

Annual deployment overview report 2023

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Germany	Sweden
Greece	United Kingdom
Hungary	





1. Introduction

Core Members of the European C Roads platform are State authorities and infrastructure operators that work together to achieve deployments that enable interoperable and seamless cross-border C ITS services for European travellers. At the current stage, representatives from eighteen European States are committed to cooperate to enable interoperable C-ITS service deployments. The European C Roads Platform is set up as an open platform inviting representatives from further European States.



Figure 1: C-Roads overview





Starting in 2016 the European C-Roads platform was focused on the development of interoperable specifications forming the basis for C-ITS deployments all across Europe. While in the beginning the focus was clearly on C-ITS deployments along European motorways, since 2019 the scope was enlarged towards urban areas. Currently more than 50 cities are starting to implement C-ITS Use Cases.

The Annual Deployment Overview Report provides a summary of the activities performed in each C-Roads Member State. The status of pilots, deployments and starting operations are described. Additionally, the numbers of all installed Road Site Units and On Board Units are listed per country.





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 (<u>ECo-AT</u>), 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 (initially 2016-2020). 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 <u>C-ITS Deployment Group</u> 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. This number has risen to 18 units overall at the end of 2023.

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 operation for testing (using Pilot PKIs and later on ECTL L0), supplanting the pilot installations from Q2 / 2021 onwards for additional C-Roads test activities. In 2022, they were put into full operational mode on bilateral trust with operational Volkswagen vehicles. When the requirements and the timeframe for operational status on the ECTL became known (at the end of 2021), efforts for ECTL L1 evaluations began, with the aim of moving to ECTL L1 as soon as Volkswagen does the same for all its vehicles. The roadside framework contract foresees for the deployment of 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 to 2 kilometres for ITS-G5, this nearly accumulates to areawide coverage of the whole network. At the end of 2023, 367 roadside stations were operational on the Austrian motorway network.

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 for 100 vehicle units 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. Fully operational status was reached in 2022, again on bilateral trust with Volkswagen vehicles while working on obtaining successful ECTL L1 evaluation at the same time. Based on very positive results and feedback on using C-ITS in these vehicles, another 100 vehicle units were purchased in late 2022. At the end of 2023, the total number of C-ITS equipped road operator vehicles had risen to 63.

From 2022 onwards, the operational deployment of C-ITS in Austria at roadside, in vehicles and by using trailers has continued in C-Roads Austria 2. Additionally, in C-Roads Austria 2, urban use cases have been implemented in the cities of Graz, Wien and Salzburg, in order to bridge the gap between motorways and urban areas. The use cases focus on public transport services, signalized intersections as well as hazardous location notifications. This has continued and will even further expand in the scope of C-Roads Austria 3 until 2025, by adding new use cases within the city of Graz and extending the implementation of C-ITS to the city of Klagenfurt.

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





Involved partners

- ASFINAG
- Contractors:
 - Siemens Mobility Austria GmbH, now Yunex Traffic Austria GmbH
 - Kapsch TrafficCom AG
- Stadt Graz
- Land Salzburg

- Stadt Wien
- Wiener Linien
- Stadt Klagenfurt
- Land Kärnten
- Institut für Technologie und alternative Mobilität
- pdcp GmbH
- KMG Klagenfurt Mobil GmbH

Location

Inter-urban





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

- The motorways around Vienna, the former "Eco-AT Living Lab", was updated to full deployment status in the first stage of deployment in 2021.
- At the same time in the first stage of 2021, the motorways from Vienna to Salzburg (including Linz), a stretch of nearly 300 km, also known as the "West Corridor" and the Austrian part of the "C-ITS Corridor" between Netherlands, Germany and Austria, thus by definition the first C-ITS deployment area, were equipped with roadside stations, as already declared in an MoU between these three countries in 2013. This initial deployment





also included the motorways around Graz (a known proving region for automated driving) and several border areas, relevant for cross-border deployment and testing.

- Deployment was extended to the rest of the Austrian motorway network in 2022, with the 2022 deployment concentrating on the "Brenner" and "Tauern" transit routes, as well as filling the gaps on the West corridor.
- In 2023, the "Tauern" transit route and the Baltic-Adriatic TEN-T Corridor from Villach to Vienna were equipped.
- The 2024 deployment is scheduled to happen mainly in Styria, on and around the A9. 2025 will fill the gaps on the rest of the Austrian motorway network, which spans around 2250 km in total. By the end of 2025, 525 roadside stations will be on the network.
- Road operator vehicles and trailers are stationed all over Austria and used operationally whenever and wherever they are needed.

Urban

Pilot Graz



Figure 3: Map of C-ITS pilot in Graz

The two motorways A9 in the West and A2 in the South of Graz are both important connections for the city and at the same time, the city area of Graz is a common bypass in the event of incidents





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

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

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

Implementations in C-Roads Austria 3 consist of:

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





Pilot Wien



Figure 4: Map of C ITS pilot in Vienna

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

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

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

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





- 4 tramways equipped with onboard units, as preparation for the PT prioritization.
- 3 different mobile onboard units were installed in a vehicle 2023, which were used to test several use cases for the urban area.
- 1 RSU has already PT priority and emergency vehicle priority implemented.

Pilot Salzburg



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

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





Planned deployment:

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





Pilot Klagenfurt/Carinthia



Figure 6: Map of C-ITS implementations in Klagenfurt

In Klagenfurt, traffic lights along the main access roads to the city centre will be equipped with C-ITS roadside units (RSU). In addition, the alternative route of the motorway A2, Klagenfurt's southern ring (light blue line), is to be equipped with RSU too. In total, around 40 traffic lights are planned to be upgraded within the projects C-Roads Austria 3 and X4ITS. This includes the replacement of the traffic light's control unit and the modernization of the electrics, if necessary, the installation of traffic detectors to optimize traffic management and the introduction of a central management system on Klagenfurt's traffic computer to control and monitor the C-ITS stations. The RSUs broadcast SPAT/MAP. Bus acceleration at traffic lights is implemented where feasible.

The following actions are planned for 2024:

- Upgrade of another 14 RSUs
- Installation of two barrier controls using C-ITS
- Upgrade of the Carinthian's traffic computer including integration of RSU management, considering the new NIS 2.0 directive
- Equip the entire urban transport bus fleet with C-ITS on-board units to enable prioritization at traffic lights (83 OBU)
- Equip three autonomous shuttles with C-ITS OBU to enable autonomous driving along a corridor with 5 traffic lights





• Installation of 4 digital displays to additionally visualize the alerts coming from the autonomous shuttles via C-ITS

Furthermore, RSUs are being installed in additional Carinthian municipalities. So far, 4 RSUs have been put into operation in Villach (three of them as part of EU funded projects). Also planned is the installation of two RSUs on a mountain pass road, which will show if snow chains are required.

Overview of progress by end of 2023

Interurban

For the interurban network 373 RSUs were purchased and 367 installed and operational until the end of 2023. Additionally, 200 vehicle stations (OBUs) were purchased and 63 of them were installed and are operational as well as 18 deployed and operational trailers. All units are in bilateral trust with operational Volkswagen vehicles and are in active evaluation to gain ECTL L1 "ready" status. A central C-ITS unit supporting both ITS-G5 VANET communication on all units as well as providing hybrid IP-based communication is operational. Following Day-1 services are operational: Road Works Warning (RWW), Hazardous Location Notification (HLN) and In-Vehicle Signage (IVS). Several Day-2 services are in various stages of pre-deployment (Automated Vehicle Guidance (AVG), Collective Perception (CP), ...).

Urban

Pilot Graz

The final version of the visualisation application was delivered in 2023. It is constantly improved and updated. Currently, it is mostly used in the service vehicle, for demonstration drives and to check if implementations are working as expected.

2023 marked the starting point for C-Roads 3 implementations in the city of Graz. A whole pilot line was equipped with RSUs and to provide insights into the benefits of a line fully operated with C-ITS. Meanwhile, the public transport provider provided enough busses with C-ITS technology (OBUs) for a more detailed test and evaluation process by the end of 2023. The final report on this topic will be finished at the beginning of 2024.

Further meetings with the local and regional public transport providers were used to discuss a large-scale rollout of C-ITS for public transport prioritisation at traffic lights. Discussions included the current framework and boundaries of the existing systems and the existing technology as well as possibilities and expected challenges for a transformation to C-ITS. So far, the conversations are going well, and a final decision is expected during the first half of 2024.

Pilot Wien

The implementation of the SSEM/SREM use case was deployed on two intersections / traffic lights in 2023. One location was the traffic light at the junction Sandleitengasse # Lobmeyrgasse where the RSU as well as the traffic light controller is from Gesig respectively Cross/Herman. The second location was the traffic light at the intersection Josefstädter Straße # Strozzigasse. This





RSU as well as the traffic light controller is from Swarco. The OBUs for this deployment test, mounted in two trams, is from Cross/Herman. The test at both junctions were successful, the traffic light prioritization by C-ITS is functional.

