

C-MobILE

Accelerating C-ITS Mobility Innovation and deployment in Europe

D4.3: Training material on C-ITS for public authorities

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Abbreviations

Abbreviation	Definition
ACC	Adaptive Cruise Control
BSD	Blind Spot Detection/ Warning (VRUs)
BSW	Blind Spot Warning
CACC	Cooperative (Adaptive) Cruise Control (Urban ACC)
C-ITS	Cooperative Intelligent Transport Systems
CTLP	Cooperative Traffic Light for Pedestrian
DS	Deployment Site
DSRC	Dedicated Short-Range Communications
EBL	Emergency Brake Light
EC	European Commission
EU	European Union
EVW	Emergency Vehicle Warning
FI	Flexible Infrastructure (HOV, peak-hour lanes)
GDPR	General Data Protection Regulation
GLOSA	Green Light Optimal Speed Advisory
GP	Green Priority
HMI	Human Machine Interface
HOV	High Occupancy Vehicle
ITS	Intelligent Transport Systems
ITS-G5	Access technology to be used in frequency bands dedicated for European Intelligent Transport Systems (ITS)
IVS	In-Vehicle Signage
IVSL	In-Vehicle (dynamic) Speed Limits
LCW	Land Change Warning
MaaS	Mobility as a Service
Mai	Motorcycle Approaching Indication
MTTA	Mode & Trip Time Advice
O&M	Operation & Maintenance
OBU	On-Board Unit
PND	Personal Navigation Device
PVD	Probe Vehicle Data
RHW	Road Hazard Warning
RSE	Roadside Equipment
RSU	Roadside Unit
RTM	Rest Time Management
RWW	Road Works Warning
SPE	SpeedAlert
SSVW	Slow or Stationary Vehicle Warning
SVW	Signal Violation Warning
TLC	Traffic Light Controller
TMC	Traffic Management Centre
UPA	Urban Parking Availability
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VMS	Variable Message Sign
VRU	Vulnerable Road User
WP	Work Package
WSP	Warning System for Pedestrian
Q&A	Questions and Answers

Executive Summary

In the past years, there has been tremendous progress in the field of intelligent transport systems; Cooperative Intelligent Transport Systems have proven their potential benefits for mobility by increasing both energy efficiency and road safety for specific transport modes. However, the large variety of cooperative applications have been designed for different goals, stakeholders or specific settings / environments and have been developed on a silo-based approach and deployed independently from each other, serving however, at higher level, similar goals and functionalities for the end-user. Scalability, IT-security, decentralization and operator openness are some of the most important properties that a technical and commercial successful solution must provide.

C-MoBILE aims to stimulate / push existing and new pilot sites towards large-scale, real-life C-ITS deployments interoperable across Europe. Well-defined operational procedures will lead to decentralized and dynamic coupling of systems, services and stakeholders across national and organizational borders in an open, but secure C-ITS ecosystem, based on different access technologies, the usage of which is transparent for service providers and seamless and continuous for the end-users across different transport modes, environments and countries.

The main scope of this document is to report on the training activities of the C-MoBILE project, executed near the completion of the project. Within the context of Deliverable 4.3: Training material on C-ITS for public authorities, the training approach adopted within the C-MoBILE project is presented and analysed. This training approach is comprised of three phases. The first phase is focused on the transfusion to the trainers (a role to be executed by consortium's members being the Deployment Site leaders) of the necessary skills to handle the varying needs and purposes of the C-MoBILE training activities but also with a reference training material. The second phase involves the execution of training activities by the said trainers dedicated to the various actors representing public authorities involved in the ecosystem of Deployment Sites. This training aims to provide to these actors the necessary knowledge, skills, and technical competence to effectively utilize the C-ITS services designed and developed during the course of the project, including their associated (mobile) applications. Further to this, the training corresponding to the second phase is oriented towards the further exploitation of C-ITS services and their integration in the current practice of Traffic Management. Building on the first training phase and on feedback reports from the local trainings performed during the second phase, the third phase involves the execution of training activities beyond the boundaries of the project as a means of promoting the further uptake of its outcomes and providing replication capabilities to cities/ regions outside the C-MoBILE consortium. This is meant as part of the wide-scale deployment strategy of the C-MoBILE project.

Subsequently, the training material drafted for the needs of the event corresponding to the first training phase, the so-called "Train the Trainer" phase is presented in detail. Said material is of particular importance taking into account that it constitutes a reference for the creation of the material of the training activities required for the execution of the events corresponding to the second and the third training phases (i.e. local trainings within the C-MoBILE Deployment Sites and training for external cities/ regions). To this end, a discrete chapter of this report is dedicated to the presentation of said material. This chapter is structured around the three main contents of the training material corresponding to the first phase, namely "Concepts and preparation for a C-ITS training and education plan", "Building training skills - Part I", and "Building training skills - Part II". The first part provides an overview of the roles of the actors involved in the ecosystem of the C-MoBILE Deployment Sites, the various existing training needs, and practical recommendations towards an effective training derived from pedagogical-related literature. The second part is focused on: a) the presentation of specific concepts related to C-ITS and connected vehicle technologies, b) the analysis of the C-MoBILE architecture along with specific communication technologies and requirements resulting from the GDPR, and c) the detailed presentation of the C-ITS services and the associated (mobile) applications designed and developed during the course of the project. Similarly, the third part is focused on: a) the presentation of specific concepts related to Traffic Management, b) the analysis of the way that the field of traffic management has been reshaped by the emergence of new technological capabilities, such V2I and V2V communication, c) the analysis of required skills that public authorities should cultivate, in order to fully exploit the capabilities of C-ITS, d) the detailed explanation of the C-MoBILE proposal on the way that C-ITS services can be linked with Traffic Management and traffic control strategies, and e) an outlook in the future of Traffic Management.

This deliverable ends up with a reporting on the training events held for each of phase of the C-MoBILE training approach. Specifically, it reports on the event held in the 5th General Assembly in Vigo corresponding to the first training phase. Further to this, it reports on the events that have taken place in each Deployment Site (DS) of the C-MoBILE project (Barcelona DS, Bilbao DS, Bordeaux DS, Copenhagen DS, Newcastle DS, North Brabant DS, Thessaloniki DS, and Vigo DS). It should be noted that while some of the events corresponding to the second phase were initially planned to be face-to-face meetings, the COVID-19 outbreak along with the resulting restrictive measures rendered this endeavour impossible. To this end, several of the events were rescheduled and took the form of online webinars. For the same reason the execution of the event corresponding to the third phase of the C-MoBILE training approach is currently pending and it is most likely to take place at the end of June 2020 as an online event. The reporting on the aforementioned events includes a brief analysis of their agenda, their targeted audience, their specific objectives, and results derived either from any existing interactive sessions, evaluations, and open discussions.

Annex 1 of the current deliverable includes the original material drafted for the event corresponding to the first training phase, Annex 2 includes the material drafted for each Deployment Site training, and an Annex 3 will be added after the completion of the third phase of the training including the respective material.

All in all, taking jointly into account the acquired feedback of the events that have taken place, it is deemed that the objectives of the C-MoBLE training strategy have been fully accomplished.

1. Introduction

1.1. C-MobILE at a glance

The C-MobILE (Accelerating C-ITS Mobility Innovation and depLoyment in Europe) vision is a fully safe & efficient road transport without casualties and serious injuries on European roads, in particular in complex urban areas and for Vulnerable Road Users. We envision a congestion-free, sustainable and economically viable mobility, minimizing the environmental impact of road transport. C-MobILE will set the basis for large scale deployment in Europe, elevating research pilot sites to deployment locations of sustainable services that are supported by local authorities, using a common approach that ensures interoperability and seamless availability of services towards acceptable end user cost and positive business case for parties in the supply chain.

1.2. Objective

C-MobILE aims to stimulate/push existing and new pilot sites towards large-scale, real-life C-ITS deployments interoperable across Europe. Well-defined operational procedures will lead to decentralized and dynamic coupling of systems, services and stakeholders across national and organizational borders in an open, but secure C-ITS ecosystem, based on different access technologies, the usage of which is transparent for service providers and seamless and continuous for the end-users across different transport modes, environments and countries.

The main scope of this document is: a) to describe the training approach adopted within the context of the C-MobILE project, including its various phases, b) to provide a detailed overview of the training material drafted for the first phase, which was oriented to navigate the remaining ones, and c) to report on the various training activities that have taken place.

1.3. Intended audience

The audience of this deliverable is key personnel from the Public Authorities involved in the deployment and operation of the C-MobILE systems and services in each of the Deployment Sites (i.e. representatives, TMC and technical staff, as well as management staff) with the aim of raising their level of awareness regarding the achievements of the project and transfusing to them new knowledge and the necessary skills to exploit such achievements in the future. Besides, this deliverable is also written for project-external stakeholders, such as public authorities and representatives beyond the C-MobILE consortium, with the aim of increasing: a) the level of awareness beyond the boundaries of the project and b) the replication possibilities of the project achievements and outputs.

1.4. Approach

Deliverable 4.3: Training material on C-ITS for public authorities, included in WP4 (Enablers for large-scale deployment) and associated with Task 4.2 (Replication capabilities for cities), contributes to the fulfilment of the C-MobILE objective 6 of the Grant Agreement and listed below. WP4's successful achievements will be measured by different means, i.e. the publication of corresponding deliverables.

- ✓ Objective 6: Define an operational process for large-scale deployment of sustainable C-ITS services in Europe.
- Lead the work towards coordinated large-scale deployment of sustainable and operational C-ITS, integrating current and future European, national and local implementations of cooperative mobility. Support further uptake of cooperative services for additional European C-ITS deployments by defining the path from pilot to operational deployment in complex urban areas with detailed deployment strategies, specifications of open interfaces and operational step-by-step process validated by all the stakeholders in the value chain.

Deliverable 4.3 contains the description and the material of the training activities that apart from their native purpose, i.e. the transfusion of new knowledge and the necessary skills to key personnel of public authorities, are also oriented to support the further uptake of the C-MobILE project's C-ITS services across Europe and their actual exploitation to address traffic and safety related issues in complex urban environments.

1.5. Document structure

The current deliverable presents the C-MobILE training activities and material. In order to facilitate the common understanding among all project's partners regarding their content and rationale, as well as their exploitation possibility, the concrete chapters around which is structured along with a high-level description of their content are listed below:

- ✓ Chapter 1 "Introduction" provides the rationale and context of the C-MobILE project.

- / Chapter 2 “Training approach” presents the rationale of the C-MOBILE training activities and their breakdown into three discrete phases along with their purpose.
- / Chapter 3 “Training material” provides an overview of the training material drafted for the first phase of the C-MOBILE training activities, which was oriented to navigate the remaining two phases.
- / Chapter 4 “Training events” reports on the various training activities that have taken place in the context of the C-MOBILE project along with their outcomes.
- / Chapter 5 “Conclusions” summarizes the conclusions derived from the C-MOBILE training activities and provides specific recommendations.

2. Training approach

2.1. Introduction

Task 4.2, titled “Replication capabilities for cities”, deals, inter alia, with the preparation and execution of training programs targeting key personnel in public authorities, in order to raise knowledge and understanding, and to create the necessary skills. Further to this, another purpose of Task 4.2 is to increase the replication capabilities in cities, external to ones participating in the C-MobILE, i.e. the Deployment Sites.

The Deployment Sites of C-MobILE are characterized by several goals and their ecosystem encloses various stakeholder types, each of whom serve one (or more) specific role(s). For instance, within the ecosystem of a Deployment Site the following types of stakeholders can be discerned: a) TMC operators, b) staff providing support to technical issues, c) maintenance supervisors, d) equipped drivers, and e) fleet managers. The first three types can be broadly categorized as public authorities and together with the equipped drivers are directly involved in the operation and exploitation of the C-MobILE services. Thus, these types of stakeholders should be provided with specific instructions. On the other end, fleet managers are less directly involved in the operation of the C-MobILE services but they do require to participate in the project’s training activities and to be kept informed as a means of enabling a broad awareness raising strategy and rendering them capable of capitalizing on the outcomes of the project and identifying new business opportunities. Therefore, it becomes evident that before the initiation of the C-MobILE training activities, a stakeholder profiling is necessary in order to design the training material and activities in a manner that will serve varying purposes and needs.

Given the above-described ambition of the C-MobILE training activities, it is deemed appropriate to adopt a three-phase approach (Figure 1). The first phase corresponds to a “Train the Trainer” session prepared and executed by CERTH. This session is oriented to equip the trainers (a role to be executed by consortium’s members being Deployment Site leaders) with the necessary skills to handle the varying needs and purposes of the C-MobILE training activities but also with a reference training material. The second phase involves the execution of training activities dedicated to representatives located in project-internal cities that encompass the previously discussed roles. The third phase involves the execution of training activities beyond the boundaries of the project as a means of promoting the further uptake of its outcomes and providing replication capabilities to cities/ regions outside the C-MobILE consortium. Section 2.2 provides more details regarding the three layers of the C-MobILE training activities.

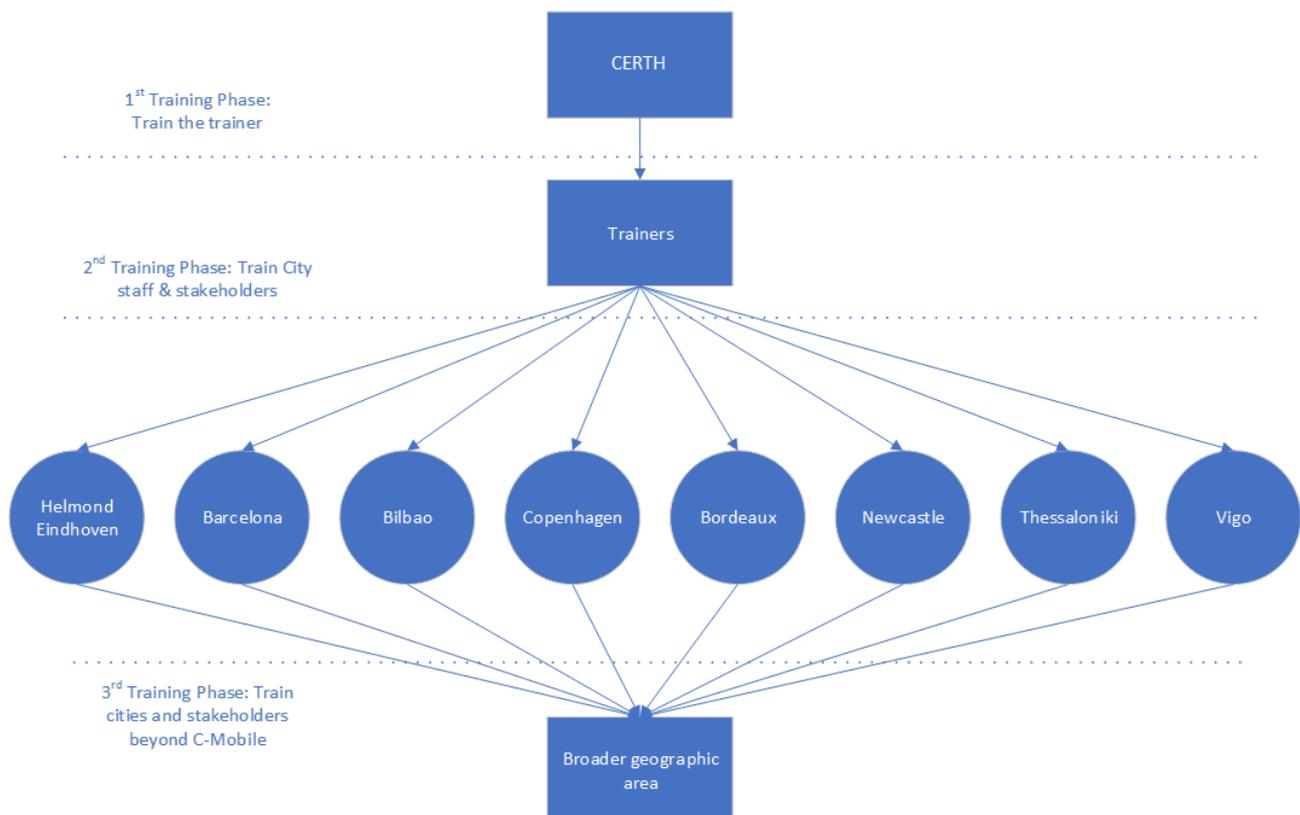


Figure 1: The three layers of the C-MobILE training approach.

