agreed enabling Kapsch to complete core aspects of their design which facilitates the delivery of downstream milestones.

In respect of MTFO ITS DC, after the aforementioned workshops, Dynniq notified TII that they no longer intend to supply their own C-ITS equipment. Dynniq is currently negotiating with an alternative supplier (Kapsch) and TII are awaiting submission of the proposed equipment supply. Dynniq, as a result, has not installed C-ITS equipment at the roadside as scheduled in the ITS DC programme, thereby missing the deadlines (milestones 33 and 34) in the grant agreement. As the expected date for installation has not been re-scheduled, site acceptance testing (milestone 35) will therefore also be delayed.

In the meantime radio modelling analysis was undertaken which has confirmed the number and location of sites on the M50 and M1 where C-ITS roadside equipment needs to be installed. The analysis indicated that fewer sites were needed to provide sufficient radio coverage compared to the original specification, thereby providing cost and potential programme efficiencies. RSU site designs have been prepared and audited by Road Safety Auditors and work continues with civils contractors prior to civils works commencing.

In respect of the urban use cases outlined in the grant agreement, several meetings and workshops have taken place with Dublin City Council to initially understand their C-ITS aspirations and to assess and define their technical feasibility in line with C-Roads specifications. A series of use-cases have been identified and a set of requirements has been defined that will be delivered by the NIMS contractor.

In parallel with the progress that has been described above, a number of other key activities have been completed. A data protection impact assessment has been prepared and will continue to be

refined throughout the pilot lifecycle. Initial stakeholder engagement was undertaken with the Department for Infrastructure – Northern Ireland (to assess potential cross-border cooperation), Dublin City Council, the Road Safety Authority, mobile network operators, Jaguar Land Rover and others – all of whom expressed interest in supporting the pilot. Planning for the evaluation and assessment (E&A) (milestones 36 and 37) of the pilot has also been undertaken – a framework for the E&A has been prepared that sets out C-Roads principles such that a common understanding of the effectiveness of C-ITS across all European pilots can be achieved. Work has been completed to determine what aspects of the pilot will be evaluated and what data is needed to complete the assessment which has fed into Kapsch’s design.

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

2019	2020	2021	2022	2023
680	890	80	2650	5850

13. The Italian Pilot site

C-Roads ITALY (2017-2021)

The main goal of the C-Roads ITALY (2017-2021) project was 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 implied 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...) invested 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, have been 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 have been fully shared across Europe through the cooperation in the C-Roads Platform.

Involved partners

The Beneficiary (Member State) is the Ministero delle infrastrutture e della mobilità sostenibili.

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

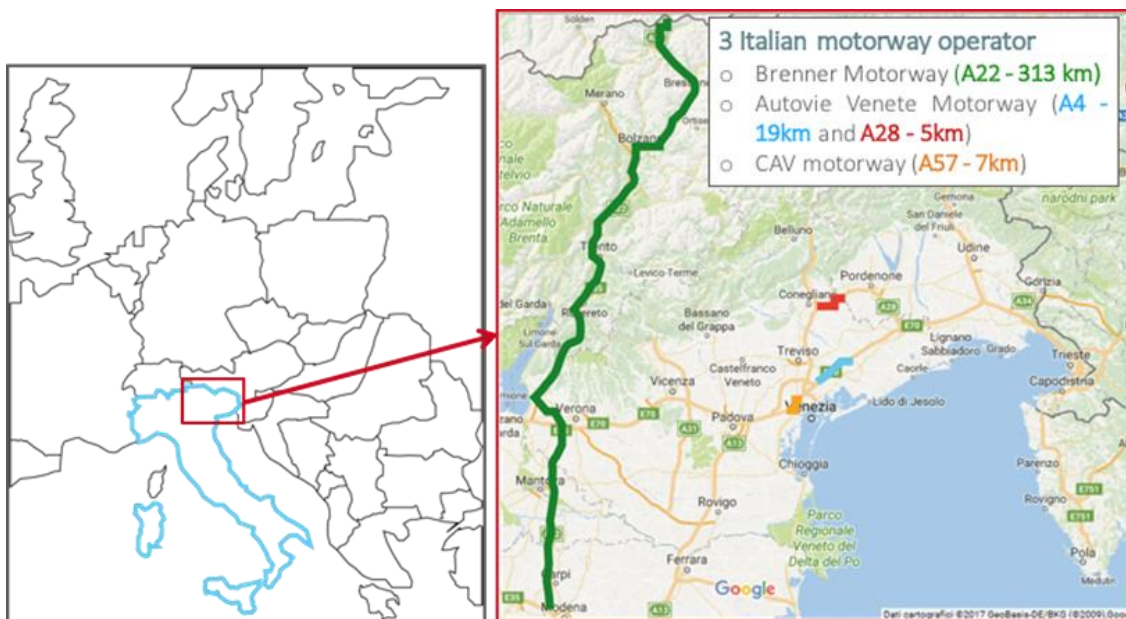


Figure 32: Location of the Italian pilot site

Overview of progress by End of 2021

- 84 RSUs installed along the 368Km (slight enlarged in comparison to the planned Km on the map) of road sections involved in the first pilot (C-Roads Italy 2017-2021)
- Trucks Platooning
From December 2020 till the end of 2021 an extensive driving activity has been done; around 300.000 km and 3.500 hours, were driven with the Platooning functionality active. Different

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

- Highway Chauffeur (passenger cars)

Italian tests

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

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

Cross-border tests with Austria

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

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

Virtual tests

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

Indicative budget overview C-Roads (in k€)

2017	2018	2019	2020	2021
2244	3752	3995	2879	5680

C-Roads Italy 2 (2018-2023)

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

Involved partners

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

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

Location



Figure 33: Locations of the C-Roads Italy 2 pilots

Overview of progress by End of 2021

The Definition of the Target Architecture for integration of Day 1.5 Applications was performed. The activities were focused on general functional requirement analysis of Day 1.5 services which have been indicated as relevant from test site stakeholders. These services are ‘off-street parking information’, ‘connected and cooperative navigation into and out of the city’, ‘traffic Information and smart routing’. Platform logical architecture and supporting communication issues about mixed network communication (mobile operator and ITS-G5 infrastructure) and mobile edge computing on 5G network were analyzed and described.