In 2023, Wien Leuchtet additionally continued the implementation of C-ITS infrastructure in the city area by deploying a few RSUs.

Pilot Salzburg

In 2023, the R-ITS-S infrastructure was supplemented by 7 additional R-ITS-S on the secondary road network of the Federal State of Salzburg. Together with the R-ITS-S, also 8 traffic cameras were installed for traffic observation and monitoring (one R-ITS-S was already installed at a location in 2022). The following use cases are supported by the 7 new R-ITS-S RWW-RC, -LC; IVS-EVFT; PVD-VDC and -EDC.

In the area of V-ITS-S, three emergency vehicles of the Austrian Red Cross, Salzburg Regional Association were equipped with V-ITS-S and the use cases Emergency or Rescue/Recovery Vehicle in Intervention (HLN-ERVI) and Emergency or Prioritised Vehicle Approaching (HLN-EPVA) were implemented and successfully tested. The V-ITS-S were also registered with the Volkswagen PKI by the supplier of the V-ITS-S and the use cases were successfully demonstrated with a C-ITS-capable Volkswagen ID.3 vehicle.

Furthermore, two vehicles of the road maintenance service of the Federal State of Salzburg were equipped with V-ITS-S for the implementation of the Road Works Warning - Winter Maintenance (RWW-WM) use case at the beginning of winter 2023/24. The functionality could only be successfully tested for the snow plough status by the end of 2023. Further work is still required for the salting vehicle status in 2024.

A public transport bus was equipped with a V-ITS-S to test and evaluate the Public Transport Vehicle Crossing (HLN-PTVC) and Public Transport Vehicle in a Stop (HLN-PTVS) use cases. Extensive test drives were conducted along the B158 entry corridor into the city of Salzburg and the two use cases were successfully demonstrated and evaluated.

Initial functional tests were successfully carried out in 2023 for the implementation of the Signalised Intersections - Traffic Light Prioritisation (SI-TLP) use case with the SSEM and SSRM status messages. In 2024, 4 public transport buses will be equipped, and the use case will be tested in real operation.

In addition, the outstanding Day-1.5 use cases ('Park & Ride Information', 'Off Street Parking Information' and 'Networked and Cooperative Navigation in and out of the City') will also be implemented and tested in 2024 on the basis of IVI free text messages. The implementation findings will be presented and discussed in the C-Roads Working Group 4 Urban C-ITS.

Pilot Klagenfurt/Carinthia

The first three C-ITS roadside units (RSU) in Klagenfurt were installed in 2022 in the Minimundus area. One of these traffic lights has VRU detection at a crosswalk. When pedestrians or cyclists cross, DENM messages are sent out.





In 2023, additional six RSUs were installed along various main streets. Each of these RSUs broadcasts SPAT and MAP. For four of the six RSUs, a bus acceleration system was also set up at the respective traffic light, which will be used by KMG's bus lines starting in mid-2024.

During 2023, KMG tendered the equipment of 83 onboard units (OBU) in their bus fleet. The implementation of the interface between the OBU and the onboard computer of the bus has already been completed and the first OBU is in test operation. The commissioning of all OBUs and thus the bus acceleration using C-ITS is planned for May 2024.

In the year 2023, four additional RSUs were installed in the city of Villach, which also broadcast SPAT/MAP.

Installed RSUs and OBUs

Interurban

On the interurban network 385 RSUs as well as 63 OBUs were installed so far.

Urban

In the urban area 131 RSUs as well as 41 OBUs were installed so far.





3. The Belgium (Flanders) Pilot site

C-Roads Flemish Pilot (2016-2021)

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

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

Involved partners

- Flemish Department of Mobility
- HERE

- ITS.be
- Tractebel Engineering

Location



Figure 7: Location of the Belgium (Flanders) pilot site



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

Final status by end of 2021

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

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

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

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

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

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

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





Antwerp – Helmond Pilot Site

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

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

The duration of every pilot on the three sites will be six months, spread in time. All pilots will start simultaneously (Jan 24). There are 3 main use cases:

1. C-ITS and ADAS

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

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

The first five services will be available on all pilot sites and available for private drivers and truck drivers. The vehicles will be equipped with an OBU system to provide the combined ISA and C-ITS services. ISA will be a half-open system to prevent the driver of speeding. The last service (rail-road crossings) will not be deployed but explored conceptually.

2. C-ITS and UVAR

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

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





The first and third service will be made available and tested in the urban area of Antwerp. The information will be provided using a smartphone application to the drivers. The second and fourth service will not be deployed but will be explored conceptually.

3. C-ITS and (urban) mobility services

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

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

The second and fourth service will be made available and tested in Antwerp and on the indicated sections of the TEN-T road network. Information will be made available for truck and private drivers (including bicycles). The first and third service will not be deployed but will be explored conceptually.

Involved partners

- Tractebel Engineering (private)
- City of Antwerp
- City of Helmond
- Lantis/BAM
- Yunex

- Be-Mobile
- V-Tron
- Transport & Mobility Leuven
- PXL Hogeschool

Location

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







Figure 8: Location of the Antwerp – Helmond Pilot Site

Overview of progress by end of 2023

Final preparations are undertaken for deployment. Deployment is planned to start January 2024.

Installed RSUs and OBUs

Neither RSUs nor OBUs have been installed so far.





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

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

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

Involved partners



Location



Figure 9: Localisation of the RSUs near Liège (Background: Google Maps)





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

Final status by end of 2021

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

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

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

Installed RSUs and OBUs

6 RSUs have been installed but no OBUs.





5. The Czech Pilot site

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

Involved partners

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

- Deployment of C-ITS services via ITS G5
 - o 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)
 - o AŽD Praha
- Deployment of hybrid C-ITS system based on ITS G5 and current LTE technologies
 - o **O2**
 - INTENS Corporation
 - o T-Mobile
 - Škoda Auto
- Deployment of new cellular technologies (LTE-V)
 - o 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 10: 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 11: Location of the Czech pilot site

Overview of progress by end of 2023

The C-Roads project was completed in the Czech Republic on 31 December 2021. Since then the C-ITS deployment work has continued. Based on the authorisation of the Ministry of Transport of the Czech Republic for operating the C-ITS central elements the Roads and Motorways Directorate ensures that they can operate continuously since September 2021. From that time, the operation of the C-ITS Central Elements at the sites built under the C-Roads project is assured.

From January 2022, the other entities (e.g. municipalities, infrastructure managers, operators and other stakeholders) are gradually joining the C-ITS ecosystem. The C-ITS central elements have been linked to the European central components to ensure the exchange of C-ITS messages in a European environment. Therefore, the beginning of 2022 is considered as the start of C-ITS live operation in the Czech Republic. In 2023, the Directorate of Roads and Motorways also continued the preparation for the deployment of C-ITS systems on the motorways within the TEN-T backbone network in the Czech Republic.

Installed RSUs and OBUs

379 RSUs have been installed so far as well as 1930 OBUs.





6. The Danish Pilot site

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

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

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

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

NordicWay 3 project (2019-2023):

- Demonstrates as a large-scale pilot the feasibility of Day-1 and Day-1.5 services using hybrid communication solutions, which are fully based on European and global standards. NordicWay 3 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 <u>www.nordicway.net</u> webpage.

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 2023

The above-mentioned activities have been concluded.

Installed RSUs and OBUs

As mentioned earlier, no permanent deployments have been carried out.





7. The Finnish Pilot site

The Finnish pilot was 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 were 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):

- Demonstrated 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. NordicWay 3 will deploy coordinated pilots on Cooperative, Connected and Automated Mobility in urban areas, interfaces between urban and interurban areas and motorway sections.
- Contributed 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.
- Supported the development and implementation of C-ITS services, adapted to the conditions, urban and interurban environments in the Nordic countries.
- Further elaborated and expanded 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 <u>www.nordicway.net</u> webpage.

Finnish national pilots

In 2023 several pilots and studies were performed. The main C-ITS pilot was located in the city of Tampere and collects data from different traffic light providers and different controller models in C-Roads compliant format to a central Tampere node. In Tampere, data from different traffic controller models from the various traffic light controller providers in the city are made available as SPAT/MAP data to the Tampere Node. In total 20 signalised intersections provide real-time data to the Tampere Node.

In 2023, an Interchange was deployed, connecting the Tampere node to the other NordicWay ecosystems and make the data accessible to other C-Roads member states.

In 2023 a pilot was performed to assess the use of LTE-V2X for providing C-ITS services, using L0 PKI. In 2023 also a study was performed to assess the capabilities of public mobile networks in Finland to provide C-ITS services.