2.2. Training layers

The training activities initiate with the “Train the Trainer” session, i.e. the 1st training layer depicted in Figure 1, prepared and executed by CERTH. During this session CERTH is responsible for training the trainers, who are

considered to be consortium members participating at Task 4.2, i.e. public authorities' representatives and the leaders of the eight C-MoBiLE DSs. This first phase of training is executed at an initial phase of the large-scale deployment in order to make it possible for participants to create the necessary skills to operate the C-ITS services deployed in their cities. The training material of this session is based on a wide range of sources, including international on-line literature sources by utilizing case specific keywords (e.g. training methods, connected vehicles, traffic management and others), the existing documentation of the C-MoBiLE project, relative courses and publications of the U.S. Department of Transportation, and the Topic Studies of the CAPITAL project, in order to cover as many knowledge gaps as possible.

The next training layer, i.e. the 2nd training layer depicted in Figure 1, takes place within the project-internal cities. During this second phase, the participants of the first phase, i.e. the trainers, inform and train other key personnel of the C-MoBiLE cities on C-ITS services and their deployment, integration and operation. The training material of the activities corresponding to this layer is based on the training material of the first phase, adapted according to additional and specific needs of the various C-MoBiLE Deployment Sites. Feedback from this second training phase is gathered by CERTH to update and enhance the reference training material developed for the first phase.

The last training layer, i.e. the 3rd training layer depicted in Figure 1, suggests that CERTH inform and train authorities in a wider city/country level. Such external authorities originate from the broader geographical area of each C-MoBiLE city or even neighbouring countries. This training layer focuses on the possibility of deploying and replicating the C-MoBiLE achievements and outcomes in other cities and regions. The training material of the activities corresponding to this layer builds upon the feedback received by the relevant activities that has taken place in the eight C-MoBiLE DSs (2nd training layer). Such feedback encompasses lessons learnt, best practices, investment/business opportunities, and C-ITS services' deployment up-scaling. Participants will be provided with "capacity building certificates".

3. Training material

The scope of this section is to provide an overview of the material drafted for the first layer of the training activities, the so-called “Train the Trainer” session. Said material is of particular importance taking into account that it constitutes a reference for the creation of the material of the training activities corresponding to the second and the third layer (i.e. local training within the C-MobILE cities and training in external cities). The material of the “Train the Trainer” session is divided into three modules. The next sections describe in detail the purpose of each module and highlights important parts of the drafted material. The original material is provided in Annex 1.

3.1. Module A: “Concepts and preparation for a C-ITS training and education plan”

3.1.1. Module specific purpose

The first module of the “Train the Trainer” session aims to enhance trainers’ understanding over the goals of the various C-ITS Deployment Sites and the roles of the various actors involved in their ecosystem. Moreover, it aims to provide information to the trainers regarding the training needs of the aforementioned actors depending on their roles. Finally, it aims to cultivate fundamental training-related skills to the trainers as well as to inform them concerning the appropriateness of the various existing training methods to serve specific objectives as well as their strengths and drawbacks.

All in all, it can be deduced that the first module is meant to pave the ground for the C-MobILE training activities and to transfuse to the trainers, i.e. the members of the consortium participating at Task 4.2, the required attitude and training-related skills, in order to accomplish the objectives of the C-MobILE training activities.

3.1.2. Description of the provided material

A first point to highlight in the first module is the determination of the Deployment Site goals. Such goals include: a) the integration of connected vehicle research goals into real-world implementation, b) the large-scale deployment and adoption of C-ITS services by a wide range of end-users, and c) the enhancement of existing operational capabilities to encourage partnerships of multiple stakeholders. Therefore, it becomes apparent that such goals encompass several dimensions ranging from technical to business ones and this should be reflected in the training activities to take place in the context the 2nd and, subsequently, the 3rd training layer.

A second point to highlight in the first module constitutes the identification of the roles of the various actors involved in the ecosystem of the C-MobILE Deployment Sites. These roles, taking into account the recommendations of the U.S. Department of Transport [1], include: a) the TMC operators, b) the technical staff, c) the maintenance supervisors, d) the equipped drivers, and e) the fleet managers. By adopting a broader point of view, these actors can be extended to also include the general public (e.g. travellers and possible end-users in the Deployment Sites), who despite not being directly involved in the deployment phase of C-MobILE services, they may be affected by or interested in their operation.

A third point to highlight in the first module is the determination of the training needs for each of the aforementioned roles. These needs are determined in accordance with the recommendations of the U.S. Department of Transport [2] and summarized in Table 1.

Role	Training needs
TMC operators 	<ul style="list-style-type: none"> / Understand how to interact with new/updated platforms to utilize C-ITS systems/components / Be able to identify and interpret any new information provided through the new/updated platforms / Be able to assess information accuracy/ integrity/ reliability / Be in position to provide limited troubleshooting / Be in position to better understand how to exploit cooperative capabilities of connected vehicles and infrastructure (C-ITS)
Technical staff 	<ul style="list-style-type: none"> / Be able to install and uninstall equipment or software (or requirements thereof) / Learn how to effectively maintain the equipment or software, e.g. scheduled maintenance, emergency repairs / Be in position to provide full troubleshooting support
Maintenance supervisors	<ul style="list-style-type: none"> / Clearly understand C-ITS scope-goals-advances

	<ul style="list-style-type: none"> ✓ Be familiar with maintenance and repair procedures, in order to supervise and assess the performance of related tasks
<p>Equipped drivers</p> 	<ul style="list-style-type: none"> ✓ Become fully familiar with the Human Machine Interface (HMI) of C-ITS services ✓ Be aware of the kind of messages they could receive (i.e. alert, advice) ✓ Be able to interpret correctly the information and react accordingly in a timely manner ✓ Understand how to provide information via the HMI (e.g. report a crash) ✓ Be able to provide feedback regarding the App (e.g. user rating) ✓ Be engaged with feedback provision procedures (e.g. surveys, DS website) ✓ Know with whom to communicate in cases of malfunctions (helpdesk)
<p>Fleet managers</p> 	<ul style="list-style-type: none"> ✓ Have a basic understanding of goals, scope, and advances ✓ Understand the features of provided C-ITS services and the nature of information they enclose ✓ Be aware of new business opportunities
<p>General public</p> 	<ul style="list-style-type: none"> ✓ Have a basic understanding of the C-ITS goals, scope, and advances ✓ Understand the features of provided C-ITS services and the nature of information they enclose ✓ Be aware of the benefits resulting from the use of C-ITS services

Table 1: Training needs of the various actors involved in the ecosystem of C-ITS deployment sites [Adapted from: [2]].

The variability of the needs of the various stakeholders, as Table 1 suggests, validates the assumption that the training activities to take place should be multi-dimensional and comprehensive but also not to be strictly oriented to technical details. To the contrary, they should contain descriptions targeted to stakeholders' increased understanding of the C-ITS services developed during the C-MoBILE project, including the main functionalities of their associated (mobile) applications.

A fourth point to highlight in the first module is the determination of training needs of the trainers. These needs, which are also in line with the recommendation of the U.S. Department of Transport [2], include:

- ✓ The full understanding of the C-ITS goals, scope, and advances
- ✓ The full understanding of the rationale of the overall training plan (including all phases and materials)
- ✓ The enhancement of their capacity towards fulfilling the individual needs of the trainee groups
- ✓ The cultivation of a wide range of new skills and the enhancement of their capacity to play a variety of roles

The first of the aforementioned needs translates to the cultivation of technical competencies to the trainers, while the remaining are mostly related to generic training skills that may apply to any party tasked with accomplishing any training activity.

A fifth point to highlight in the first module is the provision of information to the trainers regarding the various roles they should play during the training events. This information is based on the suggestions of Hyla [3]. According to these suggestions, a trainer should simultaneously be: a) a designer, b) a leader, c) a presenter, d) an expert, e) an organizer, f) a moderator, and g) an ally. More information regarding the nature of each role can be found in Annex 1.

A sixth point to highlight in the first module is the provision of information to the trainers regarding the learning process [4] and the training cycle [5]. According to the principles derived, for instance, from the training cycle, it is important to note that trainers are suggested to undergo a detailed requirement and needs identification analysis before designing their training material but also to evaluate the trainees' level of understanding. Such an approach has been also followed in the event corresponding to the 1st training layer.

A seventh point to highlight in the first module includes the provision of information to the trainers regarding the appropriateness of the various existing training methods to serve different purposes according to the evidence provided by Leigh [6]. This piece of information is summarized in Table 2. For instance, in Table 2 it may be noticed that case studies that may suitably find application in the field of Intelligent Transport Systems constitute an appropriate method to practice trainees' problem-solving capabilities, thus also contributing actively towards the practical exploitation of the developed C-ITS services and their increased acceptance rate. Trainers are also encouraged to utilize games as an appropriate method for the same as the aforementioned purposes. To this end, some case studies were included in the interactive session of the training event corresponding to the 1st training layer, which had the character of the game (see Section 4.1 for details). The promotion of these two purposes is fully in line with the main objectives of the current deliverable.

An eight point to highlight in the first module constitutes the provision of information to the trainers regarding the structure, the advantages and disadvantages of each training method, as well as the appropriate size of trainee audience. This piece of information, which is based on the suggestions provided by Leigh [6], but also validated with the suggestions provided by Lawson [7], is provided to trainers as a means of guiding their approach during the events corresponding to the 2nd training layer.

A last point to highlight in the first module, which is of significant practical utility for the trainers, is the juxtaposition of the well-known Kirkpatrick Model with specific recommendations and tools that facilitate the measurement of the trainees' reaction, level of learning, exploitation capability of the training's content, as well as the training program's overall performance. This piece of information is jointly based on the suggestions provided by the Connecticut Training and Development Network [8] and the California Social Work Education Center [9] and is depicted in Figure 2.

1=High 8 = Low	Knowledge acquisition	Attitude change	Problem solving	Interpersonal skills	Participants' acceptance	Knowledge retention
Case study	4	5	1	5	1	4
Workshop	1	3	4	4	5	2
Lecture	8	7	7	8	7	3
Games	5	4	2	3	2	7
Films	6	6	8	6	4	5
Programmed instruction	3	8	6	7	8	1
Role playing	2	2	3	1	3	6
Sensitivity group	7	1	5	2	6	8

Table 2: Appropriateness of each training method to serve different purposes [Adapted from: [6]].

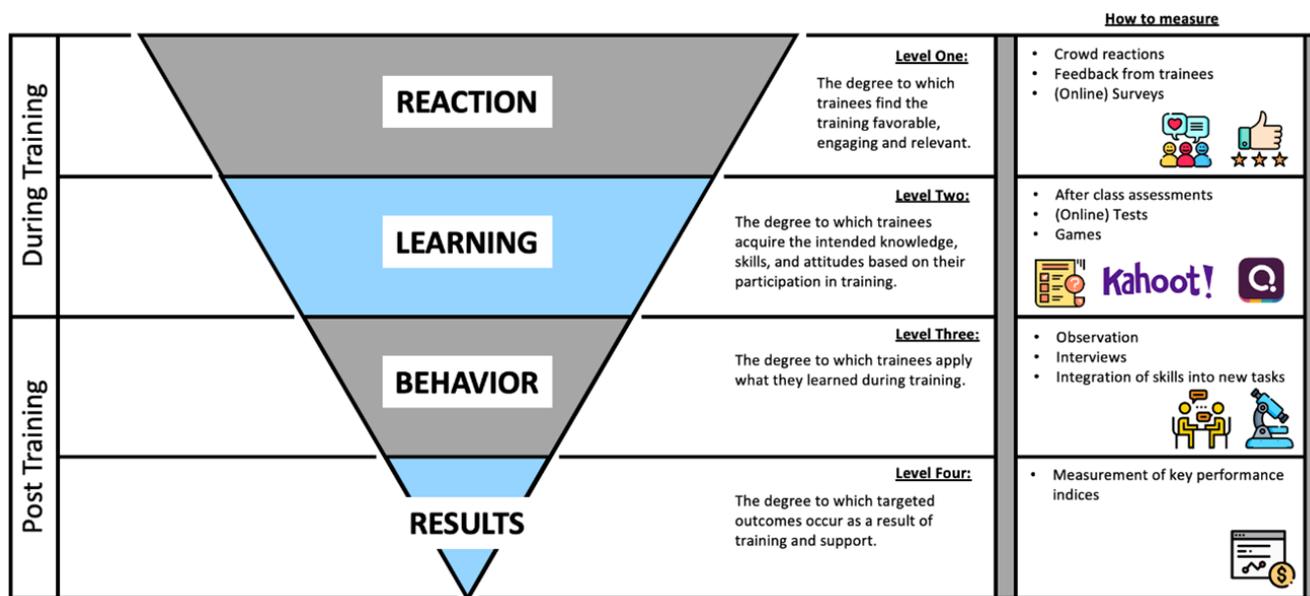


Figure 2: The Kirkpatrick Model accompanied by specific practical recommendations and measuring tools [Adapted from: [8], [9]].

In line with the evidence included in Figure 2, trainers were heavily encouraged to utilize web-based tools for quiz games in the events that were meant to organize, such as Kahoot (kahoot.com). This tool was also utilized during the event corresponding to the “Train the Trainer” phase as a means of rendering trainers familiar with its functionalities (see Section 4.1 for details).