Moreover, use cases definition for DAY 1 C-ITS services, as specified by the 3 involved cities, has been finalized, working out commonalities and differences in the test-sites to allow for (i) better exchange of experiences among implementing bodies, (ii) harmonization with C-Roads platform service definitions and interoperability tests and (iii) extended basis for project evaluation.

A detailed Pilot Architectures for C-ITS services has been performed for the whole C-Roads Italy 2; it includes approach to the integration and service chain architecture for all the available test-sites and their selected use-cases. It sets the seed for the different Implementing Bodies to prepare procurements for RSU, OBUs and decide how to integrate/adapt their existing TMCs to feed the content for the selected C-ITS services.

Regarding the Hybrid communication, an analysis of the presence of an adequate 4G radio coverage in the geographical areas where the tests are planned has been carried out. Moreover, the Release 2 of Interchange Entity node is available. It is the result of migration from AMQP protocol V0.9 to AMQP protocol V1.0, following the specification finalized in WG2-TF4.

The in-vehicle use cases have been defined, describing the in-vehicle use-cases that exploit the adoption of C-ITS Day 1 and 1.5 services in the vehicle, introducing use-case scenarios exercising day 1/1.5 services, describes functional and non-functional aspects characterizing such scenarios. In these scenarios, V2X information is used for: (i) adopting and optimizing

energy recovery and emission minimization strategies for hybrid vehicles, e.g., eco-driving solutions for reducing vehicle consumptions when the vehicle is approaching equipped traffic lights and road signs; and (ii) assisting the driver in critical conditions, e.g., potentially dangerous situations and traffic conditions, low visibility, and dense traffic conditions.

Moreover, two (a conventional ICE vehicle and a HEV vehicle) prototypes vehicles are equipped and operational to contribute in demonstrating the exploitation of the Day 1/1.5 services

The release 1.0 of a C-ITS-S software for data integration between RSU and Central facilities/infrastructures ready for pilots is up and running, fulfilling: a) automatic conversion into ETSI ITS G5 messages; b) brokering messages towards network interface (BI); c) management of RSU and 4G/LTE messages. Version 1.0 encompasses all the ETSI messages envisaged for DAY 1 services.

Regarding the Evaluation activities in 2019 focused mainly on the study of scientific material and know-how concerning the planned Use Cases and the implementation of C-ITS in urban areas. The aim of this phase was the identification of the Best Practices necessary to design the subsequent evaluation activities as much more accurate as possible and able to return valid Key Performance Indicators. Further activities have involved a first simulation of some of the planned Use Cases, such as GLOSA, and the identification of the most suitable tools to simulate the implementation of C-ITS services on a large scale. In addition, data that will be useful both for the calibration of urban mobility micro-models and for the evaluations following field tests have been identified. Finally, an analysis of the potentialities linked to the joint implementation of autonomous driving and cooperative mobility solutions has been carried out to identify the optimal implementation logic from the point of view of the Impact Areas involved, with particular emphasis on Traffic Efficiency and Safety. In 2020 the Covid-19 Pandemic obliged to cancel all physical inspections to the installations and the sites in the cities where Use Cases are planned to be put in operation. So the work was shifted more on the modelling activities. Moreover, was performed a study aimed at the definition of the socio-economic and transport contexts affecting the C-Roads Italy 2 Cities

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

- The design phase for Green Light Optimal Speed Advisory (GLOSA) / Time To Green (TTG) with definition of the hardware and software requirements for its implementation
- The design phase for Emergency vehicle approaching with definition of the hardware and software requirements for its implementation. The system of Emergency vehicle approaching was implemented in the ITS infrastructure of Verona; it is currently connected to the SUEM 118 Operations Center and gives traffic light priority to all ambulances in transit in red code.
- The design phase for Traffic signal priority request by designated vehicles by analyzing the priority request of the road sign by the designated vehicles, with the definition of the hardware and software requirements for its implementation.
- 70 traffic light upgrades, both hardware and software and are now into operation, connected with the traffic center facilities, for the implementation of the Day 1 and Day 1.5 services;

- Completion deployment and start operation for Green Light Optimal Speed Advisory (GLOSA) / Time To Green (TTG) - The hardware and software functions have been defined and implemented during the current period.

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

- the design phase for GLOSA/Traffic Signal Priority and Intersection Safety; the interventions will be implemented at 12 traffic light systems. including the updating of the software platform, the supply and installation of traffic light controllers, RSU and detection equipment.
- the design phase for the On-Street Parking; the intervention consists in the installation of n. 1000 in-ground sensors for detecting the occupation of roadside parking spaces, with real-time monitoring of the free / occupied status of the stalls. In the course of the year 2021 the tender was launched.
- Publication of the tender for 12 traffic light adjustments and RSU, 10 signal violation, software for interfacing to central facilities firstly by the definition of the equipment characteristics and of the technical compatibilities; after, the market analysis to identify the most appropriate products satisfying the project functionalities requirements

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

- Software design and specifications and Infrastructure update definition in Turin
- Analysis of existing systems in Turin by the identification of the technological components hosted and managed by 5T which are thought to be likely impacted by the deployment of C-ITS in the scope of the Pilot.
- Use cases and requirements definition by assessing the C-Roads Platform Specification about the Day1 services / Use Cases and the applicability of the specified use cases to the currently existing services and components deployed in Torino.
- Turin Pilot design – Demonstration design by the development of the service architecture and the definition of testing and validation requirements

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

- Drafting of technical specifications of smart road systems on the 9 km; definition of requirements for call for tender.
- Works awarded for fibre optic network
- Start procurement procedure for Server DSRC including RSUs
- Installation of RSUs, including Server DSRC, powered and connected via cellular network to the dedicated C-ITS cloud server. RSUs are also connected to the existing physical BS-PD Motorway network for management and monitoring purposes.

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

2018	2019	2020	2021	2022	2023
53	1264	2016	2201	3564	2553

C-Roads Italy 3 (2020-2023)

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

The main goal of C-Roads Italy 3 is to maximize the impact on road safety and traffic efficiency, achieving the continuity of C-ITS Services by extending the geographical coverage of national road network along the Core Road network of the SCAN-MED and MEDITERRANEAN European Corridors, deploying and implementing, principally, a set of C-ITS "Day1" Services and also "Day1,5" as recommended by the EC C-ITS Platform.

That implies that roads infrastructure must be equipped or upgraded with innovative technologies to allow the interaction and information exchange between road operators infrastructure and vehicles (I2V) - (V2X).