In addition, a study was finished to assess the roles of the different authorities when deploying C-ITS messages, according to European Commission and C-Roads specifications, and a study performed on the capability of public mobile networks to transfer C-ITS messages

Involved partners

The following project partners are involved:

- Finnish Transport and Communications Agency Traficom
- Finnish Transport Infrastructure Agency
- Fintraffic
- Fintraffic Road
- City of Tampere

Consultants performing the work:

- VTT Technical Research Centre of Finland Ltd
- Traficon Ltd
- Ramboll Finland LTD
- Varala Engineering
- Sitowise

Industrial partners involved in the Tampere pilot:

- Nodeon Finland
- Swarco
- Dynniq
- Normivalaistus Oy
- Solita

Location

The traffic light pilot and C-V2X pilots took place in the city of Tampere. The other studies relate to the national road network.

Overview of progress by end of 2023

The Tampere pilot has finished in 2023, but the Tampere Node remains alive in 2024. The Interchange deployed by Fintraffic also remains operative in 2024.

Installed RSUs and OBUs

1 ITS-G5 RSU has been installed but no ITS-G5 OBUs.





8. The French Pilot site

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

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

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

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

In 2023, an extension of the project by 6 months was approved by CINEA following request of the consortium. Therefore, the InDiD project will end by June 30th, 2024, instead of December 31st, 2023. This will allow partners, especially newly integrated partners, to completely finish their deployments and work on use cases and prepare a presentation of the project's results through the final seminar of InDiD.




Involved partners

v		Μ	α	u		-

	InDiD
Road operators (public)	 Ministry -public road operators 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) 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)
Road operators (private)	 Concessions companies and provider of road transport services ASFA: The Association of French Motorway Companies APRR: French freeway concession company SANEF: French freeway concession company Vinci Autoroutes (composed of ASF; Cofiroute and ESCOTA): French freeway concession company
Cities / Public Entities	 City of Paris Aix-Marseille-Provence Metropolis City of Aix-en-Provence Département de l'Isère Bordeaux Metropolis European Collectivity of Alsace (CEA) Eurometropolis of Strasbourg (EMS)
Research institutes / Universities	 CEREMA Université Gustave Eiffel Université Clermont Auvergne Université de Reims Champagne-Ardennes Bordeaux INP Institut Mines-Télécom Université Polytechnique Hauts de France Eurecom
Security experts	IDNomic
Mobility Labs / Geography experts	Institut VedecomLe LABIGN
Solution providers: C-ITS / Mobility / DIGITAL	 Valeo TomTom Green communication Transdev (until end of 2022) ATC France

Table 1: Involved partners of InDiD project





Use cases

The following use cases were specified in the InDID project:

	A – Probe Vehicle Data (PVD)							
A5	Wrong way users detection							
	B – Road Works Warning (RWW)							
B1	Alert neutralization of part of a lane, whole lane or several lanes (for connected Vehicles and Automated Vehicles)	B4	Dangerous vehicle approaching a road works: warning to the dangerous vehicle					
B5	Dangerous vehicle approaching a road works: warning to workers							
	C – Signage Applications							
C2	In vehicle dynamic speed limit information	C4	Toll Station Approaching: orientation of drivers					
C6	Toll Station Approaching: orientation of automated vehicles		Toll Station Approaching: enhanced orientation of drivers					
C8	Toll Barrier Crossing for automated vehicles		Pedestrian Crossing Outside of Signalized Intersection					
C11	1 Dangerous vehicle approaching a road works: Safety recommendation to the dangerous vehicle							
D – Hazardous Location Notifications (HLN)								
D9a	Alert temporary mountain pass route closure	D9b	Alert approaching a closed mountain pass route					
E – Traffic Information and Smart Routing								
E1	Traffic information about snow on the road	E2	Rerouting					
G – Intersection (SI)								
G1b	GLOSA TTG (Time To Green)	G2	Traffic signal priority request by designated vehicles					
G5	In-vehicle signage at a merge for vehicles on the entry slip road	G6	In-vehicle signage at a merge for vehicles on the main road					
G7	HD cartography on intersections	G8	Green phase extension for pedestrians					
H – Traffic Management								
H9	Flooded roads							
	I – Vulnerable users							
15	Vulnerable user at a public transport stop							
17	Bicycle lane in opposite direction in a one-way road							
	K - Level Crossing (Use cases SNCF - open level crossing)							
K7	Level Crossing for automated vehicles							
	M – Payment services							
M1	Payment service at a toll station							
M1	Payment service at a toll station							

Table 2: C ITS InDiD use Cases





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

On the metropolitan area of Bordeaux, new cellular services were studied such as:

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

As for service in the north pilot, the objective was to deploy urban services such as vulnerable users protection, information on bicycle paths, information on parking slots, multimodal traffic information, carpooling information, depending on the prioritization work. Day-1 and Day-1.5 services that are deployed in other pilot sites will also be considered for operations, such as accidents, roadworks, VMS, etc.

Regarding service in pilot Center-East, the following specific use cases was implemented, based on the use case prioritisation:

• Information on roads covered by snow

Location

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







Figure 12: Location of the French pilot sites for InDiD

Overview of progress by end of 2023

By end of 2023, most activities for the InDiD project were finalized.

Regarding studies, the work of 2023 focused on the integration and taking into account of the new use cases added to the InDiD scope (see previous section of this report), through specifications and development, as well as the finalization of the tests in order to produce the final evaluations of the project.

Several tests were carried out in 2023:

- Unitary tests, on table, with standalone prototypes, such as RSU or Vro-ITS-S
- Bilateral tests, in simulated or real environment, such as between coopits and the national Node,
- Full chain tests were and will also be carried out by partners on real roads.



Moreover, several transversal studies were also carried out, working on the architecture definition of the hybrid network, HD maps for automated vehicle, Security of the C-ITS chain, etc.

Regarding the status of deployments on each pilot site:

- The Mediterranean pilot site finished its deployments of OBUs and RSUs in 2023. By December 2023, several use cases about hazardous locations notification were tested, with positive results. In 2024, the pilot site will also add use cases lead by Ville d'Aix, for example GLOSA.
- The Poitiers/Bordeaux/Spain pilot site finished its deployments of OBUs and RSUs in 2023. By December 2023, several use cases about signage applications and multimodality were tested, with positive results. A proof of concept on HD Maps was also carried out and will be finalized by early 2024.
- The Toulouse/Spain experimentation pilot site its deployments of OBUs and RSUs in 2023. Work on a use case on parking lot locations started in 2023 and will be finalized in 2024.
- The Center-West pilote site focused on specifying a use case on wrong-way user detection.
- The Ile-de-France Urban Innovation district pilot site finished its deployments in 2022.
- The Île-de-France / Toll Plaza on A6 Motorway pilot site tested several use cases of a level 4 autonomous vehicle passing through the toll plaza: these tests were incurred during the first half of 2023.
- The Île-de-France Conurbation experimentation on A86 pilot site focused on extending the number of RSUs on this section to provide C-ITS services existing on other sections under responsibility of the same road operator. The deployments finished in 2022 and the extension of new services was carried out in 2023.
- The North pilot site already finished its deployments; in 2023, road operators focused on testing services related to signage applications, in-vehicle signage on intersections, and hazardous location notifications.
- The East pilot site is a new pilot site that took part in InDiD in 2022. In 2023, Collectivité Européenne d'Alsace (CeA) deployed OBUs and RSUs on its network and started working on use cases such as Alert planned road works, Winter Maintenance, Alert temporary slippery road and Alert animal on the road. Eurométropole de Strasbourg worked on selecting and specifying services including services related to bicycle paths.
- The Conurban Motorways pilot site installed RSUs and tested services related to Traffic information about snow on the road.
- The Département de l'Isère pilot site encountered many delays and is aiming to achieve its deployments in 2024.

Installed RSUs and OBUs

588 RSUs have been installed so far as well as 43 OBUs.





9. The German Pilot sites

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

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

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

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

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

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

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

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





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

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

- Green Light Optimal Speed Advisory Service Deployment (GLOSA)
- Probe Vehicle Data Service Deployment (PVD)
- Vulnerable Road User Protection (VRU)

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

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

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

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

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

The services Road Works Warning (RWW), Green Light Optimal Speed Advisory (GLOSA), Probe Vehicle Data (PVD) and Traffic signal priority request by designated vehicles (TSP) are already implemented. Additionally, the city of Kassel implemented the services GLOSA in the interurban area around Kassel at additional 6 traffic lights with R-ITS-S technology and TSP for emergency vehicles (sub-activity 4.5 and sub-activity 4.6).