3.2. Module B: “Building Training Skills Part I”

3.2.1. Module specific purpose

The second module of the trainer section aims to enhance trainers' awareness and understanding over: a) the nature of connected vehicle/C-ITS technologies, b) the architecture on which the C-MoBLE C-ITS services are based, c) the means and standards that enable the exchange of information between vehicles (V2V) and vehicle and infrastructure (V2I), or, in more generic terms, between vehicles and anything (V2X), d) some key issues concerning data privacy, e) the content and main benefits of the C-ITS services in general, and f) the specific applications developed in the frame of the C-MoBLE project. Therefore, it can be deduced that this module is heavily oriented to the current practice in the field of connected and cooperative technologies and analyzes the achievements of the C-MoBLE project as a means of enhancing the technical competencies of the trainers and at a later stage of the trainees (i.e. public authorities and other actors involved in the Deployment Sites' ecosystem).

3.2.2. Description of the provided material

A first point to highlight in the second module is the definition of "C-ITS". The provided definitions are those suggested by the European Commission and the European Telecommunications Standards Institute (ETSI) included in a relevant topic study of the CAPITAL project [10]. These definitions are provided to the trainers, in order for them to be able to communicate in a precise manner the scope of the C-ITS services during their training activities. Moreover, trainers are provided with specific application areas of C-ITS included in a schematic representation (see e.g. Figure 3). This piece of information relies on the suggestions of the U.S. Department of Transport [11] and provides a reference point for gaining an initial understanding of the practical utility of C-ITS services.

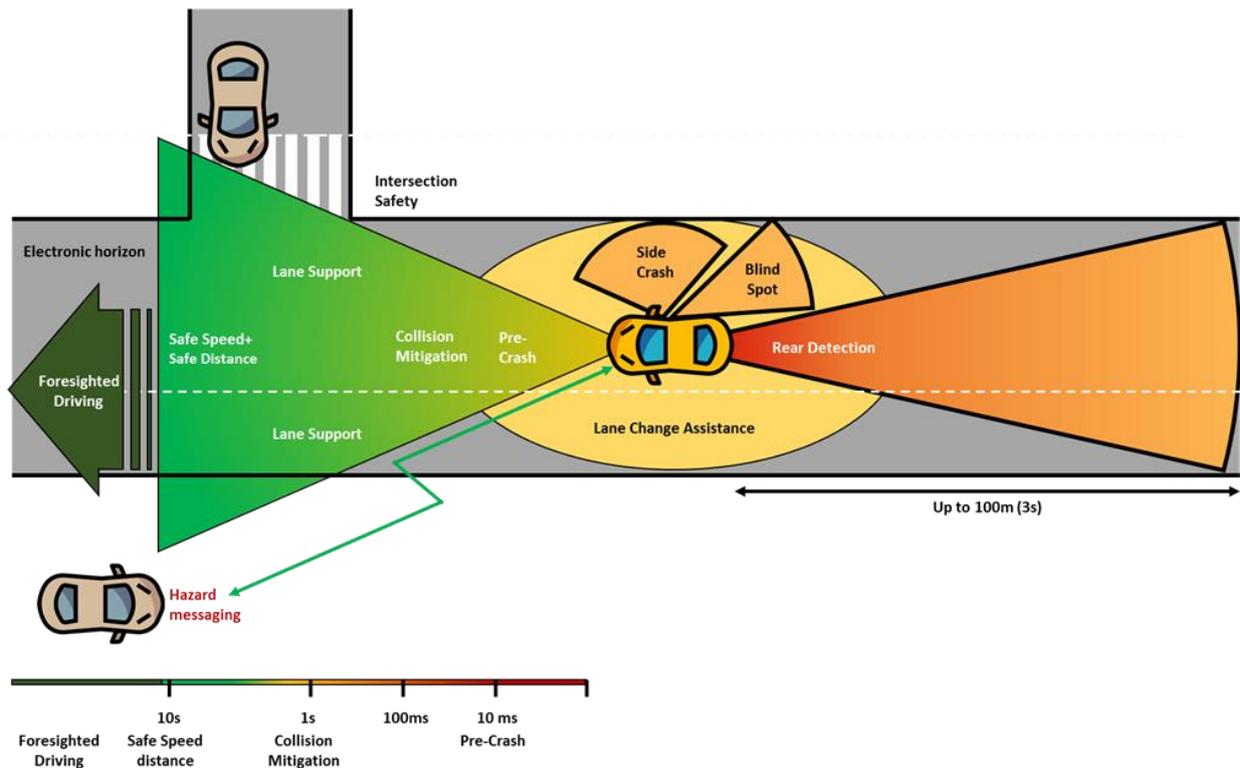


Figure 3: Application areas of C-ITS and connected vehicle technologies [Adapted from: [11]].

A second point to highlight in the second module constitutes the description, based on the C-MoBLE documentation, of the various viewpoints of its architecture, including: a) the Implementation viewpoint, b) the Functional viewpoint, c) the Contextual viewpoint, d) the Physical viewpoint, e) the Information viewpoint, and f) the Communication viewpoint. Implementation viewpoint describes the way upon which the functionality of the provided services is realized into real-life software systems. Functional viewpoint focuses on the data flow interfaces between various blocks, such as the central system orchestrating the provision of services, the roadside equipment, the on-board units, and the back office including information collected from connected vehicles. Contextual viewpoint focuses on the usage of the various blocks of the C-MoBLE ecosystem by its various actors. For instance, service providers make use of the block corresponding to the central system tasked with supporting connected vehicles, field, and mobile devices. In a similar manner, road operators make use of the subsystems covering ITS infrastructure along the physical road infrastructure (i.e. the so-called roadside system), while vehicle drivers make use of subsystems integrated within vehicles, such as on-board systems through the appropriate HMIs. Physical viewpoint focuses on the types of connection between the physical components by which the C-MoBLE "System-of-systems" is composed. For instance, the Traffic Management Centers (TMCs) are connected with traffic light controllers and incident detection devices via

wireless communications, which are in turn connected with vehicle on-board units via wide area wireless communications. Accordingly, the HMIs corresponding to travelers and Vulnerable Road Users are connected with the On-Board Units also via wide area wireless communications. Finally, the Information and the Communication viewpoints are focused on the way that data and information are stored, managed, and distributed and the communication modes employed respectively. Further to this, a description of the structure of the C-MobILE's GeoMessaging Platform is provided to the trainers, which enables the direct transmission of messages from a Traffic Management System to fixed-location Roadside Units (RSUs), vehicle On-Board Units (OBUs) and the C-MobILE compliant smartphone applications using cellular or fixed-line communications. All these technical details are provided to the trainers in an effort to equip them with the necessary skills and knowledge, in order to be able to familiarize the actors involved in the C-MobILE Deployment Sites with the various components and entities of the C-MobILE architecture and systems and render them capable of identifying their practical utility along with new business opportunities and replication possibilities.

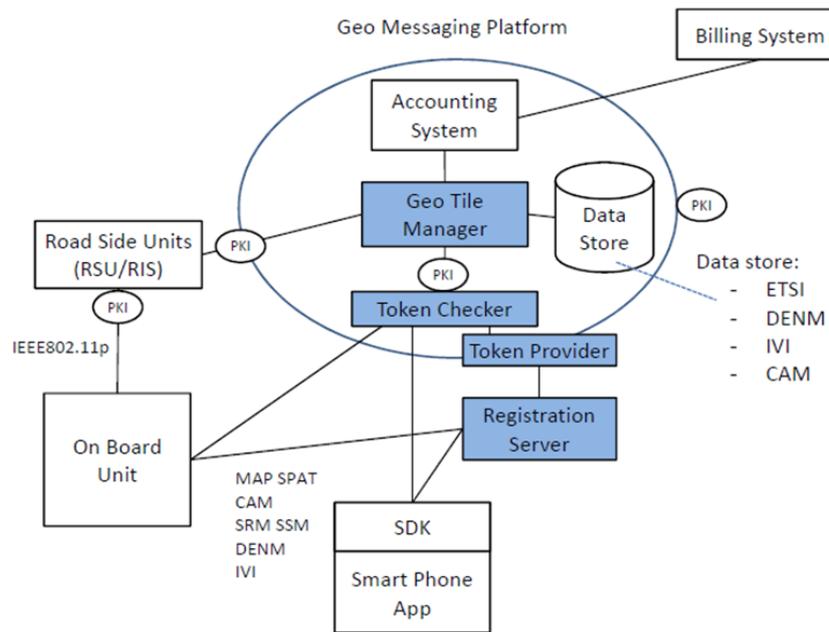


Figure 4: Structure of GeoMessaging platform.

A third point to highlight in the second module is the provision of information to the trainers regarding the standardized message sets based on which the V2X (i.e. vehicle to anything) communication is based. It should be noted each message set is purpose-built for specific types of information dispatchers and receivers but also for specific types of information. These message sets include: a) the Cooperative Awareness Message (CAM), b) the Distributed Environmental Notification Message (DENM), c) the Signal Phase & Timing (SPaT), d) the In-Vehicle Information (IVI), and e) the intersection geometry (MAP). CAM corresponds to a message sent by a vehicle one to ten times per second with data on vehicle position, direction, speed, etc. DENM constitutes a warning message (e.g. slippery road, crash) sent with a high priority to a vehicle based on information received from another vehicle or the infrastructure. SPaT is essentially a piece of information sent to a vehicle concerning traffic light state and future state changes. IVI is used for the presentation of physical road sign information inside a vehicle, while MAP describes the physical geometry of an intersection. The provision of the aforementioned information to the trainers is of particular importance, taking into account these message sets constitute commonly used terminology in the field of C-ITS and connected vehicle technology and is essential to facilitate the smooth flow of information within the Deployment Sites, especially between personnel of increased technical competencies (e.g. technical staff) and personnel responsible for other tasks (e.g. Traffic Management Centers operations management).

A fourth point to highlight in the second module is the provision of information to the trainers regarding the sensitivity of C-ITS-related data. In particular, a useful observation concerning this topic is that the sensitivity of said data grows depending on their value. Figure 5 provides further insight on this observation. Further to this, particular emphasis is given on the importance of using authorization tickets and pseudonym certificates as a means of ensuring a reliable Public Key Infrastructure (PKI).

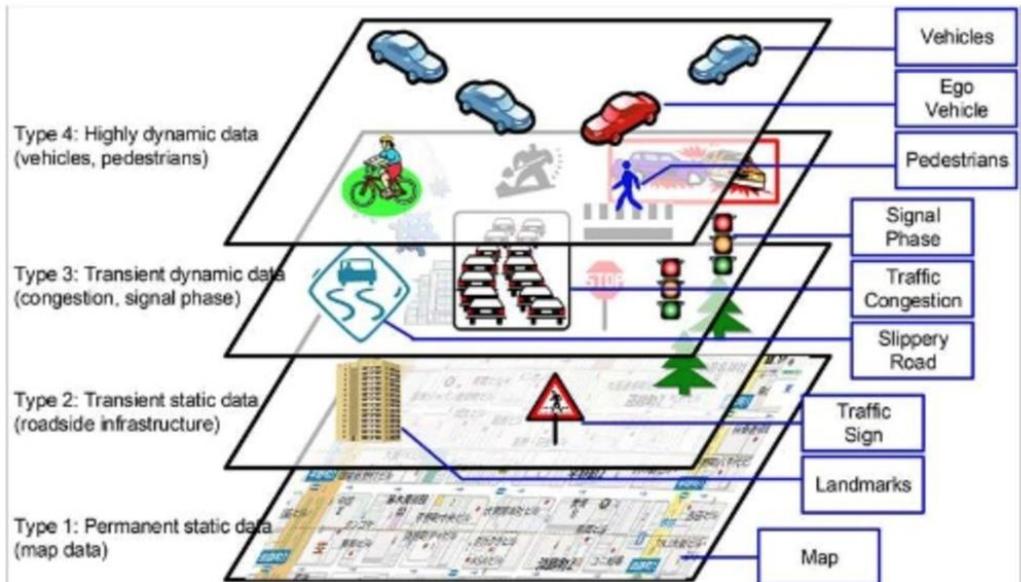


Figure 5: Data sensitivity compared with the nature and value of the exchanged data [11].

A fifth point to highlight in the second module is the provision to the trainers of information and material for a full description of all the C-ITS services developed in the frame of the C-MoBILE project (20 services). These descriptions include the definition of the scope of each service, specific technical details, their main benefits and their practical utility. What is also important in these descriptions is that each service is accompanied by a detailed schematic representation oriented both to facilitate trainees' understanding over each service and, more importantly, its effective memorization. Two indicative examples are provided in Figure 6, while the description of the entirety of services is included in Annex 1. The aforementioned approach is purely in line with the objectives of the current deliverable and takes into account that within the Deployment Sites of C-MoBILE there are varying training needs based on the level of involvement of each actor and his/her technical competence.

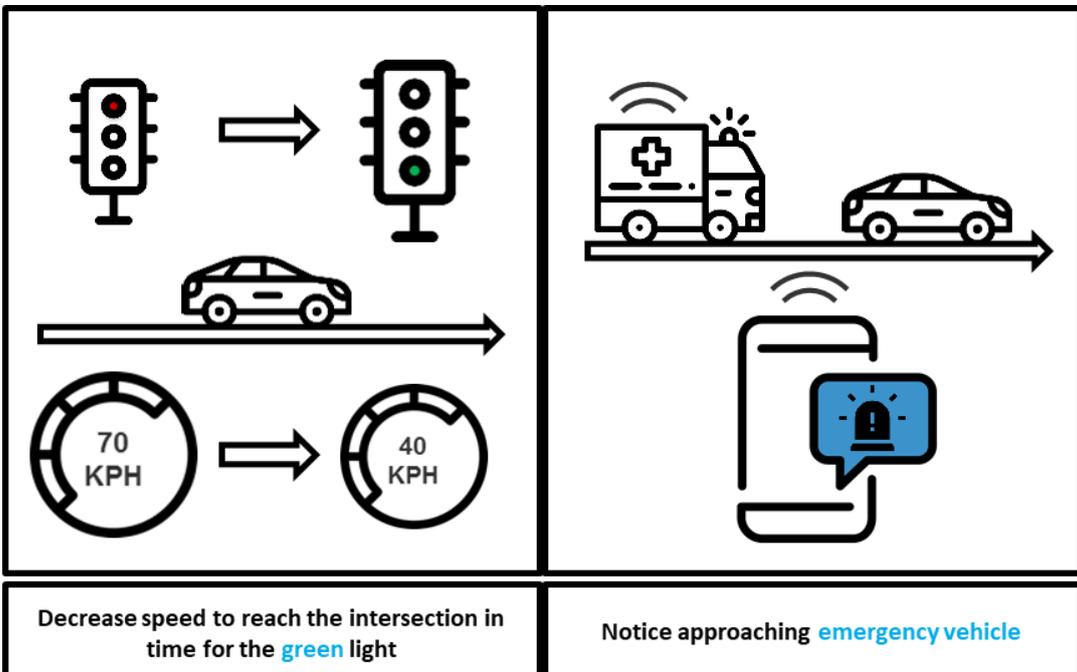


Figure 6: Schematic representation of the Green Light Optimized Speed Advisory (GLOSA) service (left) and the Emergency Vehicle Warning service (right).