Within C-Roads Italy 3, the communication design and the related architecture will be based on hybrid solution, notably: "ITS-G5" and "cellular long range network".

The aim is also to further develop what already implemented within C-Roads Italy by adding further scenarios of already developed "Use Cases" or by adding "new" Use Cases (e.g. mobile Road Works Warning and RWW - Winter Maintenance).

Involved partners

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

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

Location



Figure 34: Location of the C-Roads Italy 3 pilots

Overview of progress by End of 2021

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

- 20 new road Side Units should have been purchased. 15 of them for trailer installation and 5 for fixed installation. Road Side Units
- the first set of Use Cases (Road Works Mobile and Winter Maintenance) was finalized.

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

- preliminary study and technical description for implementation, verification of compatibility and integration with the existing systems (for the first 12 RSU on A4). (preparatory documents for the tender).
- Start of upgrade of Traffic Operation Center in Palmanova by the completion of the technical requirements, description of the activity and documentation for the publication of the public tenders.

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

- RSUs have been purchased within the end of 2020 and successfully tested
- the software DATEX II has been upgraded to permit the TCC – DATEX II integration for the new RSUs installed.
- Installation RSUs on A4 Motoway section between Padua and Passante di Mestre

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

- A detailed specification of services of the intended deployment of the C-ITS services in Rome, in three main areas of the city and in the traffic control centre.
- Start of the security architecture of the C-ITS system to be deployed in Rome.

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

- RSU/OBU scouting and first SW integration of RSUs with TCC

Indicative budget overview C-Roads Italy 3 (in k€)

2020	2021	2022	2023
152	447	1874	3529

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 35: 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 adaptations of the A16 test-site.

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

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

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

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 (in k€)

2016	2017	2018	2019	2020	2021
1100	3700	5200	3300	n.a.	n.a.

15. The Norwegian Pilot site

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

NordicWay 3 project (2019-2023):

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

The results of NordicWay 3, as well as of the previous NordicWay projects, can be viewed in the www.nordicway.net webpage.

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

Norwegian national pilots

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

The following use cases are piloted in NordicWay3:

C-ITS Day-1 services:

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

C-ITS Day-1.5 services:

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

Involved partners

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

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

- | | | |
|-------------|----------------|-------------------------|
| • Combitech | • SINTEF | • Volvo Car Corporation |
| • Aventi | • City of Oslo | • Polestar |
| • Bouvet | • Audi | • Aimsun |
| • Q-Free | • BMW | • COWI |
| • Univrses | • Scania CV AB | • Vianova |
| • BMW | • Volvo Trucks | |

Location

Norway has the following pilot sites:

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

Overview of progress by End of 2020

NordicWay 3 pilots have just started.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	1900	1800	1500	1100	0

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

2019	2020	2021	2022	2023
320	840	1010	1030	1030

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 (SPApp) 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 Holiday 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 (2^a 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 (2^a 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 be 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 (2^a 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 – 2^a 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

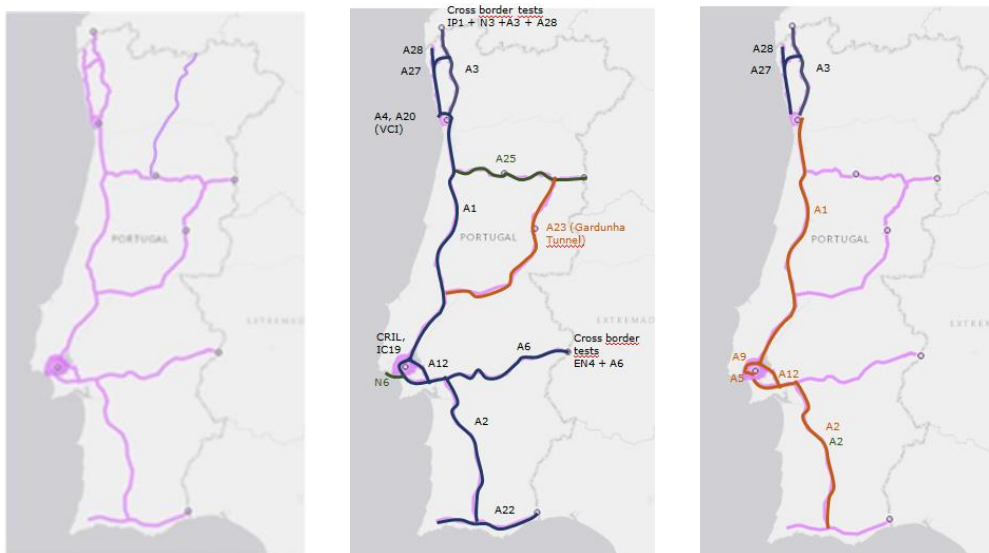


Figure 36: Location of the Portuguese pilot site 1 - 3



Figure 37: Location of the Portuguese pilot site 4-5

Overview of progress by End of 2021

By the end of the reporting period (that corresponds to the final year of C-Roads Portugal), the Action is close to finished. All the Pilot were concluded, apart from a specific project in Pilot 4 that is going to be implemented in Cooperative Streets (with CINEAS' approval). Considering the pandemic situation that led to some difficulties in the implementation of some of the projects included in the action the full implementation of the majority of the Action can be considered a success.

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

The IT structure is now fully functional and includes real life data from most 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.

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. The security framework was tested and is operational as well.

Several interoperability tests occurred in several different road sections, as planned in the GA, setting the way for the full implementation on a national level. It was not possible to establish cross border tests due to the pandemic situation.

Pilot 3 – Network preparation for Connected and Autonomous Vehicles

In 2021 the installation of all the RSUs and the needed tests were implemented. The TenTEC map is to be upgraded with these units.

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

During 2021, the new cameras were finally installed and tested, with data being sent to the server, allowing its analysis. The 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) were implemented.

The final steps included the integration of the travel time information to the mobile app and to the Variable Message Signs (VMS) panels.

Within this Pilot a parking project was severely delayed due to administrative issues in the tendering process. With CINEA’s authorization, this project will be implemented under the scope of Cooperative Streets.

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 underwent the evaluation phase.

The first RSU was installed in September 2020, later than expected, as road works were severely impaired. In 2021 the IBs involved were able 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.)