The implementation of the services Emergency Vehicle Approaching (EVA) and Connected and cooperative navigation into and out of the city (route advice) are in progress.





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

- Probe Vehicle Data Service Deployment (PVD)
- Green Light Optimal Speed Advisory Service Deployment (GLOSA)
- Traffic Signal Priority Request Service Deployment (TSP)
- Emergency Vehicle Approaching Service Deployment (EVA)
- Vulnerable Road User Protection Service Deployment (VRU)

Involved partners

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

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

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

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

Location

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







Figure 13: ITS Services in Hamburg





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

Different services are implemented in and around the city of Kassel.



Figure 14: Overview of the equipped routes and C-ITS coverage (300, 400 and 500 metres) in the city of Kassel, as well as the displays for Route Advice Service on the motorways in the Kassel area

The Digital test site for connected driving Kassel covers modern technical equipment in the traffic management center of the city of Kassel and almost 100 (98 R-ITS-S by December 2023) C-ITS roadside stations on main roads of the urban traffic network.

The map of the city of Kassel (with the surrounding motorways A7, A49 and A44) illustrates the Kassel test field with the main roads leading into the city centre of Kassel, where the traffic light infrastructure is upgraded towards an ETSI ITS-G5 I2V- and V2I-communication. Additionally, the C-ITS coverage by the R-ITS-S is illustrated with a radius of 300, 400 and 500 metres (Figure 14Figure 14).

Additionally, four locations on the motorways A44 and A49 were equipped with R-ITS-S in 2023 to implement the Route Advice service in synergy with the urban diversion concepts.

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





Five additional C-Roads R-ITS-S went into operation in 2023. Up to 20 R-ITS-S with ITS-G5 and/or cellular-V2X are planned for the C-ITS Pilot in Dresden.

Key facts:

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

Figure 15: Overview on the Dresden pilot. Source: maps.google.de

Overview of progress by end of 2023

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

The harmonisation of the German activities (Activity 2) within the CRG-UN Coordination Group and the established Expert Groups has been continuously refined and consolidated. In 2023, two Steering Committee meetings took place to discuss results and urgent topics.

The Pilot Hamburg (CRG-UN Activity 3) further increased the number of intersections equipped with ITS-G5 technology. At the end of 2023, 180 intersections broadcast MAPEM and SPATEM for the respective intersection to provide all necessary data for the SI-SPTI and SI-GLOSA services. The PVD service is based on mobile stations involved in different city internal projects, i. a., an emergency vehicle prioritisation project. At the end of 2023, only a few intersections are collecting CAMs for PVD. The roll-out is planned for 2024. All necessary hardware is already installed.





In 2023 the MAP provision, according to the C-Roads harmonisation, was further enhanced by improvements in the MAP design software. This could be archived by closer cooperation with the respective software supplier. Besides optimising the MAP output, the internal processes necessary for GLOSA deployment were also improved. In 2023, the procurement to equip an unsignalised double intersection with hardware for a vulnerable road user protection service (VRU) was conducted. The corresponding hardware was installed in the first quarter of 2024 and the C-ITS service was put into operation.

In 2023 the city of Kassel (CRG-UN Activity 4) fulfilled milestones M46. According to the defined milestone, the equipment of vehicles for the services Emergency vehicle approaching (EVA, sub-activities 4.3) and Traffic signal priority (TSP, sub-activities 4.6) were implemented. Additionally, the city of Kassel implemented the services GLOSA and TSP for emergency vehicles (sub-activity 4.5 and sub-activity 4.6) in the interurban area around Kassel at additional 6 traffic lights with Roadside ITS stations (R-ITS-S) technology.

In 2023, the city of Kassel installed 18 C-ITS capable traffic light systems equipped with R-ITS-S (by now 72 C-ITS capable traffic light systems are implemented within the project. With additional 20 R-ITS-S from other projects, in total 101 R-ITS-S are in operation). During the operation periods, the R-ITS-S transmit the ETSI ITS-G5 messages MAP, CAM, DENM, SPaT, SSEM and IVIM. Moreover, in 2023 the expansion of broadband connections between several signalised intersections and the traffic light control centre proceeded. The construction works for the installation of further fibre optic cable proceeded.

For the sub-activities 4.3 (Emergency Vehicle Approaching, EVA) and 4.6 (Traffic Signal Priority Request, TSP), four V-ITS-S were installed in police vehicles (Vev-ITS-S) for EVA / TSP. Two of these vehicles are intended for operation in urban areas, for which tests were carried out at the equipped traffic lights in Kassel. The other two vehicles are being used on motorways. Here, road users with C-ITS-capable vehicles are shown the approach of an emergency vehicle and the formation of a rescue lane. The next steps are the expansion of the tests and the productive operation of the systems.

In sub-activity 4.4 (Route Advice Service), Autobahn GmbH equipped four locations on motorways A44 and A49 with R-ITS-S: two physical locations with display boards (one mobile and one stationary display) and two virtual locations where poles with R-ITS-S were installed to transmit the information to the vehicles without an additional physical display. In the city of Kassel the functionalities of the service Connected and cooperative navigation into and out of the city (route advice) are implemented. Extensive tests in cooperation between the pilot partners Autobahn GmbH and the city of Kassel are envisaged in 2024, in which diversion strategies in the urban and motorway areas will be harmonised.

In 2023, no milestones were planned for Fraunhofer in the Dresden pilot (CRG-UN Activity 5), except for M64 "Pilot Dresden services demonstration event", which was postponed to the end of 2024 due to the prolongation of the project. In 2023 Fraunhofer installed 5 R-ITS-S (total of 18 R-ITS-S) with ITS-G5 and connected to traffic lights for the services GLOSA, PVD, TSP and VRU.





Installed RSUs and OBUs

324 R-ITS-S have been installed so far as well as 24 V-ITS-S. Further 18 R-ITS-S and another V-ITS-S are planned to be installed in 2024.





10. The Greek Pilot site

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

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

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

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

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

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

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

Involved partners

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

• Hellenic Ministry of Infrastructure and Transport (MIT) The following implementing bodies are under the MIT:





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

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

 Egnatia Odos SA will award one or more contracts through open tendering procedures related to:

a) supply and installation of RSUs and OBUs with their required configuration, control and adjustment support systems

b) supply of services for the appropriate development and extension of Egnatia Odos TMS software applications for the provision of C-ITS services under the C-Roads Greece pilot project

- Attikes Diadromes SA will award contracts with regard to the equipment or the services to be purchased for the project (for installation, customization of equipment or software development).
- MIT intends to award contracts for the purchase of software, and possibly specialized hardware, administrative, evaluation and control services.

Location

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

A. The Egnatia Odos Motorway is a motorway extending along 660 km and is part of the TEN-T Core Network Corridors, which crosses Greece from its westernmost edge (Igoumenitsa port) to its easternmost borders with Turkey (Kipoi, Evros). It has two separate directional carriageways, each consisting of two lanes (in few sections three lanes) and an emergency lane. Egnatia Odos motorway is equipped with many ITS devices and safety systems that aim at providing travel safety and comfort to end users. Along with a set of five vertical axes of 330 km connects Greece with all its north neighbouring countries (Albania, FYROM, Bulgaria). The road section of Egnatia Odos motorway that will be included in the C-Roads Greece pilot is a rural road section with continuous bridges and tunnels of approx. 30 km





with Average Annual Daily Traffic (AADT) of 11,230 (HGV: 16%). It is managed by a Traffic Control Center (TCC) and equipped with ITS related equipment (i.e. Variable message signs, CCTV traffic cameras, traffic detection inductive loops, meteorological & smoke sensors). This equipment will be utilized alongside with the C-ITS field equipment that will be installed in the course of the pilot.



Figure 16: Location of the "Egnatia Odos" Greek pilot site



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



Figure 17: Location of the "Attica Tollway" Greek pilot site

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





Overview of progress by end of 2023

C-Roads Greece is implemented according to the timetable set in the Grant Agreement work plan, achieving all 43 milestones. During 2023 C-Roads Greece maintained the existing deployments, supporting the pilot's operations, troubleshooting any issues and updating the provided services.

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

After the organization of 4 stakeholder workshops in previous years, C-Roads Greece continued internal cooperation to run smoothly the Greek pilots towards 2023.

The data collection period had been decided to be prolonged within 2023 to gather more data to be used for qualitative and quantitative analysis. The impact assessment and evaluation results from the use of the C-ITS services in the Greek pilots is described in MS42 (End of pilot data collection in both pilot sites), which was prolonged beyond 2022 granting more data that was analyzed qualitatively.