The material included in the second module ends up with a brief description of the applications developed in each of the C-MoBILE DSs. This description includes the orientation and the purpose of each application, any available technical detail, and the supported C-ITS services. Such an approach is meant to increase the awareness of the functionalities of each application within the Deployment Sites and, subsequently, promote its usage.

3.3. Module C: “Building Training Skills Part II”

3.3.1. Module specific purpose

The third module of the “Train the trainer” session aims to enhance trainers’ awareness and level of understanding over: a) the current and foreseen practice in traffic management, b) the way that C-MoBiLE services can be integrated into traffic management, c) the impacts of C-ITS services and the nature of their deployment costs, and d) future perspectives in the field of smart traffic management. Therefore, it can be deduced that this module also relates to the transfusion of new knowledge and skills to the trainers and, subsequently, to public authorities and other involved actors within the ecosystem of the Deployment Sites. Further to this, it should be noted that this module has a strong orientation towards supporting the further uptake of the services developed during the course of the C-MoBiLE project.

3.3.2. Description of the provided material

A first point to highlight in third module includes a brief overview of the field of Traffic Management, including its definition as suggested by the European Commission [12], its main application areas as suggested by Klein [13], the types of information typically utilized by Traffic Managers, the various traffic management approaches (i.e. proactive, responsive, and static) as suggested by Klein [13], and a series of new perspectives to Traffic Management offered by Rijkswaterstaat [14]. This piece of information is provided to the trainers (and subsequently to the trainees), in order to gain an initial understanding of the opportunities that do exist in the field of Traffic Management for a further uptake and exploitation of C-ITS technologies. A prominent example constitutes the responsive and proactive traffic management approaches (Figure 7), where C-ITS technologies can be utilized either for informing travelers based on the prevailing conditions within a road network or for predicting changes in supply and demand by exploiting V2X communications and orchestrating the traffic accordingly by broadcasting the appropriate messages.

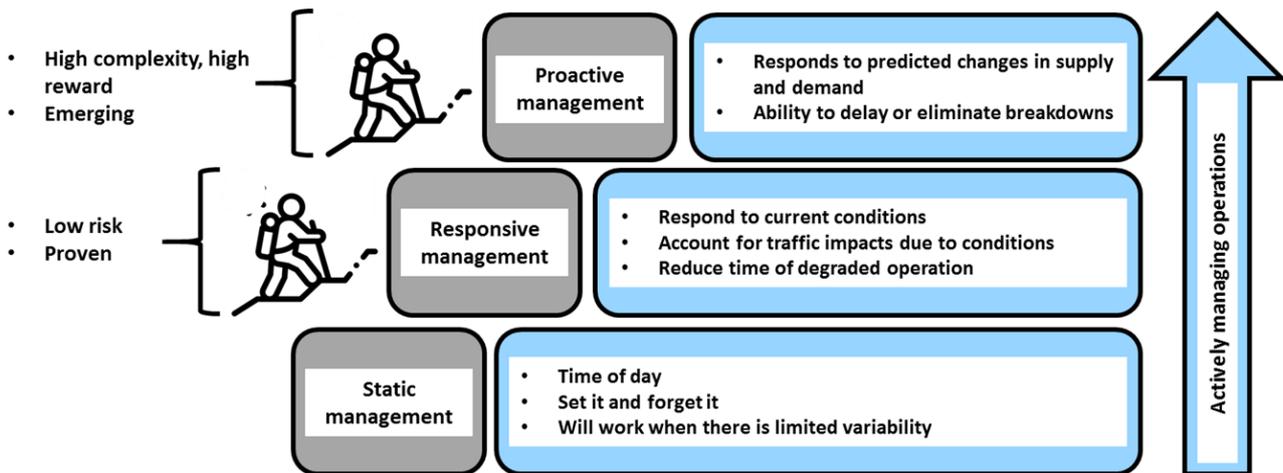


Figure 7: Traffic management approaches [Adapted from: [13]].

The second point to highlight in the third module includes a further elaboration on the way that C-ITS and connected vehicle technologies reshape the operational processes of Traffic Management Centers (TMCs). Such an analysis, which is based on the findings of a detailed study conducted by Kimley-Horn and Noblis [15], provides to the trainers (and subsequently to the trainees) tangible examples on the potential of C-ITS for Traffic Management. The provided information is structured around the type of information on which Traffic Management operations are based and the additional information enabled by C-ITS technologies. An indicative example for one type of information is provided in Table 3, while the analysis of all information types is included in Annex 1.

Information type	Currently available information	Additional information (sources) enabled by C-ITS	Potential changes to TMC operational processes
Incident 	<ul style="list-style-type: none"> / Location / Start time/end time / Duration / Severity 	<ul style="list-style-type: none"> / Geo-locating capability for precise incident location / Real-time and specific impacts to network / Restricted lanes / Types of vehicles involved / Response status 	<ul style="list-style-type: none"> / Better response by utilizing the appropriate resource and equipment / Network management that supports incident impact mitigation / Real-time information on incident clearance

		<ul style="list-style-type: none"> / Condition of potential detour routes 	<ul style="list-style-type: none"> / Improved traveller notification (incl. nearby corridors) / Determination of cause/improvements through before - and after - analysis / Improved predictive modelling/capabilities
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Table 3: Changes to TMC incident management operational process enabled by C-ITS technologies [Adapted from: [15]].

A third point to highlight in the third module is the provision of information, based on the suggestions by Kimley-Horn and Noblis [15], to the trainers (and subsequently to the trainees) regarding new required skills for the exploitation of C-ITS technologies. These skills are classified into four categories/disciplines: a) information technologies and data management, b) system analytics and processing, c) network and device management, and d) operations engineering and decision-making. Indicative examples of required skills with respect to the first and the third of the aforementioned disciplines are included in Table 4, while Annex 1 includes the required skills with respect to all disciplines. The provision of such information to the trainers and, subsequently, to the various stakeholders of the deployment sites is fully in line with the concept of lifelong learning and is expected to trigger public authorities' willingness to be prepared, in order to fully exploit the achievements of the C-MobLE project.

Technical discipline	Skill sets and credentials
Information Technologies and Data Management	<ul style="list-style-type: none"> / Hardware and software support for Big Data environment, and integrating data/information into TMC processes / Data warehousing, queries and support for data access and redistribution / Support data management and sharing policy development / Integrate new software and updates / Collaborate with system developers and integrators for new TMC systems and software
Network and Device Maintenance	<ul style="list-style-type: none"> / Specialized training for maintaining new field devices to support C-ITS / Testing and deployment of new devices / Collaborate with device vendors for technical specifications and requirements / Collaborate with IT and operations management to integrate new devices into TMC processes

Table 4: Demonstration of new skills required for the exploitation of C-ITS technologies [Adapted from: [15]].

A fourth point to highlight in the third module is provision of information to the trainers (and subsequently the trainees) regarding C-MobLE's specific proposal on the way that C-ITS technologies can be integrated into the current practice of Traffic Management. This proposal, entitled as "C-ITS Enabled Traffic Control Strategies", is comprised of four discrete stages. The first stage, the so-called "definition of the traffic management policy", constitutes a description of the importance and function of the components of a road network as well as the setting of quantitative thresholds for its links and route parts. The second stage, the so-called "discretization of the available road network", includes a distinction of the various part of a road network (incl. nodes, segments, links, route parts) with respect to their typological or topological characteristics. According to the C-MobLE approach a road network can be discretized based on the elements depicted and described in Figure 8. The third stage, the so-called "definition of traffic control strategies", includes the means of achieving set policy objectives that may be applied in escalating phases. Such means, according to the C-MobLE approach, are the following: a) inform traffic, b) enlarge outflow, c) reduce inflow, and d) reroute traffic. Finally, the fourth stage, the so-called "association of C-ITS services with traffic control strategies", is tasked with defining the C-ITS services that are able to accomplish policy objectives via the realization of the appropriate traffic control strategies. Table 5 provides an initial association of the services developed within the course of the C-MobLE project with the four mentioned control strategies. The provision of this information, in the context of the C-MobLE training material, is perceived as the cornerstone of promoting the integration of the C-ITS services developed within the course of the project into the practice of Traffic Management.

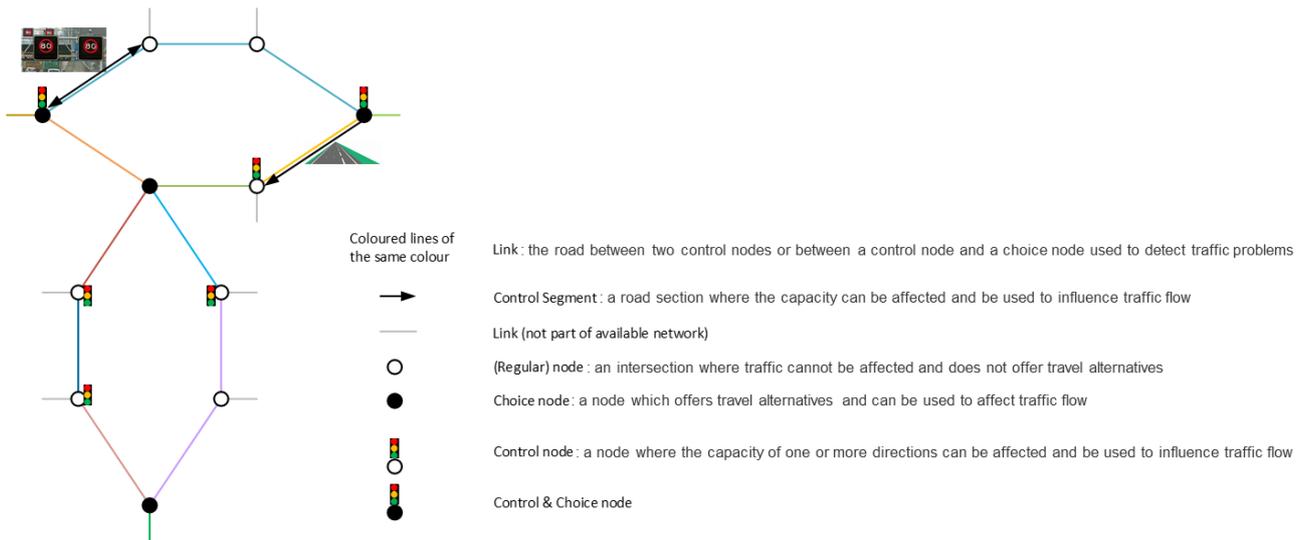


Figure 8: Network discretization based on the C-ITS enabled traffic control framework of the C-MOBILE project.

Smart mobility measure	Primary objective	Inform traffic	Enlarge outflow	Reduce inflow	Reroute traffic
Green Priority for Designated Vehicles	Reduce delay time at traffic light for designated vehicles	-	Enlarge the outflow of priority directions	-	-
Flexible Infrastructure (e.g. peak-hour lanes)	Control available road capacity	-	More road capacity increases the outflow	Less road capacity reduces the inflow	-
In-vehicle Signage Road Section	Present dynamic road sign information for road sections in the vehicle (personalized and extrapolated)	Inform about conditions and restrictions	e.g. speed harmonization increase outflow	e.g. speed harmonization reduces inflow	-
In-vehicle Signage Route	Present route and travel time information in the vehicle (personalized and extrapolated)	Inform about options	-	-	e.g. travel time information and route advice
Mode & Trip Time Advice (e.g. by Incentives)	Multi-modal travel and departure time advice (MaaS-like concept, by incentives)	Inform about conditions, restrictions, and options	-	-	Delayed trips or trips by collective modes reduce demand

Table 5: Association of C-ITS services with traffic control strategies.

A fifth point to highlight in the third module includes the provision of information to the trainers (and subsequently the trainees) regarding the impacts of C-ITS services and the nature of their deployment cost. This piece of information is considered of particular importance taking into account that public authorities and policy-makers usually require evidence concerning the socioeconomic and environmental benefits and the cost of new mobility technologies, in order to commit resources for large-scale deployment. This is also one of the main objectives of the C-MOBILE project. The multi-category impacts for two indicative C-ITS services are provided in Table 6, while Annex 1 include the impacts of 11 C-ITS services. Included information relies on the

findings of a topic study of the CAPITAL project [16]. In addition, the deployment costs include the following categories [17]:

- / Integration of C-ITS services into TMCs (e.g. costs related to: the integration of RSUs into TMCs, the development of new interfaces from RSUs to local traffic controllers, the operation and maintenance of the TMC back office, and the development of software applications)
- / Roadside units (RSUs) and dedicated short-range communications (e.g. beacons on gantries or poles for providing ITS-G5 communication, operation and maintenance costs, such as realigning the antennas and routine checks, power consumption, development of security credential systems)
- / In-vehicle devices (e.g. On-board units - OBUs, devices attached to vehicle communication buses enabling V2V and V2I communication, development of integration systems and software applications, ongoing costs related to secure communication and OEM maintenance)
- / Personal devices (e.g. smartphones, tablets, Personal Navigation Devices (PNDs), software development, and subscription fees)
- / Data collection (e.g. data collection through infrastructure-based means or subscriptions to 3rd party services)

C-ITS service	Safety	Accidents	Congestion	Efficiency	Comfort	Environment
Road Hazard Warning (RHW)	Less accidents	2.4-2.5% less injuries & 1.7-2.4% less fatalities (due to traffic jam related warnings) 4.1-4.2% less injuries and 3.1% less fatalities (due to hazardous location warnings)	Less congestion	-	-	-
In-Vehicle Signage (IVS)	Less accidents	0.5-1% less fatalities and injuries through the use of "children" and "pedestrian crossing ahead" signs 2-7% less fatalities & injuries (due to signage related to speed limits)	-	Low impact	-	1.4% less speed and 2.3-3.5% less fuel consumption (due to signage related to speed limits)
<i>Note: "-" indicates an unknown impact and not necessarily an absence of impact.</i>						

Table 6: Impacts of indicative C-ITS service on conventional transport-related concepts

"Train the Trainer" session ends up with an outlook on the future of Traffic Management as a means of enabling the insightfulness of the training receivers. In this analysis, particular emphasis is given on cooperative traffic management schemes and business models, such as the TM2.0 platform [18]. Specifically, an overview of the TM2.0 platform is provided, including its building blocks (i.e. road operators, traffic management plans, service providers, and the end-users) and the added value that may result from its application for city administrators and traffic managers, traffic information service providers, and the end-users.