Indicative budget overview C-Roads (in k€)

2017	2018	2019	2020	2021
791	1688	2136	2263	1765

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 transshipments, CO₂ 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:

- Instituto da Mobilidade e dos Transportes, I.P. (IMT, I.P.)
- Infraestruturas de Portugal, I.P.
- IP Telecom, SA
- Câmara Municipal de Lisboa
- Câmara Municipal do Porto
- STCP - Sociedade de Transportes Colectivos do Porto, SA
- EMEL – Empresa Pública Municipal de Estacionamento de Lisboa, E.E.M.
- FEUP – Faculdade de Engenharia da Universidade do Porto
- Brisa Concessão Rodoviária, SA (BCR)
- Ascendi Beiras Litoral e Alta, Auto Estradas das Beiras Litoral e Alta, S.A.
- Auto-Estradas Norte Litoral – Sociedade Concessionária – AENL, S.A.
- Autoestrada do Algarve – Via do Infante – Sociedade Concessionária – AAVI, S.A.
- CaetanoBUS - Fabricação Carroçarias, S.A.
- A-to-Be – Mobility Technology, S.A.
- GMVIS Skysoft, S.A.
- ARMIS, Sistemas de Informação, LDA
- Siemens Mobility, Unipessoal LDA
- Vialivre, S.A.
- DMS Displays & Mobility Solutions Lda
- Scutvias - Auto-Estradas da Beira Interior, S.A.
- Lusoponte - Concessionária para a Travessia do Tejo, S.A
- Brisal – Auto-Estradas do Litoral, S.A
- AEDL – Auto-Estradas do Douro Litoral, S.A
- AEA - Auto-Estradas do Atlântico,- Concessões Rodoviárias de Portugal, S.A
- Ascendi Grande Lisboa – Auto-Estradas da Grande Lisboa, S.A
- Ascendi do Grande Porto – Auto-Estradas do Grande Porto, S.A
- Ascendi Norte – Auto-Estradas do Norte, S.A
- Ascendi Costa de Prata - Auto-Estradas da Costa de Prata, S.A
- Norscut – Concessionária de Auto-Estradas, S.A.
- TIS.PT, consultores em Transportes, Inovação e Sistemas, SA
- Via Verde Serviços, SA
- Ascendi IGI, Inovação e Gestão de Infra-Estruturas S.A.
- Yuttraffic, Unipessoal Lda.

Location

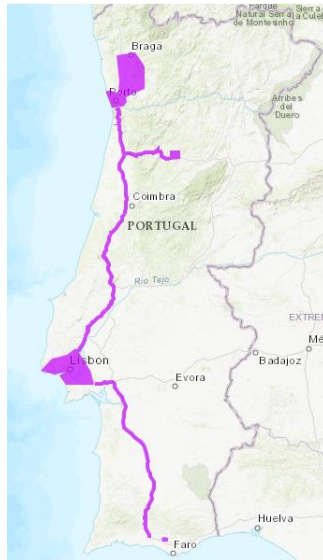


Figure 38: Pilots in Portugal

Overview of progress by End of 2021

In 2022, with the foreseeable (at this point) decreasing concerns with the pandemic situation, many tenders and procurement procedures are being launched, and it is expectable that in general, the deployment of many of the projects recovers to some extent.

Pilot "Extended Multimodal National Access Point (NAP)"

The Grant Agreement stated that the tender for the extension of the NAP should take place in 2020. However, the delay in the road NAP, the effects of the pandemic and the lengthy public procurement process meant that the multimodal extension of the NAP only went into production in 2021. This delay did not affect the execution of C-Streets, as other pilots still have enough time during the remainder of the project to ensure their connection to the NAP.

The final value of the tender was below the initial projections, which might provide an opportunity to proceed with further developments.

The entry into operation of the Multimodal NAP was an important step in this activity. However, given the magnitude of the information, resulting from the wide spectrum of different stakeholders, there is some risk on the connection process to all pilot endpoints, using the correct protocols, namely NeTEx and Datex II. The delay of these protocols' deployment and their adaptation to a national profile could be a hurdle to consider, but the continuous monitoring of the MMTIS pilots will reduce these risks.

Pilot "From C-Roads to Cooperative Streets"

Pilot C-ITS Central System - Activities planned for 2022-2023:

- Present planned proof of concept according to a new framework as per requirement
- Agree on a sorted number of providers to interact with the new engine
- Identify services to be published
- Revise processes, activities, and resources to address the POC
- Deploy the POC to address requirements and specifications

Pilot Intelligent surveillance and communication system – Activities to be held in 2022-2023:

- Initiate procurement for sustainable automated surveillance solutions. This initiative considers open-source solutions to facilitate interaction using existing communication protocols and streaming services.
- Risk assessment regarding the I&D of cloud-based infrastructure versus acquisition of SAAS for the ecosystem
- Describe the functional requirements to be implemented with the pilot
- Acquire two automated surveillance cameras
- Acquire one tethered drone unit to be installed onboard a moving vehicle
- Address the process to comply with the company's operational activities
- Apply I&D for a cloud-based GUI (graphic user interface) platform
- Address connectivity QA with surveillance units for the pilot services rely on decision-acquisition to be deployed:
 - Test the front-end user interface for event caption
 - Key user training

Pilot C-ITS on telematic systems - Activities held in 2022-2023: CCTV mobile surveillance units

Pilot "Cooperative Streets"

All the project within this Pilot are expected to also proceed at a steady pace. A strong development is expected in the implementation of C-ITS solutions.

During the next few months, and until the end of the implementation of the action, we intend to implement the following activities:

- On-demand transport.
- Traffic information and occurrences.
- Trip planning.

Regarding the status of progress in the implementation of the activities mentioned, and since the respective tasks are running as planned, no delay is expected in relation to the deadline previously established.

Nevertheless, some Implementing Bodies are still in the process of defining specifications and tenders. For those, the current activities are focused on the production of suitable specifications for different public tenders. This lengthy process is necessary due to different scopes within the current action and some of them can be optimized using resource sharing.

The existing deviation is due to the public tender's preparation process, as well as due to a global activities assessment following municipal elections in September 2021 and Legislative Elections in late 2021.

A public tender schedule plan usually is an expected risk in the way that the process itself allows different and unexpected interactions to any possible contractor. This unavoidable risk can sometimes be mitigated using time-consuming process reviews and fast-tracking documentation approval.