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

Installed RSUs and OBUs

35 RSUs have been installed so far as well as 2 OBUs.



C C-ROADS

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 18: System architecture

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

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





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

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

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

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

Planned progress of the Action

The main Pilot site for C-Roads 2 stays Zalaegerszeg. The intersections have been chosen after detailed research and in accordance with the local authorities for the best possible effect. There will be one intersection dedicated to test and validate only VRU use cases. One of the locations is equipped with a Traffic Signal Priority and Emergency Vehicle Priorisitation where the implementing body will carry out tests with the public transport company and Emergency services. After the feedback is received it will be evaluated and the possibility of extending the locations of the service will be discussed with the municipality of Zalaegerszeg.







Figure 19: Intersections in C-Roads 2 in Zalaegerszeg

Involved partners

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

Other stakeholders:

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





Location

With the extension, a major part of motorway M7 (Mediterranean corridor) has been covered, and urban deployments 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 20: Location of the Hungarian RSU Positions

Overview of progress by end of 2023

All the new RSUs were deployed by end of the year, the TEN-TEC map has been updated accordingly. No further deployment is planned in the upcoming years within the scope of C-Roads.

Installed RSUs and OBUs

130 RSUs have been installed so far as well as 60 TEST OBUs with L0 PKI.





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 21 Figure 21 shows the location of the pilot corridors, which have been divided into the following sections where specific services will be piloted:

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

Involved partners

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

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





Location



Figure 21: Location of the Irish pilot site and use cases





Overview of progress by end of 2023

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

Civils designs for non-gantry RSU sites were completed and issued to appropriate civils contractors. In October 2023, all the different types of infrastructure needed for the pilot were installed. By the end of 2023, all 74 RSUs were installed on the M50 and the southern section of the M1 covering approximately 60km.

In June 2023, Ireland hosted a series of successful cross border tests that demonstrated the C-ITS solution delivered all the required functionality and use-cases as per the C-Roads specifications. France, Austria, and Hungary participated in the cross-border tests as visiting members. In addition, members from BASt - Germany, University College Cork – Ireland and Meridian Project – Ireland attended the event as observers.

OBU application software was finalised for the each of the use-cases being implemented in Ireland. Similarly, development on the C-ITS smartphone app was completed and passed acceptance tests.

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

A specialist company was appointed to recruit a target number of approximately 1500 pilot participants and to provide marketing support. Furthermore, a specification for the development of a pilot participant data platform (PPDP) was prepared to administer the recruitment process and to provide a portal to enable user acceptance questions to be issued/accessed and for pilot participants to access training/briefing materials.

During 2023, the PPDP was completed and underwent a series of tests to facilitate as streamline as possible participant on-boarding experience. The 'front end' of the data platform is accessed from cits.tii.ie, which is where all marketing efforts point members of the public to, to find out more and to enrol.

The data protection impact assessment was updated to reflect changes in how personal data will be handled in light of design developments, including contractor product limitations. A specification for a data analysis platform was prepared and subsequently developed to receive raw encoded C-ITS log data from the contractor's central system and perform the necessary translations to enable data analysts to run queries and interrogate the data. The platform was developed in compliance with GDPR.

In terms of C-ITS security and privacy, the Irish pilot was registered with the EU PKI Level 0 service provided by Atos. A part 1 factory acceptance test (FAT) was undertaken of RSUs and





OBUs and demonstrated the registration of both unit types with the EU PKI service and receipt of Level 0 PKI certificates for EU PKI service for signing the messages. Registration of the central C-ITS station with the EU PKI service was undertaken in early 2023.

Significant progress was made on modelling the impact of C-ITS using microsimulation modelling. A model of the M1 corridor from the junction with the M50 (all part of the TEN-T core network) was developed and various scenarios created in order to understand what the impact of select C-ITS use cases is on KPIs such as journey times at different levels of C-ITS market penetration.

The pilot will continue throughout 2024 with the final evaluation and assessment report due in December.

Installed RSUs and OBUs

74 RSUs have been installed so far as well as 62 OBUs.





13. The Italian Pilot site

C-Roads ITALY (2017-2021)

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

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

Involved partners

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

The following entities are considered as implementing bodies:

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





Location



Figure 22: Location of the Italian pilot site

Final status by end of 2021

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

Trucks Platooning

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





Highway Chauffeur (passenger cars)

Italian tests

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

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

Cross-border tests with Austria

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

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

Virtual tests

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





C-Roads Italy 2 (2018-2023)

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

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

Involved partners

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

ALMAVIVA

Location

- 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



Figure 23: Locations of the C Roads Italy 2 pilots



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Overview of progress by end of 2023

The project ended on 31/12/2023, here after a short summary of the achievements. In the Final Report more exhaustive description.

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

At national level, the C-ITS server was finalized in order to enhance the security and performance and to support the message flow to the RSU management systems of the national Implementing Bodies (Implementation and testing of MQTT broker & client for Verona, Trento and Torino).

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

Two vehicle prototypes (Stellantis-CRF) have been equipped to demonstrate the exploitation of the Day 1/1.5 services in the identified use-case scenarios. Both vehicle prototypes use the hybrid V2X connectivity, including both short range communication

A conventional ICE vehicle has the connectivity capability needed for realizing driver-assistance use-cases. A HEV vehicle uses the connectivity capability for the energy recovery and optimization use-cases. In both vehicles, CRF V2X onboard unit is interoperable with the C-Roads Italy 2 test sites and implements the C-ITS services foreseen in the project. Relevant C-ITS information, processed by the V2X OBU, is passed on to the AD/DA Control Unit which evaluates the scenario, interacts with the driver and generates the needed settings for driver assistance and/or powertrain optimization. On the HEV, longitudinal motion settings computed by the AD/DA Control Unit are given to the Smart e-coasting algorithm, which optimizes propulsion and energy consumption based on the received information.

The Smart e-Coasting feature, thanks to the information exchanged between the intelligent road infrastructure and the vehicle itself through V2X, anticipates the driver's reaction, avoiding, for example, sudden acceleration or braking to the detriment of the use of Internal Combustion Engine (ICE) and of dissipative hydraulic brakes.

At the end of the 2023, the pilot tests were successfully completed and the data thoroughly analysed, V2X messages of road events, hazards and signage from the infrastructure to the vehicles were received by tests running in Trento, Torino and Verona and along Brescia-Padova motorway.

In summary, C-ITS solution developed on-board the vehicle is interoperable with the road infrastructure of Italy and through Virtual test site, the interoperability could be addressed also with other European Member states.





Regarding Hybrid communication, the activity confirmed that the 4G signal levels comfortably meet the radio requirements outlined for the project's intended use cases, enabling the adoption of a hybrid connectivity approach.

In principle, the AMQP Basic Interface defined by TF4 is intended for backend integration. According to the assumptions made by the C-Roads Platform, in a real-world scenario, direct communications with vehicles might be overseen by OEMs through a proprietary protocol. In this realm of communication, MQTT has emerged as the predominant choice, quickly establishing itself as the de facto standard.

The definition of the Italian end-to-end architecture for long-range C-ITS communication has been finalized and put in operation.

The Interchange Entity stands as Telecom Italia's significant contribution to C-Roads Italy 2. It empowers highway and urban operators to effortlessly publish and disseminate C-ITS messages, leveraging the extensive coverage of the cellular network across the entire national territory. It also ensures the cross-border interoperability of C-ITS services.

In the course of 2023, all ETSI messages provided by the MOVALIA Back-End have been arranged following the Message Profile v2.0.7 provided by the C-Roads Platform.

During 2023 the integration between the Datex node of Autostrada BSPD and the Datex Node of Verona Municipality was designed. A particular effort was devoted to define the type of the network connection to be implemented. The integration as well between the C-ITS Server and the Broker TIM to implement Hybrid Server for IP based communication was designed. The interface was designed taking into account the "C-ITS IP Based Interface Profile" document of C-Roads.

Evaluation

Moreover, a socio-economic evaluation has been done order to examine whether cumulative benefits and systems costs associated with the test sites deployments would result in a profitable investment in the long-term.

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

- analysis of the existing data and its completeness to satisfy the data requirements for implementing use cases and if such data did not exist, what were necessary to retrieve such data from existing infrastructure
- design of architecture and selection of Central C-ITS server which will perform the translation of data into C-ITS messages and its distribution to G5 and IP channels The planned Design activities for detecting parking areas and slots by means of cameras and artificial intelligence have been completed, including also the definition of the communication protocols according to the operational standards. That allowed to start the commissioning and installation phases.
- city of Verona has chosen to make use of central C-ITS server which are shared with other urban partners Turin and Trento.





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

- consolidation of the Day1/Day1.5 C-ITS services to be implemented according to the C-Roads Platform Technical Specifications and the definition of the technical perimeter in which such implementation would have taken place in Turin.
- tests on use cases started, organized in collaboration with the other Implementing bodies CRF, Politecnico di Milano, Almaviva and Movalia
- the integration activity to ensure the interoperability of the RSU with the C-ITS services implemented by the C-ITS Server, to exchange C-ITS messages with vehicles was completed.
- completion of preparatory activities and start of joint tests on use cases, organized in collaboration with CRF, Politecnico di Milano, Almaviva and Movalia.