4. Training events

This section aims to report on the events that have taken place during the C-MobILE project's training activities. Section 4.1 reports on the event that corresponds to the 1st training layer which took place in the 5th General Assembly in Vigo. Section 4.2 reports on the various events that correspond to the 2nd training layer, dedicated to providing training to public authorities and other actors involved in the ecosystem of the C-MobILE DSs (Barcelona, Bilbao, Bordeaux, Copenhagen, Newcastle, North Brabant, Thessaloniki, and Vigo). Section 4.3 reports on the event that corresponds to the 3rd training layer, oriented mainly towards increasing the possibility of the C-MobILE project's services replication and further uptake.

4.1. Phase I

The event corresponding to the 1st training layer, the so-called "Train the Trainer" layer, was prepared by the Centre for Research and Technology Hellas (CERTH) and held in Vigo on June 19th 2019 in the context of the 5th General Assembly of the C-MobILE project (18-19 June 2019). The event took place at 13:00 - 16:00 CET in the facilities of the Centro Tecnológico de Automoción de Galicia (CTAG) (Avenida Principal, 2, 36475 O Porriño, Pontevedra) and its agenda included the following:

- / Concepts and preparation for a C-ITS training and education plan | 13:00 - 13:30 CET | Presenters: Evangelos Mitsakis and Areti Kotsi (CERTH)
- / Building trainer skills - Part I | 13:30 - 14:15 CET | Presenters: Evangelos Mitsakis and Areti Kotsi (CERTH)
- / Building trainer skill - Part II | 14:30 - 15:15 CET | Presenters: Evangelos Mitsakis and Areti Kotsi (CERTH)
- / Interactive session | 15:15 - 15:55 CET | Presenters: Evangelos Mitsakis and Areti Kotsi (CERTH)
- / Wrap-up and end of training | 15:55 - 16:00 CET

The event was attended by 27 participants. The content of the first three modules included in the event's agenda is purely reflected in the descriptions provided in Section 3. The Interactive session was dedicated to enhance trainers' understanding of the material covered in the three previous modules. This session was enabled by an interactive quiz game set up on the Kahoot platform, comprised of 20 questions and attended by 25 participants. The content of the questions that have been asked to the participants along with the derived results is provided next.

The first question (Figure 9) is related with the first module "Concepts and preparation for a C-ITS training and education plan" and was intended to remind to the participants the various roles that a trainer should play, in order to accomplish the objectives of the C-MobILE training plan. The number of participants that achieved to answer this question was 24 out of 25 in an average time of 13,43 seconds and the success rate is 68%. This rate is overall satisfactory but it could have been higher considering the difficulty of the current question.

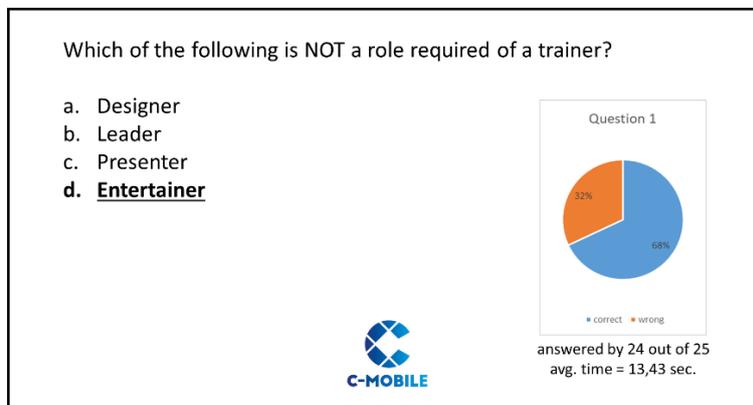


Figure 9: Interactive session of the "Train the Trainer" event – Question 1

The second question (Figure 10) is also related with the first module "Concepts and preparation for a C-ITS training and education plan" and was intended to remind to the participants that the learning process encompasses multiple stages, which should be taken into account during the design and implementation of the training events corresponding to the 2nd training layer. The entirety of the participants (25 out of 25) achieved to answer this question in an average time of 20,17 seconds and the success rate is 28%. This rate is relatively low compared with the rate of the remaining questions, which is attributed to the difficulty of memorizing specific pedagogical terms on behalf of the participants in the context of a single training event covering a wide range of scientific fields. However, the announcement and the explanation of the correct answer to the participants during the discussion phase that has taken place after the completion of the game is considered constructive and fully served the purpose of this question.

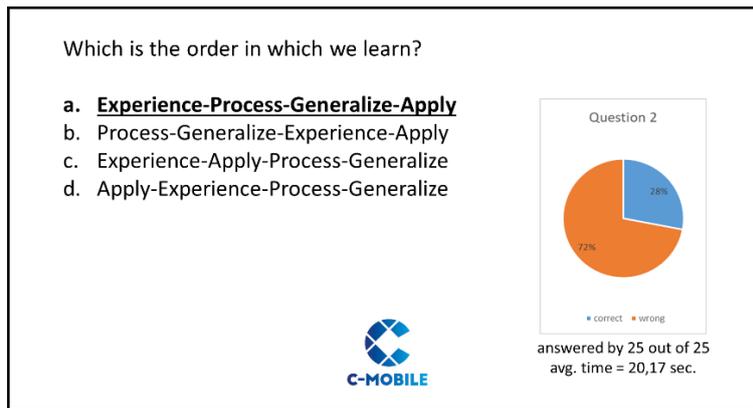


Figure 10: Interactive session of the “Train the Trainer” event – Question 2

The third question (Figure 11) is also related with the first module “Concepts and preparation for a C-ITS training and education plan” and was intended to remind to the participants the practical utility of the various existing training methods, in an effort to enrich the training events corresponding to the 2nd training layer with more participatory and “active” learning techniques. The number of participants that achieved to answer this question was 24 out of 25 in an average time of 14,37 seconds and the success rate is 84%. This success rate is satisfactory.

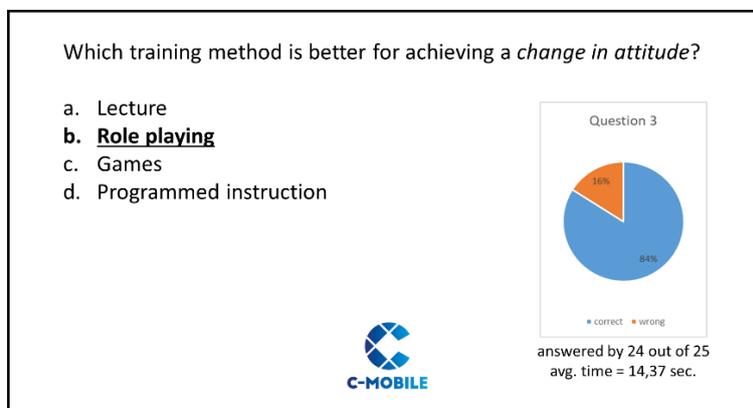


Figure 11: Interactive session of the “Train the Trainer” event – Question 3

The fourth question (Figure 12) is last question related with the first module “Concepts and preparation for a C-ITS training and education plan” and was intended to remind to the participants that each training methods is more or less effective towards serving a specific purpose. Role playing was chosen as a demonstrator. The number of participants that achieved to answer this question was 24 out of 25 in an average time of 18,00 seconds and the success rate is 36%. This rate is relatively low compared with the rate of the remaining questions, which is attributed to the difficulty of memorizing the strengths of all training methods on behalf of the participants. However, the announcement and the explanation of the correct answer to the participants during the discussion phase that has taken place after the completion of the game is considered constructive and fully served the purpose of this question.



Figure 12: Interactive session of the “Train the Trainer” event – Question 4

The fifth question (Figure 13) is related with the second module “Building Training Skills - Part I” and was intended to remind to the participants the functionalities and the application areas of C-ITS technologies as a means of enabling their effective replication in the training events corresponding to the 2nd training layer. The entirety of the participants (25 out of 25) achieved to answer this question in an average time of 19,86 seconds and the success rate is 56%. This rate is overall satisfactory but it could have been higher taking into account the difficulty of the current question.

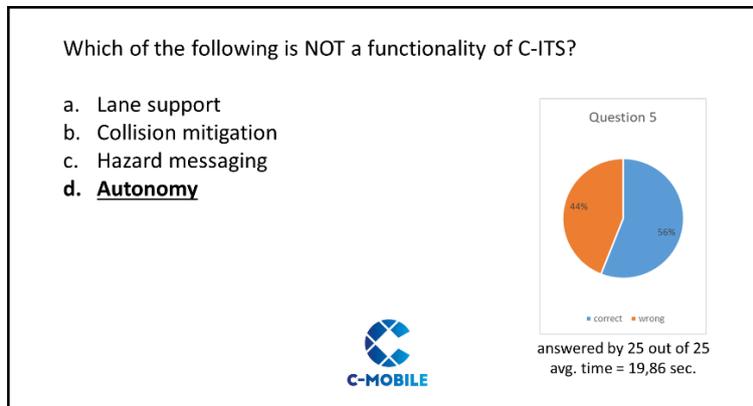


Figure 13: Interactive session of the “Train the Trainer” event – Question 5

The sixth question (Figure 14) is also related with the second module “Building Training Skills - Part I” and was intended to remind to the participants the importance of knowing the scope of each of the standardized C-ITS message sets. Such message sets are included to a great extent in the commonly utilized terminology of C-ITS. The number of participants that achieved to answer this question was 24 out of 25 in an average time of 16,53 seconds and the success rate is 76%. This rate is perceived as satisfactory.

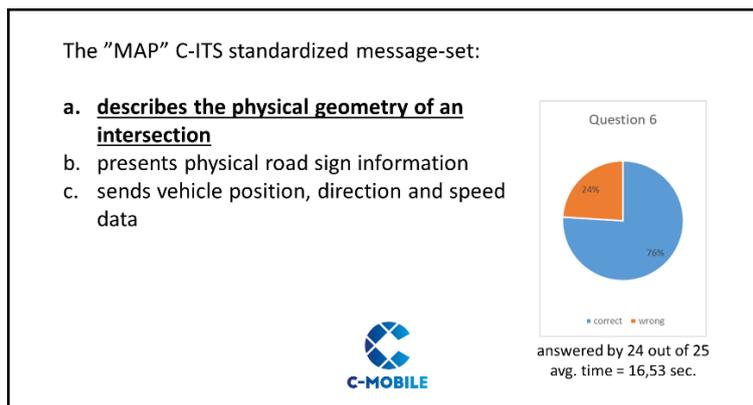


Figure 14: Interactive session of the “Train the Trainer” event – Question 6

The seventh question (Figure 15) is also related with the second module “Building Training Skills - Part I” and was intended to remind to the participants the temporal taxonomy and the nature of data exchanged/utilized in the field of C-ITS. This taxonomy is also correlated, as already noted in Section 3.2, with data sensitivity. The entirety of the participants (25 out of 25) achieved to answer this question in an average time of 18,84 seconds and the success rate is 80%, which is perceived as satisfactory.

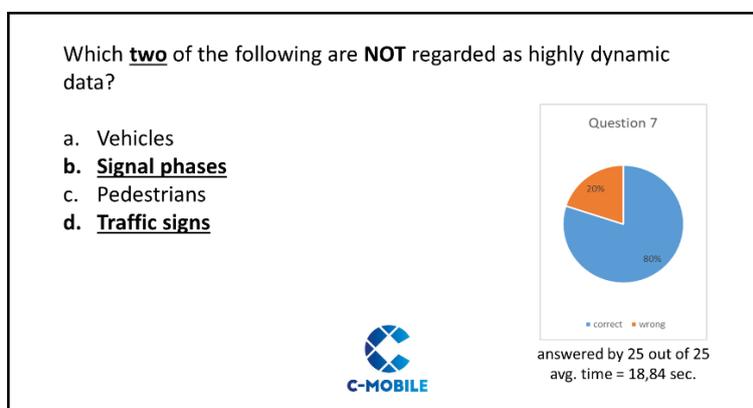


Figure 15: Interactive session of the “Train the Trainer” event – Question 7

The eight question (Figure 16) is also related with the second module “Building Training Skills - Part I” and was intended to remind to the participants two principles of GDPR that are of particular importance for C-ITS, namely transparency and data minimization. The former was chosen in the context of the current question. The entirety of the participants (25 out of 25) achieved to answer this question in an average time of 17,06 seconds and the success rate is 44%. This rate could have been higher given the importance of the aforementioned topic. To this end, particular emphasis was given during the discussion after the completion of the game on this topic by explaining to the participants that the principle of transparency expects users to be aware of the nature and purpose of data collection and that it is currently unknown whether the variety of data exchanged between and among the various entities involved in the C-ITS ecosystem allows this principle to be realized.

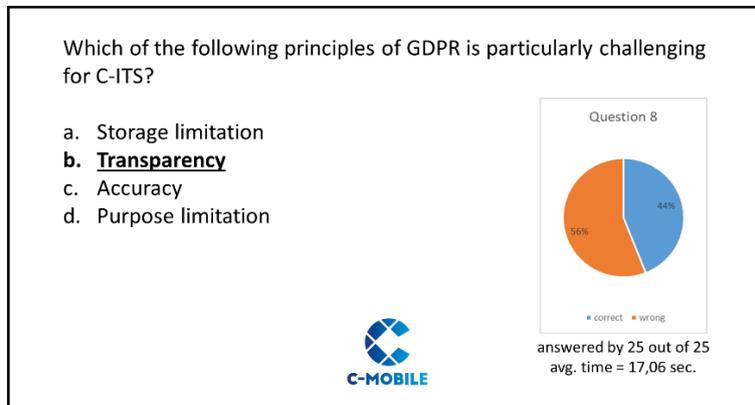


Figure 16: Interactive session of the “Train the Trainer” event – Question 8

The ninth question (Figure 17) is also related with the second module “Building Training Skills - Part I” and was intended to remind to the participants the practical utility of the “Road Works Warning (RWW)” C-ITS service. The entirety of the participants (25 out of 25) achieved to answer this question in an average time of 12,63 seconds and the success rate is 88%, which was the highest rate amongst all questions of the game.

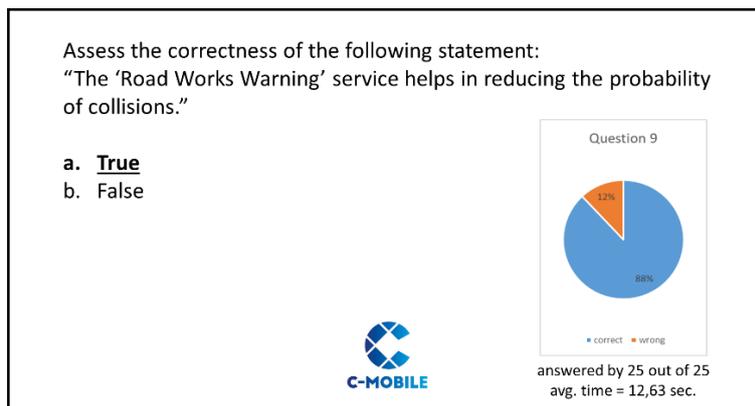


Figure 17: Interactive session of the “Train the Trainer” event – Question 9

The tenth question (Figure 18) is also related with the second module “Building Training Skills - Part I” and was intended to remind to the participants the content of the “Motorway Parking Availability (MPA)” C-ITS service. The number of participants that achieved to answer this question was 24 out of 25 in an average time of 14,61 seconds and the success rate is 76%. This rate is perceived as satisfactory.