Pilot "MMTIS"

This Pilot is likely to keep on moving, but expectations need to be cautious, due to the aforementioned involvement of many public entities. The conclusion of the procedures with the specifications allowed to launch of many of the necessary public tenders, leading to the final study and coordination of harmonized interoperability mechanisms that ensure the communication of the various mobility services in standard formats. However, public tenders are often the stage for litigation and delays, which can obviously delay the Action's implementation.

Alongside several new actions in the context of communication and dissemination of information produced by these systems were put forward, which guarantee transversality and universality of the availability of information, regardless of digital resources and the level of mobility of the target population.

The proposed actions were:

- Web environment: construction of a mobility website and app (MOVE-T) ;
- Face-to-face environment: deployment of equipment to be installed in the mobility store, MOVE-T (55' Monitor and 55' Interactive Table). These devices will provide information on the various mobility services (networks, timetables, availability of services, routes, etc.).
- Document printing: in various layouts, depending on the information to be transmitted.

The inclusion of these actions will ensure the democratization of access to information to the public, namely to those who, for the most diverse reasons, do not have access to the information made available through digital channels.

Finally, and considering that the monitoring of mobility in an urban context is of paramount importance for the process of planning and management of the actions to be developed, it was considered important to include counters in the municipal project with the ability to count and classify the different modes of mobility. The information collected will be extremely important for the planning and management process, with capital importance in the investment, management and even communication and public disclosure options that may be taken.

According to the state of development and execution of this Activity, the following actions will be put forward during the year 2022:

- Installation of Public Information Panels (1st semester);
- Installation of Epapers (1st semester);

- Installation of the car park management system and public information equipment (1st semester);
- Installation of meters for the different modes of transport (2nd semester);
- Installation of traffic sensors (2nd semester);
- Construction of a mobility website and app (2nd semester)

Pilot "Urban tested - Zone to free test technology"

The Free Technological Zones (ZLT) project will continue to allow the development of innovative products and accelerate their market entry and attract innovative projects and foreign investment related to emerging technologies. Entities wishing to test new technologies that require special regulatory regimes can now submit an Expression of Interest to this ZLT. The project will be testing and experimenting with new technologies, including those related to G5 and autonomous vehicles, in a real environment to accelerate the entry of innovative technologies and solutions into the markets. Furthermore, the Technological Free Zone will make it possible to reduce barriers to the adoption of technology, in an adaptive and anticipatory approach, defining the appropriate regulatory conditions, involving users earlier in the adoption process.

The zones are intended to allow the testing and experimentation of technologies, products, services and processes based on technology, in a real or near-real way, with direct and permanent control by the competent regulatory authorities, namely in terms of tests, supply of information, guidelines and recommendations, corresponding to the concept of "regulatory sandboxes".

In this ZLT, companies can test innovative products, services, business models and delivery mechanisms without immediately incurring all the normal regulatory consequences related to the activity in question.

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

2019	2020	2021	2022	2023
1559	3875	14467	5905	3601

17. The Slovenian Pilot site

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

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 would correlate with better real time traffic information and in the preparation for the future full scale hybrid C-ITS services.

The objective of the first phase includes also testing the hybrid solution, in particular, C-ITS infrastructure and 3G/4G/LTE cellular connected vehicle, that interacts with the cloud information services to deliver the C-ITS Day 1.0 services. An upgrade of existing mobile application with location and driving direction awareness is envisaged to deliver real time traffic information and test “Infrastructure to vehicle” (I2V) and “Vehicle to infrastructure” (V2I) communication.

In order to test the C-ITS Day 1.0 services with different solutions, the C-ITS infrastructure needs to be upgraded on the network as well as data integrated into the regional traffic management centre. The software which will serve as messages exchange point for the C-ITS real time traffic information needs to be developed.

The objective of the “The C-Roads Slovenia 2” is the extension of roadside C-ITS infrastructure to the pilot length of 300 km on selected locations on complete motorway A1, A3, H4, H5, H6 and at critical points of A2 with the central C-ITS server real-time platform located at Main Traffic Management Centre. Roadside ITS-G5 stations will also be installed at motorways cross-border areas to ensure coexistence of C-ITS system with RTTT DSRC tolling system.

The pilot results will serve as the basis for later full scale C-ITS hybrid deployment on the complete motorway network. C-Roads Slovenia 2 aims to provide a more comprehensive pilot area including new critical motorway sections (e.g. tunnels). This activity will develop a flexible centralized server platform for C-ITS information exchange that will also include C-ITS certificate policy.

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) covers 24 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. Cellular connected car and Cloud information services are available on all motorways and public roads in Slovenia by using the mobile application Promet+.

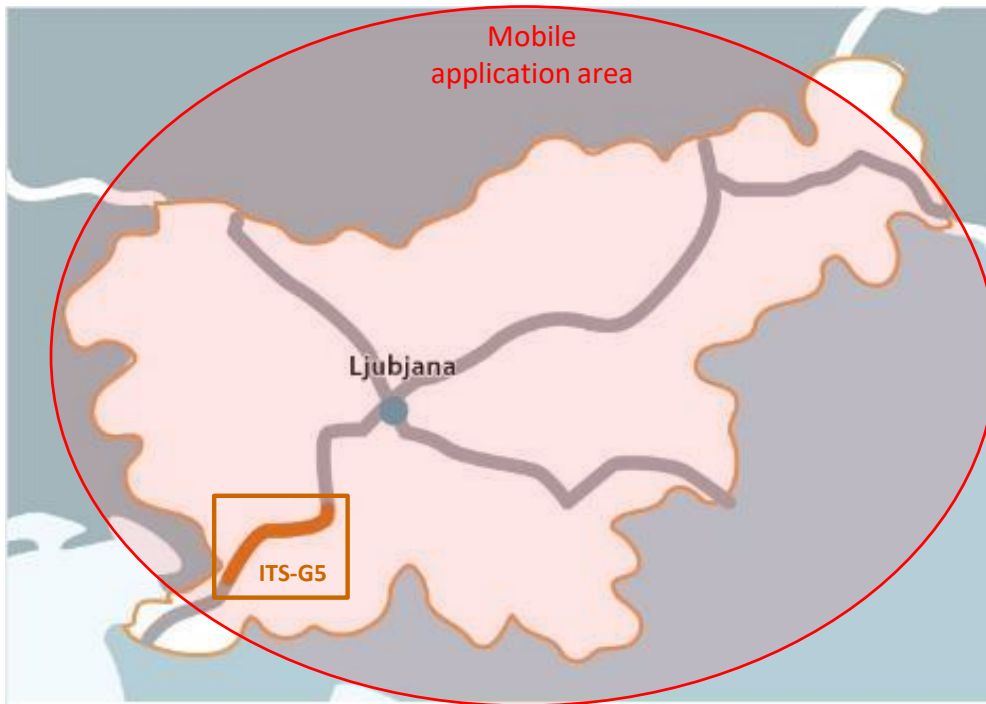


Figure 39: Location of the Slovenian C-Roads pilot site (first phase)

On the “C-Roads Slovenia 2” pilot site the roadside ITS-G5 infrastructure will be extended to the length of 300 km on complete motorway A1, A3, H4, H5, H6 and at critical points of A2.