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

Use cases tested and available

- SI-GLOSA (on 13 traffic-lighted intersections)
- SI-SPTI (on 13 signalized intersections)
- SI-ISVW (on 13 signalized intersections)
- SI-TLP (on 13 traffic-lighted intersections)
- IVS-TS (on 13 signalized intersections)
- On Street Parking management & information (on 1150 parking spaces)

RSUs were installed in order to optimize the yield in the short-range diffusion of cooperative messages, providing optimal coverage on the test site, also thanks to hybrid operation via cellular network.

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

- the integration between the Datex node of Autostrada BSPD and the Datex Node of Verona Municipality is operational.
- the integration between the C-ITS Server and the Broker TIM to implement Hybrid Server for IP based communication is working. The interface was designed taking into account the "C-ITS IP Based Interface Profile" document of C-Roads.
- Internal tests, using OBU installed on company vehicles, have been performed
- Cross-border test session has also been performed involving Greece, Ireland and Austria. Most C-ITS functionalities were correctly verified, and some significant improvements were suggested and considered; software modifications were done to satisfied them.





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).

Involved partners

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

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



Figure 24: Location of the C Roads Italy 3 pilots

Location



Overview of progress by end of 2023

The project ended on 31/12/2023, here after a short summary of the achievements. In the Final Report more exhaustive description.

National technical experts have contributed to the C-Roads Platform activities in WGs and TFs.

In line with the C-Roads Platform specification in C-Roads Italy 3, the communication design and the related architecture is based on hybrid solution, notably: "ITS-G5" and "cellular long-range network".

Further scenarios of already developed "Use Cases" or by adding "new" Use Cases were performed:

- 1. RWW Winter Maintenance (RWW-WM)
- 2. RWW Road Works Mobile (RWW-RM)
- 3. HLN Emergency Vehicle Approaching (HLN-EVA)

RWW – Road Operator Vehicle Approaching (RWW-ROVA)

During the project, the UCs HNL-EVA and RWW-ROVA were removed from the C-Roads Platform specifications and replaced afterwards with analogues more general UCs defined as "HLN – Emergency or Prioritized Vehicle Approaching (HLN-EPVA)".

Road tests for scenario generation yielded positive results. The collaboration with Centro Ricerche Fiat not only facilitated real-time analysis but also allowed for a more dynamic and interactive assessment of mobile scenario management system.

The road tests were conducted with active participation from an A22 vehicle serving as the sender and a vehicle provided by the car manufacturer as the receiver.

This effective approach enabled the successful management of all planned scenarios, marking a significant milestone in the system's development and validation.

Notably, the maintenance and upgrade initiatives successfully incorporated and managed new scenarios, including:

- IVS-FT (Free Text)
 - Integration of a new UCs involving the management of free text information, enhancing the system's versatility.
- HLN-APR (Animal or Person on the Road)
 - Integration of a new Use Case specifically addressing the detection and management of animals or persons on the road.
- HLN-WCW (Weather Condition Warning) Manage More Subscenarios:
 - Expansion of the HLN-WCW scenario to include the management of additional subscenarios related to weather condition warnings.
- HLN-TSR (Temporary Slippery Road)
 - $\circ\,$ Introduction of a new Use Case dedicated to addressing temporary slippery road conditions.

As part of the concerted effort to foster the harmonious development of C-ITS across Europe, Autostrada del Brennero played an active role in the Cross Border Test Sessions (CBT).





Throughout both sessions in which A22 actively participated, namely in November 2022 and September 2023, the outcomes were notably positive. The results garnered excellent feedback from participating partners, underscoring the success of the collaborative efforts in advancing C-ITS capabilities and interoperability.

Autostrade per l'Italia (ASPI), through some RSU installed on the Motorway A1 (North of Florence, IT), has realized the hybrid C-Roads X-Test 2023. Contextually additional C-ITS messages have also been generated from C-Roads Italy partners such as CAV (Concessionarie Autostradali Venete), Autostrada Del Brennero, Autovie Venete.

DENM messages have been made available to C-Roads partners to check contents with the collaboration of AUSTRIA TECH and they were decoded correctly.

Many of the Use Cases developed along the CAV motorway network has been tested within the Cross Border Test Sessions with Austria and France.

Roma Servizi Mobilità developped its C-ITS Platform (Short-Range and Long Range communication) within the urban context of the city of Rome. This platform comprises a network of sensors and radio devices deployed on roads (RSU - Road Side Unit) and vehicle (OBU - On Board Unit), along with modular software components such as C-ITS Server and RSU-Management.

Along the Brenner motorway additional 20 RSU have bene installed:

- \circ 5 MK5 RSUs have been positioned at strategic points along the route
- 15 MK5 OBUs have been installed on the company fleet to act as mobile RSUs for road works and for the management of winter operations.
- Further 10 MK6 RSUs were purchased at the end of the project, even if they were originally not foreseen by the Grant Agreement, with the aim of creating a corridor with double technology to implement advanced tests with different car makers.

Along the A1 Autostrade per l'Italia A1 motorway additional 20 RSU have bene installed

Along the CAV A4 motorway additional 25 RSU have bene installed and the system has been tested on road with the portable OBU boxes used on the cars connected by wifi with the associate android tablets with HMI application.

In the 4 test's area of the city of Roma, 15 RSU have been installed to cover of 20 signalized intersection and 3 OBU have been used.

Along the Autovie Venete/ Autostrade Alto Adriatico A4 motorway 20 RSU have bene installed.

Installed RSUs and OBUs

In the three mentioned C-Roads Italy actions 206 RSUs and 24 OBUs have been installed.




14. The Dutch Pilot site (2016-2019)

The Dutch pilot area is situated in the south of the Netherlands. The area consists of the TEN-T Core Network road section from Europoort Rotterdam to the Belgian border, A15 A16 and the motorway section from the Belgian border via Eindhoven to Venlo, A67. To connect these two Core network sections and have a meaningful ongoing corridor to roll out the proposed services, the road section Breda to Eindhoven (A58, A2) of the comprehensive network, has been added because of the major C-ITS developments which take place there. Next to that also the Core network section on the A2 around the Leidsche Rijn Tunnel was added. The total network stretches across 268km of which 60km or 22% are comprehensive network.

Next to these road sections the port of Rotterdam, industrial and logistic area makes part of the Dutch corridor. Also the Moerdijk industrial area and the Venlo Trade Port are included. Both Rotterdam and Moerdijk are seaports on the core network. Venlo Trade Port is a multimodal platform on the CEF Corridor North Sea Mediterranean. To strengthen the corridor A58 and A67 in the Province of Noord Brabant, budgets have been allocated for innovative solutions. To improve the accessibility of the region "Smart Mobility" solutions were piloted and implemented. Combining the Brabant Corridor initiatives with the services proposed within the InterCor project, the region benefits even more.

Involved partners

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

Location

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







Figure 25: Location of the Dutch pilot site

Final status

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

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

Data from the PVD service have been collected during all naturalistic and controlled driving in the InterCor pilot. For this service, Rijkswaterstaat has commissioned TNO to organize a





dedicated workshop with representatives from road authorities, service providers and the automotive sector. This workshop focused on the value of the data from the PVD service, its impact on the respective organisations, the challenges and solutions. The outcome of the discussions has been reported in InterCor deliverable M13 on evaluation.

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

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

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

In general terms The Netherlands is working on three use cases:

- Road Works Warning (RWW)
- Emergency or Priority Vehicle Approaching (EPVA)
- Emergency or Rescue Vehicle in Intervention (ERVI)

Installed RSUs and OBUs

19 RSUs have been installed so far for testing purposes only. Up to summer 2024 over 200 RSUs will be updated and C-ITS ready but there are no plans for the near future to install C-ITS services on the RSUs. There are no OBUs in use.





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. NordicWay 3 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 <u>www.nordicway.net</u> webpage.

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 NordicWay 3:

C-ITS Day-1 services:

- Connected Traffic Signals including:
 - o Green Light Optimal Speed Advisory (GLOSA)
 - Signal Phase and Timing Information (SI-SPTI)
- Roads works warning.

C-ITS Day-1.5 services:

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





Involved partners

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

- Combitech
- Aventi
- Bouvet
- Q-Free
- Vianova
- BM systems

- SINTEF
- City of Oslo
- Audi
- BMW
- Ramudden
- Ramudden
- Volvo Car Corporation
- Polestar
- FourC
- COWI
- Metsa
- Metsa

Location

Norway has the following pilot sites:

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

Overview of progress by end of 2023

The above-described pilots were completed by the end of 2023.