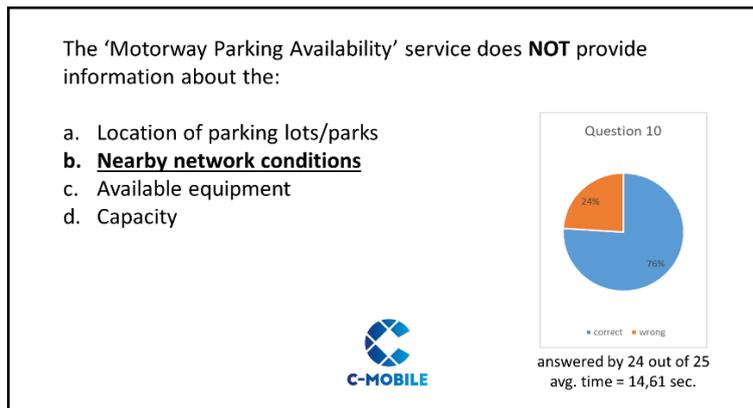


Figure 18: Interactive session of the "Train the Trainer" event – Question 10

The eleventh question (Figure 19) is also related with the second module "Building Training Skills - Part I" and was intended to remind to the participants the nature of the "Cooperative Adaptive Cruise Control (CACC)" C-ITS service. The number of participants that achieved to answer this question was 23 out of 25 in an average time of 16,16 seconds and the success rate is 68%. This rate is perceived as satisfactory.

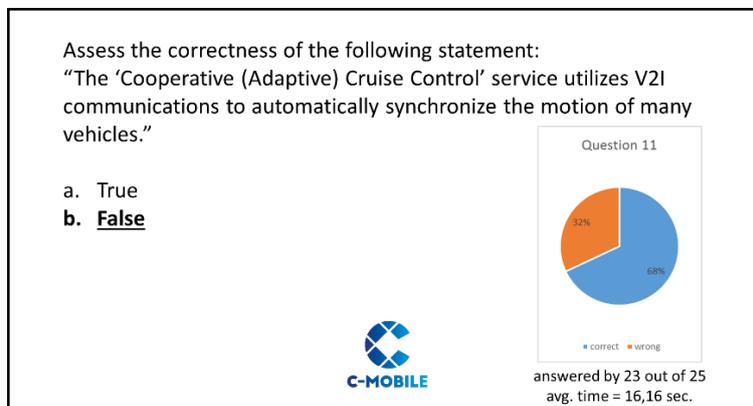


Figure 19: Interactive session of the "Train the Trainer" event – Question 11

The twelfth question (Figure 20) is last question related with the second module "Building Training Skills - Part I" and was intended to remind to the participants the nature of the "Green Priority (GP)" C-ITS service. The number of participants that achieved to answer this question was 24 out of 25 in an average time of 15,05 seconds and the success rate is 70%. This rate is perceived as satisfactory.

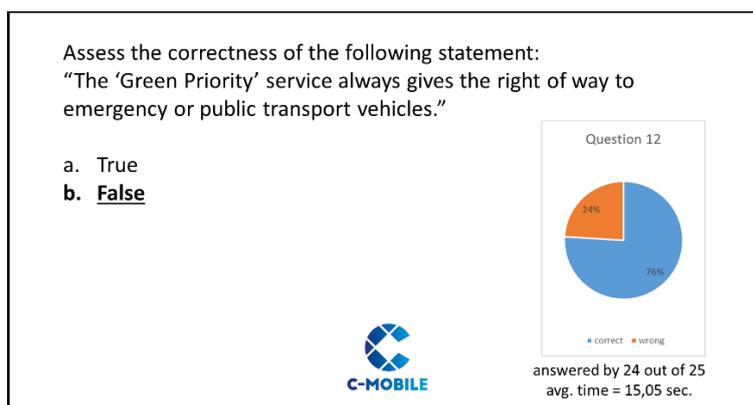


Figure 20: Interactive session of the "Train the Trainer" event – Question 12

The thirteenth question (Figure 21) is related with the third module "Building Training Skills - Part II" and was intended to remind to the participants the level of complexity of each traffic management approach but also the opportunities that arise from the deployment of the C-ITS technologies developed during the course of C-Mobile. The number of participants that achieved to answer this question was 23 out of 25 in an average time of 12,40 seconds and the success rate is 60%. This rate could have been even higher given the difficulty of the question.

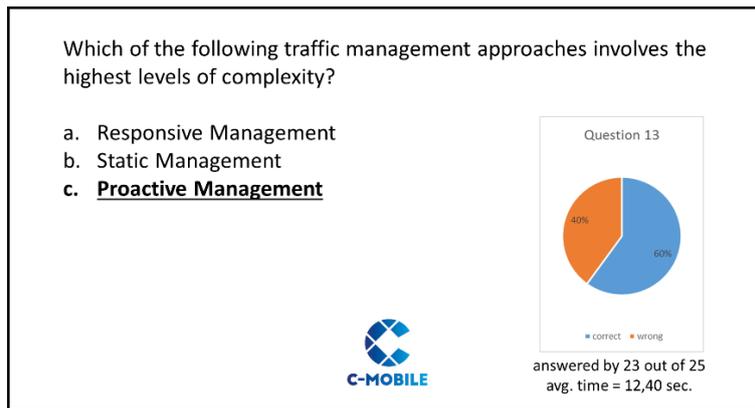


Figure 21: Interactive session of the “Train the Trainer” event – Question 13

The fourteenth question (Figure 22) is also related with the third module “Building Training Skills - Part II” and was intended to remind to the participants the increasing responsibility of Traffic Management Centres in the C-ITS environment. The number of participants that achieved to answer this question was 24 out of 25 in an average time of 19,59 seconds and the success rate is 72%. This rate is perceived as overall satisfactory.

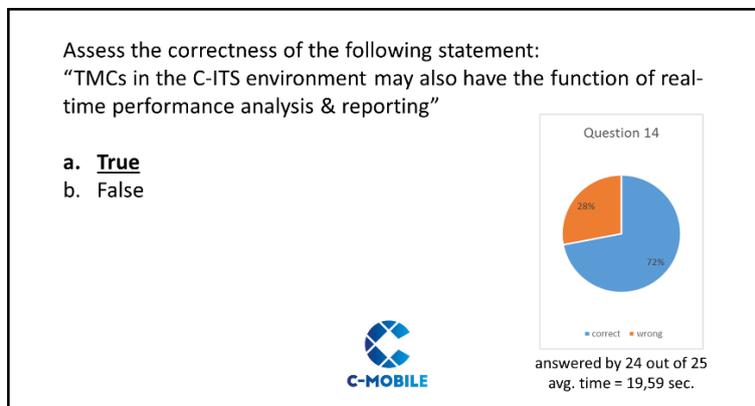


Figure 22: Interactive session of the “Train the Trainer” event – Question 14

The fifteenth question (Figure 23) is also related with the third module “Building Training Skills - Part II” and it is in essence a combination of a game and a case study. This case study presents to the participants a potential traffic-related scenario within the central business district of the Thessaloniki city. Specifically, according to this scenario 10 out of 14 links into which the Tsimiski street of Thessaloniki may be distilled are congested and there are 9 control and choice nodes and 6 control nodes. The participants were asked to select the most appropriate objective based on which a traffic control strategy may be based. The ability of the trainers and at a later stage of the trainees to identify the most suitable objective is considered of particular importance, in the context of this question, taking into account that such a task is closely related with the first step of the “C-ITS enabled traffic control strategies” proposed by C-MobILE. The number of participants that achieved to answer the current question was 23 out of 25 in an average time of 31,44 seconds and the success rate is 80%, which is satisfactory.

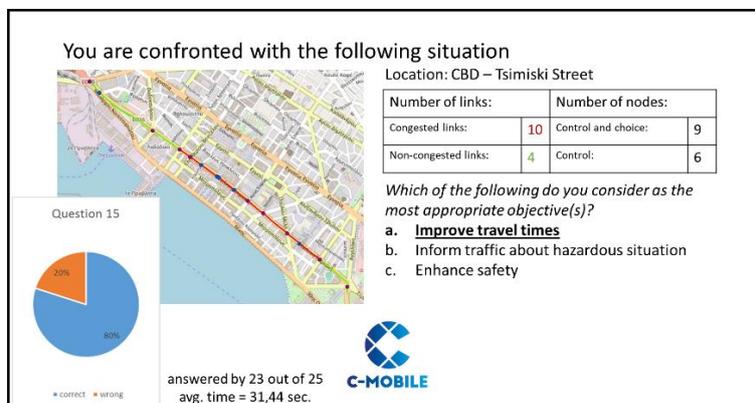


Figure 23: Interactive session of the “Train the Trainer” event – Question 15

The sixteenth question (Figure 24) relies on the same scenario. Participants were asked to assess a statement indicating the way upon which said scenario should be approached before identifying the most appropriate traffic control strategy. The content of this question is closely related with the second step of the “C-ITS enabled traffic control strategies” proposed by C-MobILE. The number of participants that achieved to answer the current question was 23 out of 25 in an average time of 21,76 seconds and the success rate is 76%. While the average answer time is noticeably increased, the success rate remained as satisfactory.

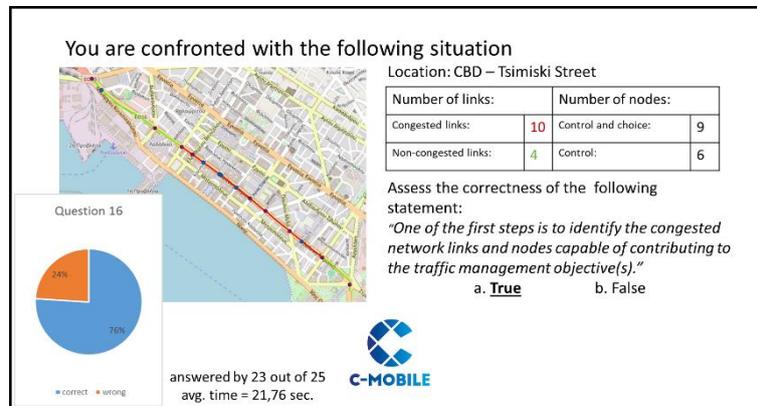


Figure 24: Interactive session of the “Train the Trainer” event – Question 16

The seventeenth question (Figure 25) also relies on the same scenario as the previous two. Participants were asked to identify a C-MobILE service that may alleviate the congested links of the part of the road network included in this scenario. Participants had firstly to observe that there are three services noticeably not-related with the described scenario and after that to observe that this part of the road network includes several control nodes. In that case, it was easy for them to come to a conclusion that the “Green Light Optimized Speed Advisory (GLOSA)” service is the only rational choice. The number of participants that achieved to answer the current question was 23 out of 25 in an average time of 20,34 seconds and the success rate is 72%, which is perceived as overall satisfactory.

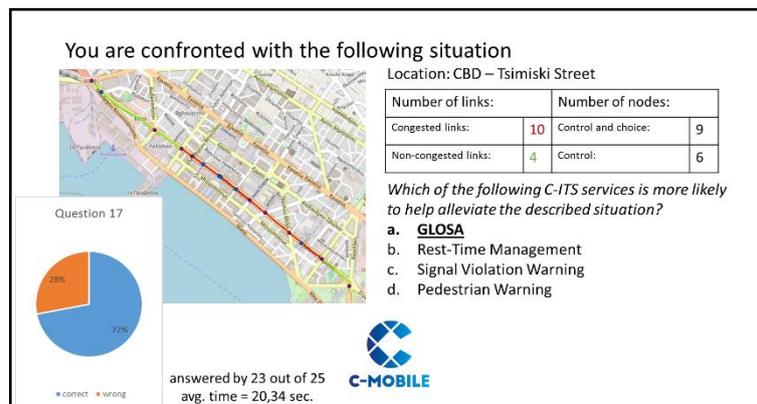


Figure 25: Interactive session of the “Train the Trainer” event – Question 17

The eighteenth question (Figure 26) addresses a new scenario involving the peripheral ring road of Thessaloniki, where a road event has caused congestion in 2 links. The current question aims to assess participants’ ability to select the most appropriate objectives in relation with the described situation. The participants had to observe that all objectives included in the multiple choices are relevant. The number of participants that achieved to answer the current question was 23 out of 25 in an average time of 20,64 seconds and the success rate is 68%, which is perceived as satisfactory given the intricacy of the current question.

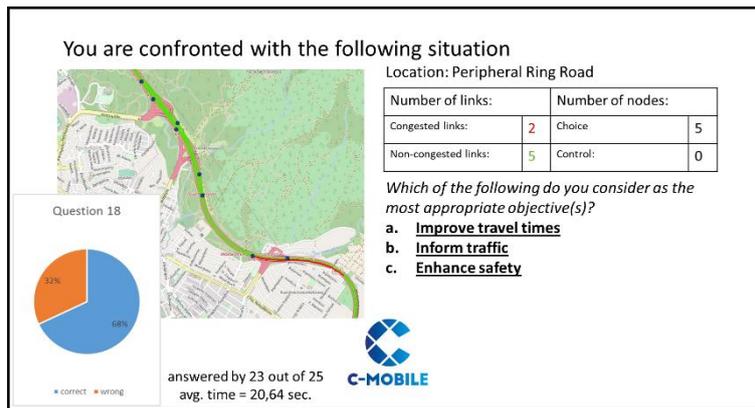


Figure 26: Interactive session of the “Train the Trainer” event – Question 18

The nineteenth question (Figure 27) also relies on the scenario involving the peripheral ring road of Thessaloniki. Participants were asked to confirm that the second step of the “C-ITS enabled traffic control strategies” proposed by C-MobILE remains relevant. The number of participants that achieved to answer the current question was 23 out of 25 in an average time of 19,61 seconds and the success rate is 44%, which is perceived as marginally satisfactory. However, participants’ fatigue should be also taken into consideration.