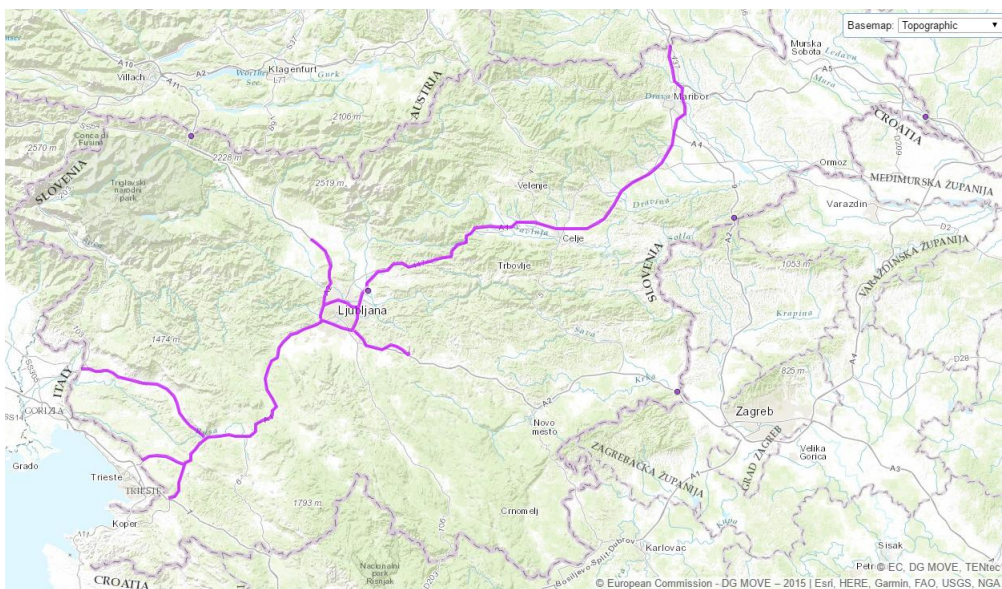


Figure 40: Location of the C-Roads Slovenia 2 pilot site

Overview of progress by End of 2021

C-Roads Slovenia

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

3G/4G/LTE Cellular Connected Vehicle with the Cloud Information Services were deployed on complete motorway network in 2019. A mobile application with location awareness was deployed which delivers real time traffic information to all application users and in the same time provides traffic related information gathered from mobile devices. The application was successfully tested and evaluated.

In 2021, the cross-border interoperability testing of C-ITS services was successfully performed virtually with different C-Roads member states. National assessment plan was drafted and harmonised with the C-Roads Platform assessment and evaluation plans and findings. A final C-Roads Pilot Slovenia evaluation report was delivered and integrated in C-Roads platform Evaluation and Assessment Final Report at the end.

C-Roads Slovenia 2

The pilot implementation of automatic transfer of traffic events from tunnel control systems into Information cloud and C-ITS system was successfully implemented in Traffic control centre Kozina and supported by installation of 2 additional ITS-G5 roadside units. An extension of the project to the other regional Traffic control centres is envisaged in 2022 and 2023. Furthermore, the preparations of project for automatic transfer of traffic events from other traffic management and control systems, have already started.

Implementation of C-ITS services using 3g/4g/LTE cellular networks and hybrid solutions has been in progress in 2020 and concluded in 2021. Within this Action DARS (Motorway Company in the Republic of Slovenia) has developed solutions that enable information flow using cellular network with connected cars on the basis of local awareness and cloud solutions. The existing mobile app Promet+ has been upgraded to function as On-Board Unit (OBU) that is able to communicate with infrastructure in both directions (receiving and sending information).

Additionally, C-ITS Basic Interface was developed in line with the confirmed specifications within WG2/TF4.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
152	170	553	1129	1560	1794

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

2019	2020	2021	2022	2023
0	1035	232	1000	732

18. The Spanish pilot site

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

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

Involved partners

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

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

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

Location

The five Spanish pilots are the following:

- **DGT 3.0**, located along the overall road network in Spain with an extension of approximately 12,270 Km. It 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.

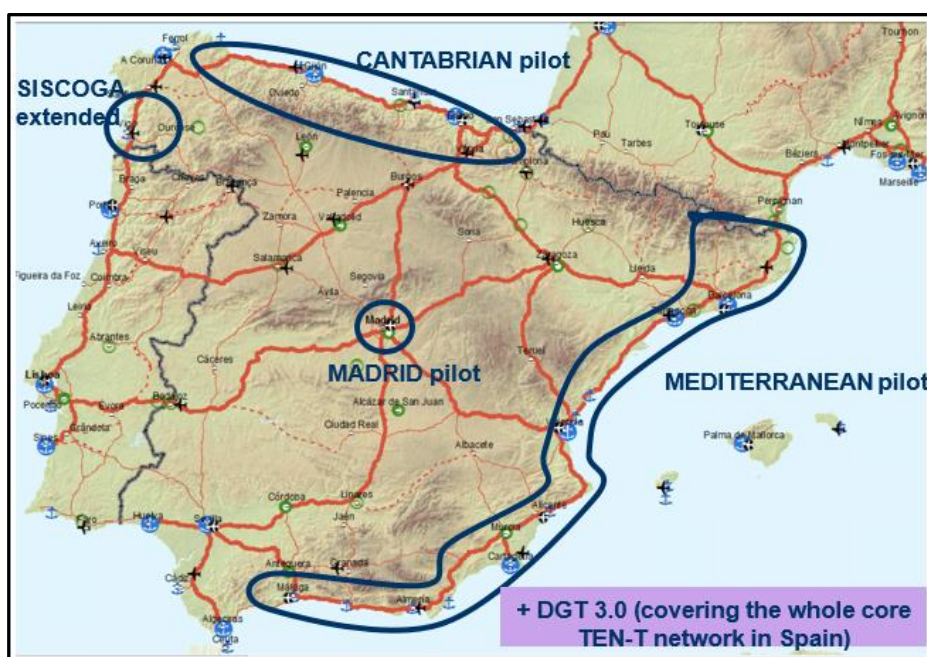


Figure 41: Location of the Spanish pilot site

Overview of progress by End of 2021

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

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

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

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

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

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

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

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

Table 4: Summary Cooperative Services implemented in each pilot

Indicative budget overview C-Roads (in k€)