The RWW services will be further deployed in 2024, with the goal of a coverage of about 40% of main roads.

Installed RSUs and OBUs

No RSUs have been installed.

For deployment of the RWW Mesta uses a mobile application as OBU. Each maintenance vehicle is equipped with this application.





16. The Portuguese Pilot site

C-Roads Phase 1 (2017-2021)

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

Combined with the testbed pilot cases, the project will also develop a study aiming for the National large-scale deployment of C-ITS services, notably Day-1 services and, selected, Day-1.5.

Involved Partners

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

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



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

Location

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



Figure 26: Location of the Portuguese pilot site 1 - 3







Figure 27: Location of the Portuguese pilot site 4 - 5



Final status

The five planned pilots have been successfully deployed.

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

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

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

C-Roads Phase 2 – Cooperative Streets

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

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

Harmonisation includes, amongst other, the following critical aspects:

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







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

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

Pilot "Extended Multimodal National Access Point (NAP)"

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

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

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

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

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

Pilot "From C-Roads to Cooperative Streets"

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





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

Main objectives:

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

Pilot "Cooperative Streets"

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

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

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

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

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

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

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

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





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

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

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

Pilot "MMTIS"

MMTIS solution with the inclusion of real-time dynamic information, enabling public transport users to make more sustainable travel options according to their preferences (duration, number of transhipments, CO₂ emission ...).

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

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

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

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

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

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

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





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

Pilot "Urban testbed - Zone to free test technology"

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

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

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

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

Involved partners

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

- Área Metropolitana do Porto
- Associação Porto Digital
- A-to-Be, S.A.
- BGI Brisa Gestão de Infraestruturas
- Brisa Concessão Rodoviária, SA (BCR)
- Câmara Municipal de Cascais
- Câmara Municipal de Gondomar
- Câmara Municipal de Lisboa
- Câmara Municipal de Loulé
- Câmara Municipal de Matosinhos
- Câmara Municipal de Santo Tirso
- Câmara Municipal de Valongo
- Câmara Municipal de Vila Nova de Gaia

- GMVIS Skysoft, S.A..
- Infraestruturas de Portugal, I.P.
- Instituto da Mobilidade e dos Transportes, I.P. (IMT, I.P.)
- IP Telecom. Serviços de Telecomunicações, S.A.
- ISEL Instituto Superior de Engenharia de Lisboa
- Município da Trofa
- Município de Lousada
- Quadrilátero Associação de Municípios de Fins Específicos Quadrilátero Urbano





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



Figure 28: Pilots in Portugal

Overview of progress by end of 2023

By the end of 2023, most of deployments planned were launched and significant recoveries were possible, reabsorbing some of the delays that happened due to public tendering difficulties.



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Location



Given the complexity of the Action, and the associated complexity in the preparation of procurement procedures, many tenders were only launched in 2022/2023 and deployment was finally possible.

In 2023, IMT continued to enhance contact with multimodal data owners to improve data uploads to the National Access Point (NAP). Several meetings were held with public transport authorities to train NAP users and expand data coverage. Significant updates include the publication of public transport data from major Portuguese cities and advancements in STePP, the national public transport database.

Activity 4 aims to test C-ITS services in several urban areas in Portugal, namely in the fields of MaaS platform, shared mobility, parking management, traffic management and on-demand transport, among others. The main activities included:

- Continued technical support and knowledge transfer to project partners regarding security-specific subjects and issues related to C-ITS.
- Further development and laboratory testing to facilitate the production release of public PKI web services.
- Preparing infrastructure and developing a variant of public PKI web services to cover the latest ETSI standards and efforts to comply with EU CCMS (Common Criteria for Information Technology Security Evaluation) Level 1 requirements.

While activities generally proceeded according to the grant agreement, the development and testing of the production release of the first-generation PKI web services proved more challenges than initially anticipated. Plans are underway to enhance capacity, optimize development and testing efficiency, and mitigate the aforementioned risks.

The Implementing Bodies have focused on decision-making regarding the design and technical specifications of equipment and the implementation of awarded procedures for project implementations.

With the publication of the Ordinance N^o 165/2023 (21 June 223), the formalisation of the ZLT was finished. Some tests have already been concluded associated with small, low emission and connected vehicles (4-wheels and 2 wheels), connectivity devices and data platforms. The ZLT has integrated the Testbed 5G and Digital Transformation, led by NOS Comunicações, as an experimentation zone to test products and services enabled by 5G connectivity.

Project management, harmonization, and communication tasks have been actively carried out throughout 2023, encompassing the drafting and gathering of overdue documents and procedures. All milestone reports have been brought up to date. In spite of the one-year extension granted by the GA amendment, there have been no adjustments to the total eligible costs (both overall and for planned activities).

Installed RSUs and OBUs

132 RSUs have been installed so far. The exact number of OBUs is unknown.



17. The Slovenian Pilot site

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

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

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

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

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

Involved partners

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

Location

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







Figure 29: Coverage of ITS-G5 implementation



Figure 30: Coverage of mobile application Promet+ services





Overview of progress by end of 2022

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

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

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

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

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

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





Installed RSUs and OBUs

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





18. The Spanish pilot site

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

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

Involved partners

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

- Public authorities:
 - o 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)
 - o Indra Sistemas S.A. (Indra)
 - o Grupo Mecánica del Vuelo Sistemas S.A.U. (GMV Sistemas)
 - Opus Remote Sensing Europe (OPUS RSE)
 - o Gertek Sociedad de Gestiones y Servicios S.A. (Gertek)
 - o ICEACSA Consultores, S.L.U.
 - o Ingartek Consulting, S.L.
 - Abertis Autopistas España S.A.
 - o Automóvil Club Asistencia S.A. (ACASA)
 - Ferrovial Corporación S.A.
 - Kapsch TrafficCom Transportation S.A.U.
- Universities:
 - o 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)
 - o Asociación Centro Tecnológico Ceit-IK4
- Regional authorities:
 - o Council of Vigo city
 - o Diputación Foral de Bizkaia Bizkaiko Foru Aldundia

Location

The five Spanish pilots are the following:

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



Figure 31: Location of the Spanish pilot site





Final status by end of 2021

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

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

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

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

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

The **Mediterranean pilot** of C-Roads Spain was composed of two road sections located in Catalonia near the city of Girona with 35 km of AP7 highway and 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	 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	 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	 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	 Stationary vehicle (Catalonia, Andalusia) Shockwave Damping (Catalonia) Traffic Jam Ahead (Andalusia) Road works warning (Catalonia, Andalusia) Weather conditions (Catalonia, Andalusia) Probe vehicle data (Catalonia, Andalusia) 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 3: Summary Cooperative Services implemented in each pilot

Installed RSUs and OBUs

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



19. The Swedish Pilot site

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

NordicWay 3 project (2019-2023):

- Demonstrates as a large-scale pilot the feasibility of Day-1 and Day-1.5 services using hybrid communication solutions, which are fully based on European and global standards. NordicWay 3 will deploy coordinated pilots on Cooperative, Connected and Automated Mobility in urban areas, interfaces between urban and interurban areas and motorway sections.
- Contributes 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 <u>www.nordicway.net</u> webpage.

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

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

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

In C-Roads terms it is the following services.

- 1. Display warning sign or speed "limit" in vehicle, IVI-TS (In Vehicle Information Traffic Sign),
- 2. Display Variable Message Sign and Free Text in-Vehicle, IVS-FT (In Vehicle Signage Free text)
- 3. Send event notification from Road Authority to vehicle, IVS-HLN (In Vehicle S Hazardous Location Notification)





- 4. Send traffic data from Vehicle to Road/Transport Authority, PVD-VDC, (Probe Vehicle Data Collection)
- 5. Transferring flow and speed data from the Motorway Control System to vehicle industry

Involved partners

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

- SOS Alarm
- Carmenta AB
- Monotch
- Scania CV AB
- Volvo Car Corporation
- VTI
- ACTIA
- Knowit
- FourC
- City of Stockholm

- Region Stockholm
- Ciy 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.

NordicWay 3 has the following pilot sites:

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

Overview of progress by end of 2023

The above-described pilots were completed by the end of 2023. No permanent deployments were done as part of the pilots.





Installed RSUs and OBUs

No RSUs have been installed. OBUs have been used throughout the pilots, but none are permanently installed after the end of the NordicWay 3 project.





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





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Figure 32: Location of the UK pilot site (Phases 1 & 1a deployed)





Final status

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

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

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

Installed RSUs and OBUs

33 RSUs have been installed so far. The OBUs were rented for the period of the pilot and afterwards handed back to the supplier, so none are currently deployed.