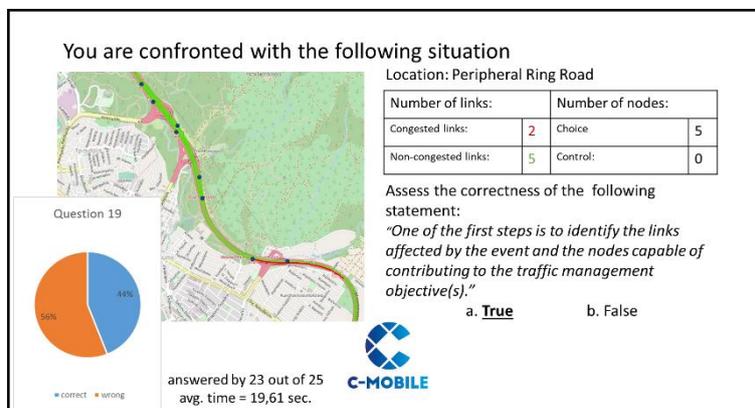


Figure 27: Interactive session of the “Train the Trainer” event – Question 19

The last question (Figure 28) also relies on the scenario involving the peripheral ring road of Thessaloniki. Participants were asked to identify the C-ITS service that is relevant with the described scenario. It can be easily understood that the only service that did so from those included in the multiple choices is “Road Hazard Warning (RHW)”. The number of participants that achieved to answer the current question was 22 out of 25 in an average time of 22,02 seconds and the success rate is 24%, which is perceived quite low taking into account the difficulty of the current question. However, as also stated in the previous question’s description, participants’ fatigue should be taken into consideration.

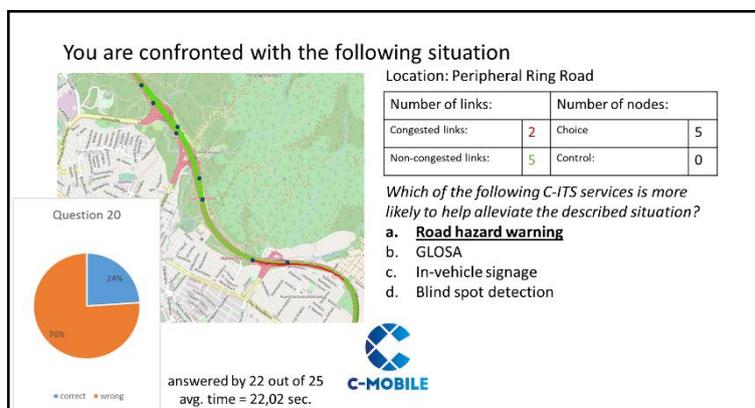
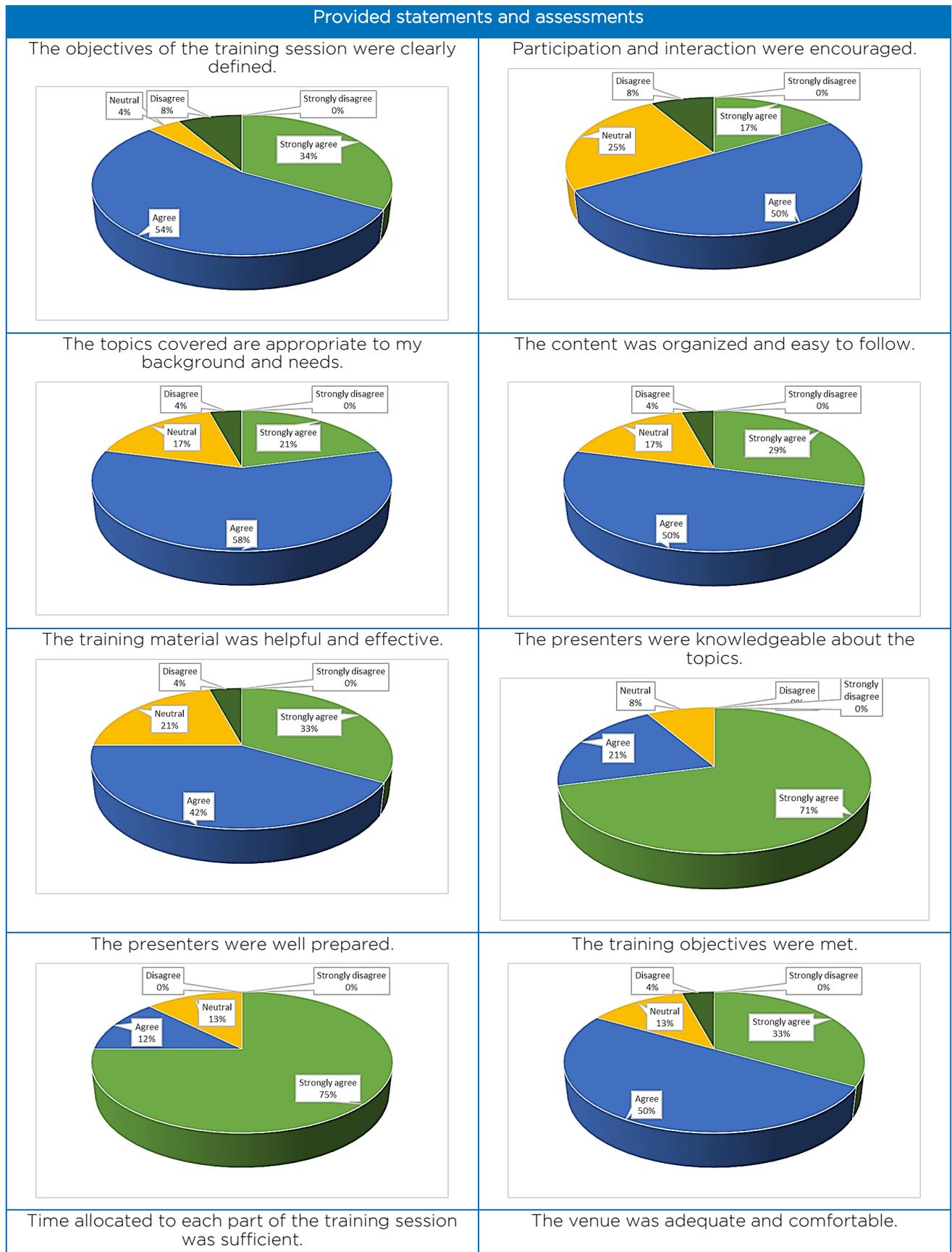


Figure 28: Interactive session of the “Train the Trainer” event – Question 20

Finally, “Train the Trainer” session included an evaluation of the provided training. This evaluation was based on 10 statements to be assessed by the participants on a 5-level scale and 6 open questions. In total 24 participants took part in this evaluation exercise. Table 7 includes the statements that were included in the questionnaires provided to the participants along with their response. The response of the participants in this

evaluation exercise showcased a significantly high satisfaction for the training event corresponding to the 1st training layer (i.e. the “Train the trainer”).



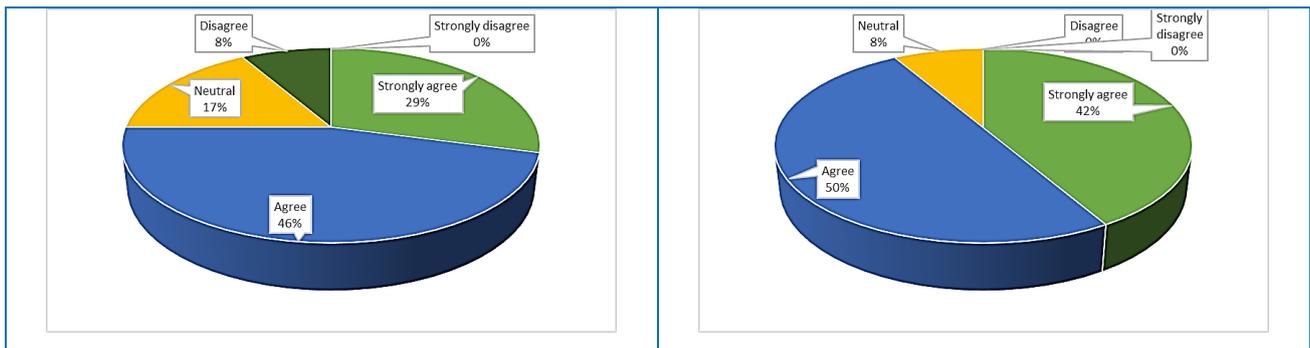


Table 7: Results from the evaluation of the "Train the Trainer" event held in the 5th General Assembly in Vigo.

On the other hand, the content of the open questions was the following:

- / What was the most interesting thing you learned in this training session?
- / What was the least interesting thing you learned in this training session?
- / What did you like most about this training session?
- / What aspects of this training session could be improved?
- / What additional training topics would you like to have been included?
- / Please share other comments or expand on previous responses.

Concerning the first question, the participants showcased an increased interest for the provided information regarding the organization of an effective training event, the various "learning hints", the potential of C-ITS for benefiting TMC operations, the provided analysis of the TM2.0 platform, the global view of C-ITS, and the analysis of the Traffic Management field's future readiness.

Concerning the second question, some participants showcased a decreased interest for having been informed for all C-ITS services and the impacts of C-ITS services on conventional transport-related concepts (e.g. safety, efficiency). Moreover, a small fraction of the participants showcased a decreased interest for the Kahoot-based quiz game, partly due to the increased difficulty of some questions.

Concerning the third question, the vast majority of participants enjoyed the Kahoot-based quiz game. Some other participants welcomed the separation of the presented material in three modules, the provision of information for C-ITS "starters", and the presentations per se.

Concerning the fourth question, some participants proposed the incorporation of video material and the allocation of more time to the interactive session or even the creation of an interactive session for each of the training's modules. Moreover, some other participants proposed the provision of more technical details regarding the C-MobILE architecture, while some others felt that the overall duration of the training should be reduced.

Concerning the fifth question, the vast majority of participants deemed that nothing more should be added to the training material. However, some others proposed the following topics: a) technical details of the required equipment, b) benefits of C-ITS by adopting a "citizen point of view", c) in-depth analysis of public sector's role, and d) analysis of recruitment models.

Concerning the last question, the vast majority of the participants declared that they enjoyed the "Train the trainer" event, while some others insisted on the provision of more technical details. Such an issue had already concerned CERTH's team tasked with the preparation of the training material, but the last choice to include in the training material information for C-ITS "starters" was based on the recommendations of the US Department of Transport [2]. This choice has been applauded by several participants.

4.2. Phase II

4.2.1. Barcelona Deployment Site training

Barcelona's deployment site training was organized by Applus+ IDIADA with the collaboration of the City Council of Barcelona and the Royal Automobile Assistance Club SA (RACC). Its objectives were to present the C-MobILE project, to explain how to exploit C-ITS services and to show the services deployed in Barcelona. The training was held on May 6th 2020 from 11:00 to 12:45 CET and the agenda was the following:

- / C-MobILE project and the training objectives | presenter: Mònica Lores
- / Introduction to C-ITS | presenter: Jacint Castells
- / C-ITS Architecture | presenter: Jacint Castells

- / C-ITS Services | presenters: Jacint Castells and Alex Vallejo
- / C-ITS Applications | presenter: Jacint Castells
- / Questions and discussion

It should be noted that the Deployment Site training in Barcelona was initially planned to be face-to-face by the end of March 2020 but unfortunately due to the COVID-19 outbreak and the associated restrictive measures, it was rescheduled to an online Zoom webinar on May 6th 2020. The training has been recorded and uploaded on Applus+ IDIADA's YouTube account.

The webinar was attended by 60 participants out of 95 that had been initially registered. The targeted audience included public authorities (i.e. municipalities, regional government, etc.), road operators, and traffic and fleet managers. The webinar has been disseminated via the following means: a) design of a banner (Figure 29) posted on IDIADA's, RACC and C-Mobile LinkedIn accounts and used by FIA for promoting the event through their newsletter; this banner has been also used by ERTICO for the C-Mobile Twitter account, b) personal emails sent to targeted contacts, and c) and internal dissemination within the Barcelona DS organizations.



Figure 29: Banner of the Deployment Site training of Barcelona

The original material upon which the Deployment Site training of Barcelona was based is included in Annex 2. This material is comprised of 61 slides written in the Spanish language and build upon the material drafted for the event corresponding to the 1st training layer, the so-called "Train the Trainer" phase (Section 3). Said slides are structured around 6 main parts:

- / C-Mobile project and training objectives: This part included a brief description of the project and the C-Mobile Deployment Sites, the objectives of the training, and the target audience.
- / Introduction to C-ITS: This part included an explanation of ITS, C-ITS, communication technologies (ITS-G5 vs Cellular) and the importance of C-ITS in a world with autonomous vehicles.
- / C-ITS Architecture: This part contained an example of the EVW service deployed in ITS-G5 and cellular, with the different blocks involved in each case. The C-ITS architecture has been presented in 3 layers, being Central Systems, Infrastructure and Users. Each layer contains relevant blocks/systems/devices especially picked based on the target audience.

- ✓ C-ITS Services: This part is perceived as the core one and has the main the objective of demonstrating how C-MoBILE services improve mobility, either in terms of safety, efficiency, or environmental performance. In this part all C-MoBILE services have been mentioned placing particular emphasis on the services of the Barcelona DS. These services have been classified in the following main groups: a) services related to VRU safety (i.e. Motorcycle Approaching Indication and Warning System for Pedestrian), b) services related to road safety (i.e. Road Hazard Warning, Signal Violation Warning), c) services related to priority optimization (i.e. Emergency Vehicle Warning, Green Priority), d) services related to traffic efficiency (i.e. Green Light Optimized Speed Advisory, Flexible Infrastructure, In-Vehicle Signage), and e) services related to probe data analysis (i.e. Probe Vehicle Data service). The presentation and description of the aforementioned services was complemented by relevant case studies, demonstrating their application. Finally, the C-MoBILE video for Barcelona (available at: <https://www.youtube.com/watch?v= zOFhHYCWQ4>) was shown to the participants.
- ✓ C-MoBILE Barcelona application: In this part the C-MoBILE Barcelona app has been described to the participants.
- ✓ Q&A: This part is divided in two main activities: a) a poll asking the attendees to give feedback and evaluate the concepts explained in the training (results are provided next), and b) a Q&A round where 22 C-ITS related questions were raised by the audience and answered by the presenter.

The live poll mentioned in the last bullet point was oriented to gather instant feedback from the attendees and based on 9 questions. The answers on these questions are provided in Table 8. Such answers showcase an increased attendance of the webinar by public entities and traffic managers, which is purely in line with the objectives of the current deliverable and the second phase of the training events, but also a very positive stance of attendees against both the content of the training webinar and the C-ITS field in general.