2017	2018	2019	2020	2021
2969	6328	5428	2242	1011

19. The Swedish Pilot site

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

NordicWay 3 project (2019-2023):

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

The results of NordicWay 3, as well as of the previous NordicWay projects, can be viewed in the www.nordicway.net webpage.

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

Swedish national pilot

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

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

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

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

C-ITS Day-1 services:

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

C-ITS Day-1,5 services:

- Dynamic and semi-dynamic traffic restrictions

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

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

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

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

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

In C-Roads terms it is the following services.

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

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

Involved partners

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

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

Location

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

NordicWay3 has the following pilot sites:

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

Overview of progress by End of 2021

In 2021 we focused our efforts on aligning NordicWay 3 with C-Roads specifications for Hybrid communication. We attempted to close the gaps regarding messages and security, so that pilots will start in 2022. The goal is to be able to do cross border testing with other pilots in European countries who have implemented the hybrid communication specification.

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
0	140	1500	2400	2200	0

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

2019	2020	2021	2022	2023
100	300	3200	3200	3100

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

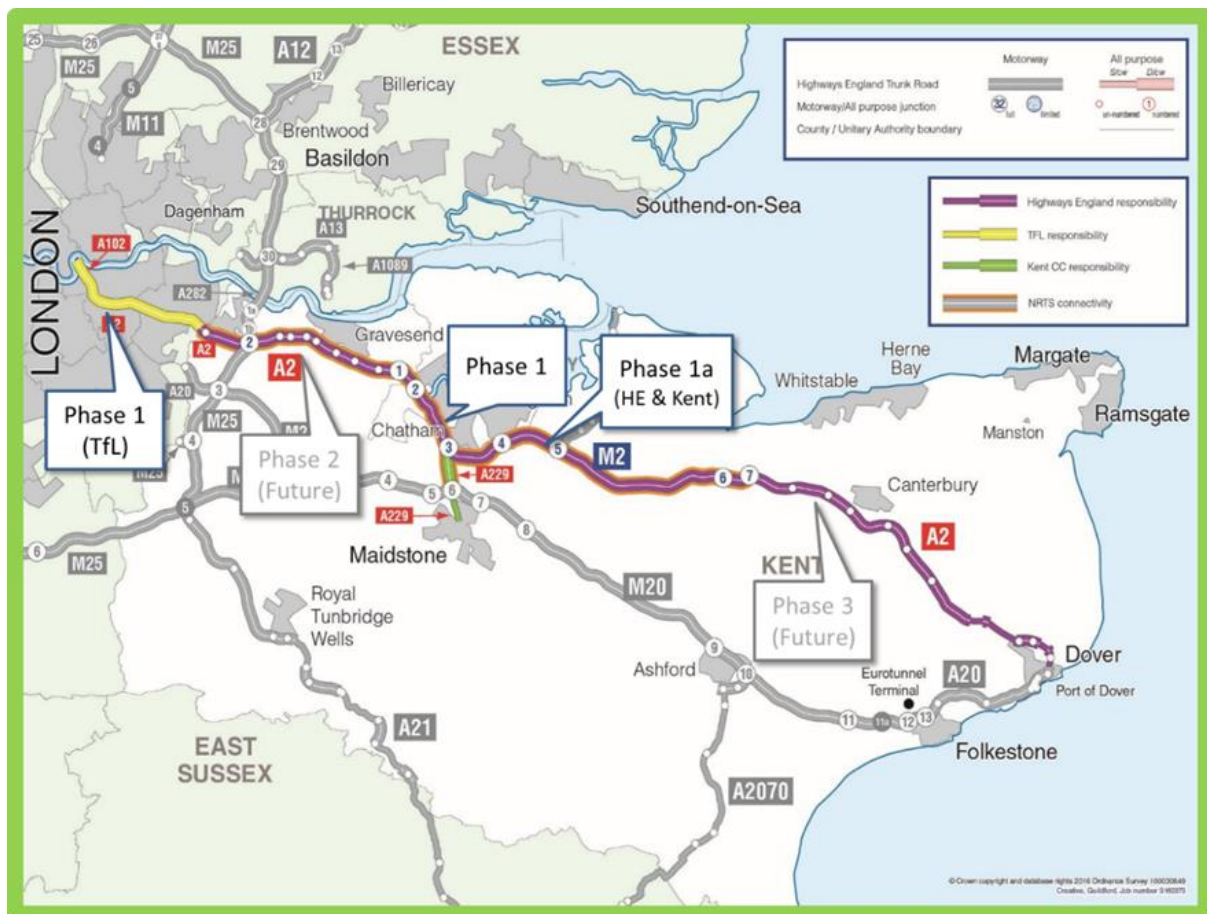
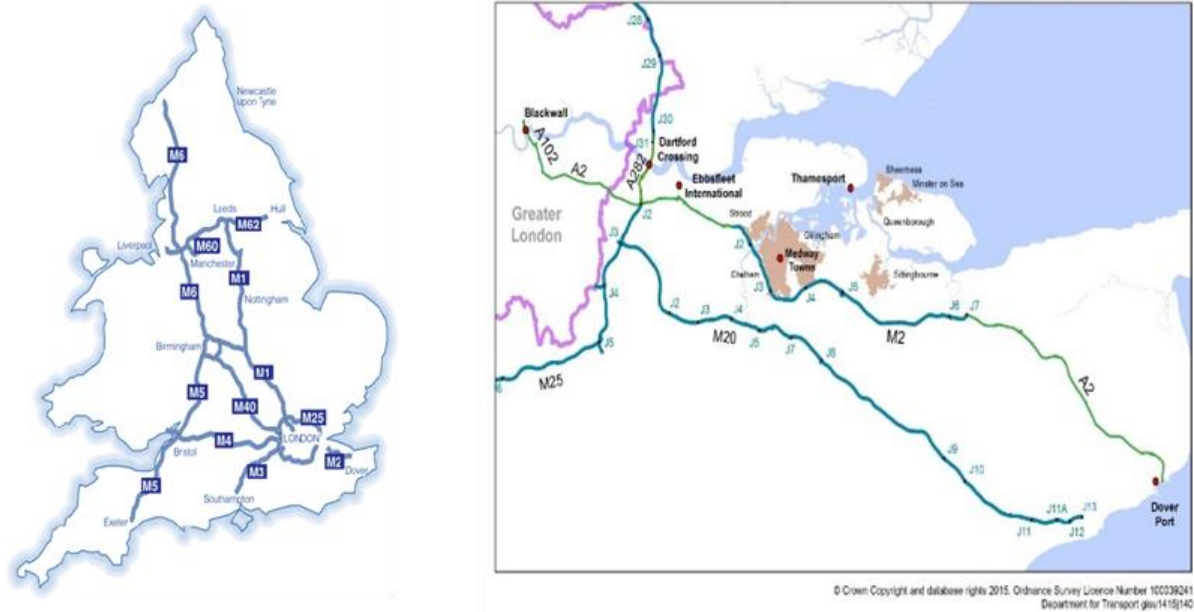