21. Summary

Based on the C-Roads technical specifications, developed from 2017 on, harmonised with the technical specifications of the Car-2-Car Communication Consortium, and regularly updated, C-ITS deployments are undertaken all across Europe. Hereby, aside direct communication via ITS-G5, "Day One C-ITS services" are also transferred via IP-based networks and therefore qualify as fully hybrid C-ITS solution. Very active participation and information sharing of many C-Roads partners to prepare public procurement tenders for single deployments also in cities, but as well for the integration of C-ITS system elements into traffic management have been carried out.

To ensure interoperability of C-ITS services in Europe, the basic C-Roads releases have been concluded at the level 2.1.0, in December 2023. This release forms the basis for C-ITS installations along motorways. In addition, more and more cities in the C-Roads Member states continued to implement C-ITS stations at intersections with C-ITS Services and use cases based on the SPAT/MAP message in order to facilitate the priorities for Public Transport fleet vehicles at these intersections and enable the swift passage of emergency service vehicles like ambulances and fire brigades. These use cases have different levels of priorities for the respective city, in the same way that each use case holds benefits that might be more useful/needed for some cities than others.

Additionally, participating cities in C-Roads started to contribute very actively to new C-ITS use cases, involving vulnerable road users (VRUs), like cyclists. Up to now more than 50 cities are part of the C-Roads Platform and have taken part in the roll-out of C-ITS units, where various use cases were covered out of the different C-ITS services.

An overview of C-ITS projects co-funded by the European Union is included in <u>Table 4</u>Table 4.



Title	(Coordinating) applicant	Location	Total eligible costs	Maximum EU Contribution
AUTOCITS: Regulation study for interoperability in the adoption of autonomous driving in urban nodes	Indra Sistemas S.A	EU	€ 2 606 550,00	€ 1 303 275,00
C-ITS for Trucks (CITRUS)	Be-Mobile NV	BE	€ 1 822 745,00	€ 911 373,00
CONCORDA	ERTICO - ITS Europe (BE)	BE, DE, FR, GR, ES, FR, IT, NL	€ 20 000 000,00	€ 10 000 000,00
Cooperative Streets	Ministério do Planeamento e das Infraestruturas	PT	€ 31 410 086,00	€ 15 705 043,00
C-Roads 2 Hungary	Ministry for Innovation and Technology	HU	€ 2 016 187,00	€ 1 008 094,00
C-Roads ANT-HEL	Tractebel Engineering	BE	€ 2 349 568,00	€ 1 174 784,00
C-Roads Austria	Bundesministerium fur Verkehr, Innovation und Technologie	AT	€ 19 100 000,00	€ 9 550 000,00
C-Roads Austria 2	Bundesministerium für Verkehr, Innovation und Technologie	AT	€ 14 710 000,00	€ 7 355 000,00
C-Roads Austria 3	AustriaTech	AT	€ 12 924 968,00	€ 6 462 484,00
C-Roads Belgium/Flanders	Flemish Department of Mobility and Public Works (MOW)	BE	€ 3 176 500,00	€ 1 588 250,00
C-Roads Belgium/Wallonia	Société wallonne de Financement Complémentaire des infrastructures (SOFICO)	BE	€ 4 329 000,00	€ 2 164 500,00
C-Roads Czech Republic	Ceska Republika - Ministerstvo dopravy	CZ	€ 18 926 791,00	€ 16 087 775,00
C-Roads France	Ministère de l'Ecologie, du Développement durable et de l'Energie (MEDDE)	FR	€ 14 413 213,00	€ 7 206 615,00
C-Roads Germany – Urban Nodes	ITS mobility GmbH	DE	€ 39 355 618,00	€ 19 677 809,00
C-ROADS Greece	Ministry of infrastructure and transport (MIT)	GR	€ 2 569 300,00	€ 1 284 650,00
C-ROADS Hungary	Ministry of National Development	HU	€ 1 995 431,00	€ 1 696 116,00
C-Roads Ireland	Department of Transport, Tourism and Sport	IE	€ 10 161 141,00	€ 5 080 571,00
C-ROADS ITALY	Ministero delle Infrastrutture e dei Trasporti - Direzione generale per lo sviluppo del territorio, la programmazione e i progetti internazionali	IT	€ 20 864 000,00	€ 10 432 000,00
C-ROADS Italy 2	Ministero delle Infrastrutture e dei Trasporti - Direzione generale per lo sviluppo del territorio, la programmazione e i progetti internazionali	IT	€ 13 740 000,00	€ 6 870 000,00
C-ROADS ITALY 3	Ministero delle Infrastrutture e dei Trasporti - Direzione generale per lo sviluppo del territorio, la programmazione e i progetti internazionali	IT	€ 6 005 000,00	€ 1 201 000,00
C-ROADS Portugal	Ministério do Planeamento e das Infraestruturas	PT	€ 8 354 796,00	€ 4 177 398,00
C-Roads Slovenia	Republic of Slovenia, Ministry of Infrastructure	SI	€ 2 314 000,00	€ 1 157 000,00
C-Roads Slovenia 2	Republika Slovenija, Ministrstvo za infrastrukturo (Republic of Slovenia, Ministry of Infrastructure)	SI	€ 3 100 000,00	€ 1 550 000,00
C-Roads Spain	DIRECCION GENERAL DE TRAFICO MINISTRY OF INTERIOR	ES	€ 17 979 954,00	€ 8 989 977,00
C-Roads-Germany	ITS automotive nord GmbH	DE	€ 9 930 884,00	€ 4 965 442,00
InDiD	Ministère de la Transition Ecologique et Solidaire	FR	€ 21 533 414,00	€ 10 766 707,00
InterCor	ERTICO - ITS Europe	EU	€ 29 999 999,00	€ 15 000 000,00
MATIS	ASFA	FR	€ 124 000 000,00	€ 62 000 000,00
Meridian	Bundesministerium für Digitales und Verkehr	DE	€ 131 477 544,00	€ 65 738 772,00
Mobilidata	Agentschap Wegen en Verkeer (Flemish Government)	BE	€ 5 190 429,00	€ 1 038 086,00
NordicWay	Republic of Finland, Ministry of Transport and Communications	FI	€ 5 200 000,00	€ 2 600 000,00
NordicWay 2	Statens Vegvesen (NO)	DE, FI, NO, SE	€ 18 943 000,00	€ 9 471 500,00
NordicWay 3 - Urban Connection	Trafikverket (Swedish Transport Administration)	DE, FI, NO, SE	€ 19 030 000,00	€ 9 515 000,00
SCOOP@F Part 2	Ministère de l'écologie, du développement durable et de l'énergie (MEDDE)	FR	€ 20 036 598,00	€ 10 018 299,00
SOLRED C-ITS Monitoring Network (SolC-ITS)	SOLRED, S.A.	ES	€ 1 811 000,00	€ 905 500,00
URSA MAJOR neo	Bundesministerium für Verkehr und digitale Infrastruktur (DE)	DE, IT, NL	€ 149 461 712,00	€ 32 129 388,00
X4ITS	AustriaTech	AT	€ 64 786 742,00	€ 32 393 371,00
		Total	€ 875 626 170,00	€ 399 175 779,00

Table 4: C-ITS projects co-funded by the European Union



C C-ROADS

Maximum EU Contribution	EU contribution in %		
€ 1 303 275,00	50,00		
€ 911 373,00	50,00		
€ 10 000 000,00	50,00		
€ 15 705 043,00	50,00		
€ 1 008 094,00	50,00		
€ 1 174 784,00	50,00		
€ 9 550 000,00	50,00		
€ 7 355 000,00	50,00		
€ 6 462 484,00	50,00		
€ 1 588 250,00	50,00		
€ 2 164 500,00	50,00		
€ 16 087 775,00	85,00		
€ 7 206 615,00	50,00		
€ 19 677 809,00	50,00		
€ 1 284 650,00	50,00		
€ 1 696 116,00	85,00		
€ 5 080 571,00	50,00		
€ 10 432 000,00	50,00		
€ 6 870 000,00	50,00		
€ 1 201 000,00	20,00		
€ 4 177 398,00	50,00		
€ 1 157 000,00	50,00		
€ 1 550 000,00	50,00		
€ 8 989 977,00	50,00		
€ 4 965 442,00	50,00		
€ 10 766 707,00	50,00		
€ 15 000 000,00	50,00		
€ 62 000 000,00	50,00		
€ 65 738 772,00	50,00		
€ 1 038 086,00	20,00		
€ 2 600 000,00	50,00		
€ 9 471 500,00	50,00		
€ 9 515 000,00	50,00		
€ 10 018 299,00	50,00		
€ 905 500,00	50,00		
€ 32 129 388,00	21,50		
€ 32 393 371,00	50,00		
399 175 779 00			