Figure 42: Location of the UK pilot site (Phases 1 & 1a deployed)

Overview of progress by End of 2021

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

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

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

Indicative budget overview C-Roads (in k€)

2016	2017	2018	2019	2020	2021
40	1191	4397	5954	437	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.

To ensure interoperability of services in Europe, it is important to carry out cross-border tests between C-Roads partners and with the participation of external industry partners from the C2C CC. A complete C-ITS test and validation campaign was carried out in 2021 under severe restrictions of the Covid-19 pandemic crisis, with limitations to partners' movements and at site test performance. For this reasons C-Roads partners developed a virtual test procedure for C-ITS services and have worked in their C-ITS X-Test campaign according to this procedure successfully and confirming the interoperability of day one C-ITS services in participating EU member states by June 2021, were the results have been presented in the C-Roads Roadshow in Brno, Czech Republic. Additionally to the virtual Tests also the C-Roads members Italy, Austria, Spain and Portugal conducted a physical C-ITS X-Test on motorway corridors crossing their borders and demonstrating the seamless operation of cross boarder C-ITS services.

One trial took place on the Austrian-Italian border [A22 (IT) /A13 (AT)] on the "Brenner Corridor". Two different routes were selected as test routes. Route 1: Nößlach to Brenner and back, and a longer, Route 2: Nößlach to Sterzing and back. The goal was cross testing of C-Roads specifications and traffic events, communicated via ITS G5 and a long range telecom based data communication channels and both routes were run a total of three times, examining different test cases. All messages were error-free decoded and displayable for the test and validation tool without any problems. The tests were successful.

The Spanish-Portuguese test was conducted on the border between Minho (PT) to Galicia (ES). The main goal was the physical verification of the interoperability between the two countries and the validation of vehicle equipment and security infrastructure. Different scenarios were executed in a short run of 30 minutes and one long run of 60 minutes. The conducted trial proved partial interoperability with security between national C-ITS networks. Spanish vehicles (OBUs) were able to receive information from Portuguese roadside units and Portuguese vehicles were able to get road safety messages from Spanish broadcasting units. These tests also proved to be successful. Minor service differences between the partners involved were addressed and further tests should take place in 2022 within the framework of C-Roads Portugal.

Additionally to the C-ITS installations on motorways, in 2021 many cities in the C-Roads Member states have implemented C-ITS Services and Use-Cases in order to facilitate the priorities for Public Transport fleet vehicles at these intersections and enable the swift passage of emergency service vehicles like ambulances and fire brigades. The Use Cases have different levels of priorities, in the same way that each Use Case holds benefits that might be more useful/needed for some cities than others. Up to now 37 cities have taken part in the roll-out of C-ITS, where various use cases were covered out of nine different C-ITS Services. The use-case SI-GLOSA is the most popular among cities, as well the SI-TLP, both belonging to the C-ITS Service

Signalized Intersections. In the C-ITS Service Hazardous Location Notification, the use-case HLN-EVA related to emergency vehicle approaching is the most common. All C-ITS installations distribute the highly dynamic C-ITS messages at intersections to all vehicles.

C-Roads 1 + 2 + 3								
Member State	2016	2017	2018	2019	2020	2021	2022	2023
Austria	335	1 266	1 919	1 150	5 671	3 618	6 319	5 710
Belgium/Flanders	20	560	1 670	1 510	340	123	-	-
Belgium/Wallonia	-	23	204	778	840	2 483	-	-
Czech Republic	124	808	2 052	5 164	4 590	2 102	60	60
Denmark	-	50	130	175	220	200	170	170
Finland	-	2 300	1 300	1 500	900	1 000	1 400	1 500
France	3 332	947	1 796	5 640	9 881	8 613	5 925	2 806
Germany	725	1 493	2 091	4 018	8 450	8 897	12 411	11 199
Greece	-	-	-	27	242	928	1 134	235
Hungary	-	-	-	-	-	10	1 400	610
Ireland	-	-	-	680	890	80	2 650	5 850
Italy	-	2 244	3 805	5 259	5 047	8 328	5 438	6 082
Netherlands	1 100	3 700	5 200	3 300	-	-	-	-
Norway	-	1 900	1 800	1 820	1 940	1 010	1 030	1 030
Portugal	-	791	1 688	3 695	6 138	16 232	5 905	3 601
Slovenia	152	170	553	1 129	2 595	2 026	1 000	732
Spain	-	2 969	6 328	5 428	2 242	1 011	-	-
Sweden	-	140	1 500	2 500	2 500	3 200	3 200	3 100
UK	40	1 191	4 397	5 954	437	-	-	-
Sum (k€)	5 828	20 552	36 433	49 727	52 923	59 861	48 042	42 685

Table 5: Indicative budget overview C-Roads 1+2+3 (in k€)