Questions/answers																													
<p>Which sector do you work in?</p> <table border="1"> <caption>Which sector do you work in?</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Public entity (municipality, regional government, etc.)</td> <td>39%</td> </tr> <tr> <td>Traffic manager</td> <td>8%</td> </tr> <tr> <td>Road operator</td> <td>3%</td> </tr> <tr> <td>Fleet operator</td> <td>5%</td> </tr> <tr> <td>Consultant</td> <td>0%</td> </tr> <tr> <td>Other</td> <td>45%</td> </tr> </tbody> </table>	Sector	Percentage	Public entity (municipality, regional government, etc.)	39%	Traffic manager	8%	Road operator	3%	Fleet operator	5%	Consultant	0%	Other	45%	<p>Did you already know about C-ITS?</p> <table border="1"> <caption>Did you already know about C-ITS?</caption> <thead> <tr> <th>Response</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Yes</td> <td>63%</td> </tr> <tr> <td>Yes and I have even worked with them</td> <td>26%</td> </tr> <tr> <td>No</td> <td>11%</td> </tr> </tbody> </table>	Response	Percentage	Yes	63%	Yes and I have even worked with them	26%	No	11%						
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<p>Could you already identify any area in your work environment where you could apply C-ITS?</p>	<p>The contents of this training were appropriate to my needs and knowledge.</p>																												

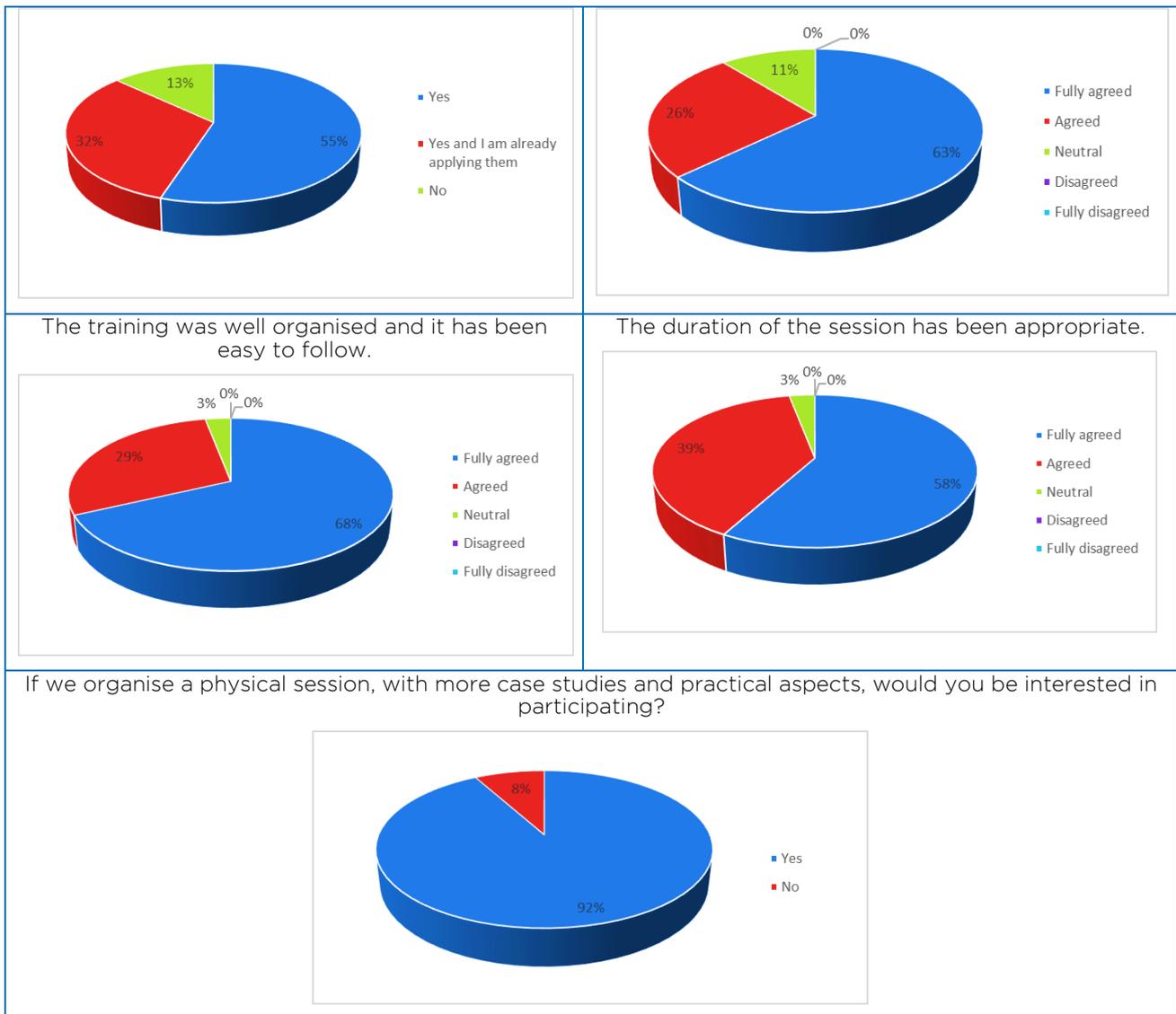


Table 8: Content and results of the live poll of the Barcelona DS training

4.2.2. Bilbao Deployment Site training

Bilbao's Deployment Site training was organized by the City Council of Bilbao (BLB), the Basque Country Mobility and Logistics Cluster (MLC) and CEIT association. The main objective was to introduce the C-ITS concept as well as to present the C-MoBILE project and the specific deployments of Bilbao DS. The training was originally planned to be face-to-face at the municipalities' facilities on the 16th of March 2020. However, due to the COVID-19 outbreak and the associated restrictive measures this event was postponed for the 22nd of April 2020 and it was re-planned in order to take the form of a webinar based on Zoom platform. The agenda of the training included the following:

- / Reception and introduction of all the attendees | 12:00 CET | presenter: Nerea Rojas - MLC/ITS Euskadi
- / Introduction to C-ITS | 12:05 CET | presenter: Pablo Isusi - Bilboko Udala
- / Presentation of the C-MoBILE project | 12:20 CET | presenter: Olatz Iparraguirre - CEIT
- / Presentation of the services deployed in Bilbao DS | 12:35 CET | Olatz Iparraguirre - CEIT
- / Question and training online evaluation | 12:50 CET | Presenter: Nerea Rojas - MLC/ITS Euskadi

The training was targeted towards public authorities (i.e. TMC operators, maintenance supervisors) as well as other city administrators who might be interested in the project. The number of attendees, further to local partners, was 20. The list of attendees mainly included representatives from Bilbao's Municipality and BilboTIK but also some representatives from private companies and the city council.

The main objective of the current Deployment Site can be summarized as follows: Firstly, to introduce the C-ITS systems to the people that will be in contact (directly or indirectly) with these new deployments. Secondly,

to disseminate C-MobILE project and present the advances of the deployment site. The last action was considered as a means of facilitating the extension of the work carried out to other cities and gather new users for the evaluation of the existing services.

The original material upon which the Deployment Site training of Bilbao was based is included in Annex 2. This material is comprised of 31 slides written in the Spanish language and build upon the material drafted for the event corresponding to the 1st training layer, the so-called “Train the Trainer” layer (Section 3). Said slides are structured around 4 main parts:

- ✓ Theoretical part: This part contained the purpose, a description of the structure of the training material presented and it was purposed to create a basic understanding of the main C-ITS components and the C-MobILE project.
- ✓ Introduction to C-ITS: This part contained three subparts, namely “Evolution of the ITS”, “Examples of C-ITS services”, and an “Interactive session”.
 - Evolution of the ITS: This subpart included a review on the sequence of ITS development and transformation. Such subpart was considered as an appropriate means of further facilitating the understanding of C-ITS, including their future steps. It also explained the context, communication schema, and the different business models of C-ITS.
 - Examples of C-ITS services: This subpart included the presentation and description of indicative C-ITS services complemented by a video oriented to offer to the attendees a practical point of view of the concepts presented and described in the presentation’s slides. The services that were presented and described to the participants included: Urban Parking Availability, Road Works Warning, Road Hazard Warning, Green Priority, GLOSA, and Flexible Infrastructure.
 - Interactive session: This subpart was based on a Kahoot poll. Figure 30 depicts an indicative instance of this poll.

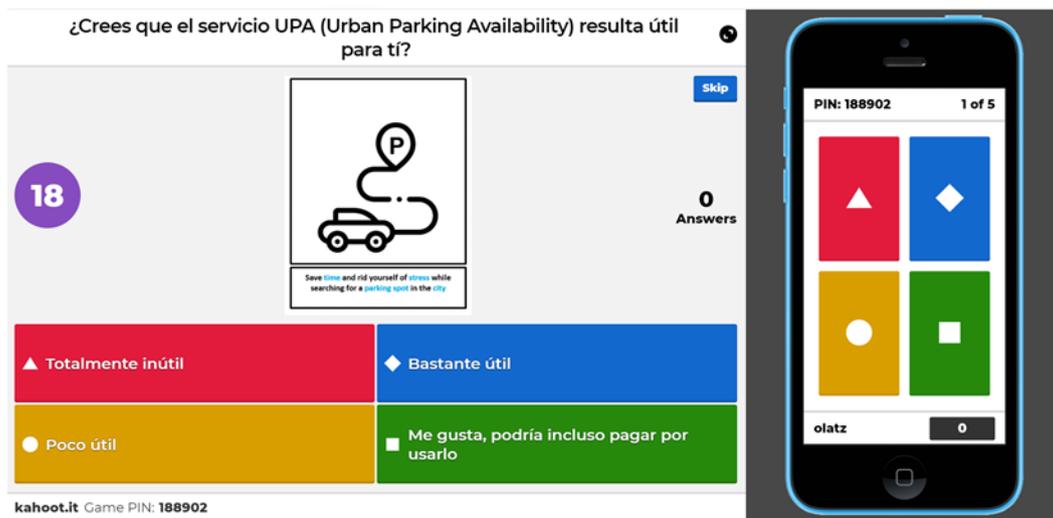


Figure 30: Instance of a Kahoot-based quiz game played in the deployment site training of Bilbao

- ✓ Presentation of the C-MobILE project: This part contained a brief description of the scope of the project, the cities involved, as well as a description of the concepts of connectivity, interoperability, and deployment. Moreover, it included an initial description of the “bundling” concept of C-MobILE by matching some of the services with which the attendees were already familiar. Finally, it included an overview of the C-MobILE architecture as means of helping attendees understand the information flow in the context of the C-ITS services developed during the course of the project.
- ✓ Presentation of the services deployed in Bilbao DS: In this part the services deployed in Bilbao were presented one by one. This presentation included: a) a brief description of each service, b) their targeted users, c) their scope, d) their main benefits, e) their interoperability, and f) the current status of each service.

Moreover, the Deployment Site training in Bilbao included an interactive part that took place at three different moments. At the start of the training, each attendee presented him/herself via the Zoom platform. At the middle of the training, all attendees participated in the Kahoot-based poll that included questions relevant to the presented services. In this respect, they evaluated the usability of each service based on their personal experience. At the end of the training, attendees were given the possibility to ask any doubt or make any comment to the presenters and other local partners, in the context of an open section. Additionally, participants were asked to complete an evaluation form (Google Forms platform) to give their overall feedback on the training session.

As depicted in Figure 31, the overall feedback received by the participants was very positive. All agreed that the training was well organized and effective. The most interesting point of the current training webinar, as perceived by the participants, was the debriefing regarding the status of the C-MobILE project because it gave them the opportunity to feel that public administration's data are indeed useful to generate services for the citizens. Moreover, they found very positive the brief and concise training material as well as their participation in the Kahoot-based poll, where they had the chance to gain insight on the opinions of the rest participants. However, some of them would prefer to have face-to-face training, where participation is more fluid and natural (networking). Finally, they were asked to comment on additional topics they would like to have been included in this training. Most of them found the current topics adequate; nevertheless, some of them indicated that it would have been nice to receive further information regarding scalability problems or future implementations.



Figure 31: Results from the evaluation of the Bilbao Deployment Site training

4.2.3. Bordeaux Deployment Site training

Bordeaux's deployment site training was organized by NeoGLS in cooperation with GERTRUDE. While the training was initially planned to be face-to-face, due to COVID-19 outbreak and the associated restrictive measures, it took place on 27th of April 2020 in the form of a webinar by utilizing the GoToMeeting platform. The purpose of the training webinar was to permit all employees of Bordeaux DS to be up to date about C-ITS technologies and their use cases, in order to be capable of communicating them to their clients (Gertrude has around 10 cities as clients, while NeoGLS has around 8 cities). Another purpose was to validate the material necessary for the 3rd training layer by concluding to a comprehensive and commonly shaped presentation. The training was attended by 22 participants from its very beginning, while 4 more participants arrived some minutes later (in total 26 participants joined the training).

The material upon the training in Bordeaux was based is included in Annex 2. In the first part of the training, Mr. André Perpey (Deployment Site Leader for Bordeaux in the C-MobILE project) provided an overview of C-ITS and an explanation of the different technologies utilized (ITS-G5 and 4G). Then the application and their functionalities were presented. Mr. André Perpey informed participants where they can find the application developed in the context of C-MobILE and what version of Android is needed. He also explained how said application can be used in parallel with a navigation application (Waze and Google Maps) in overlay mode. This also provides an understanding of the permissions required by the application. Then, the following use cases were presented one-by-one:

- / GLOSA: The operational process of GLOSA was explained to the participants by Mr. André Perpey in cooperation with Gertrude, which is the traffic light controller in Bordeaux. Then the different speed advices were explained (i.e. CONTINUE, SLOW DOWN, STOP/ECO). Finally, the benefits resulting from GLOSA were explained (i.e. fluidification of traffic, fuel consumption reduction).
- / Road Hazard Warning (RHW)/Road Works Warning (RWW): The type of information presented to the drivers when approaching road works or a road-hazard zone was presented to the participants.
- / Mode and Trip-Time Advice (MTTA): The main purpose of MTTA, which is to increase the number of users that use the tramway of Bordeaux, was explained to the participants. Moreover, participants were informed regarding the potential of MTTA to reduce the number of vehicles in the centre of Bordeaux.
- / In-Vehicle Signage (IVS): The main functionalities of IVS (e.g. provision of information to drivers regarding road signs and speed limits) and the resulting benefits (e.g. safety-related) were discussed with the participants.

Moreover, some other use cases were discussed with the participants, including Urban Parking Availability, Green Priority, Emergency Vehicle Approaching, Red Light Violation Warning, and Flexible Infrastructure.

The Bordeaux Deployment Site training also included an interactive section based on a Kahoot quiz game. This game included 11 questions related with the material presented to the participants. The game was joined by the entirety of participants and their success rate was up to 45,85%, which is perceived as overall satisfactory by the organizers of the training taking into account the difficulty resulting from the fact that this training was not a face-to-face one. The winner of the game was Mr. Clément Ruffin from NeoGLS (Figure 32).

Finally, the Deployment Site training in Bordeaux included an open section, where participants had the opportunity to ask questions and receive answer by the organizers. Two indicative questions along with their answers are provided next:

Question 1: I used the app two years ago during a trip to Bordeaux during some days. There was no particular issue using the application. I have a question about the virtual message signs. The information is hiding Waze advice and is maybe displayed too big. Did you experience the problem?

Answer 1: Yes, we already had feedback on this. We already reduced the display and try to answer every enhancement request.

Answer 2: Alerts can also be closed by clicking on it. Maybe we can see if a semi-transparent alert could be better.

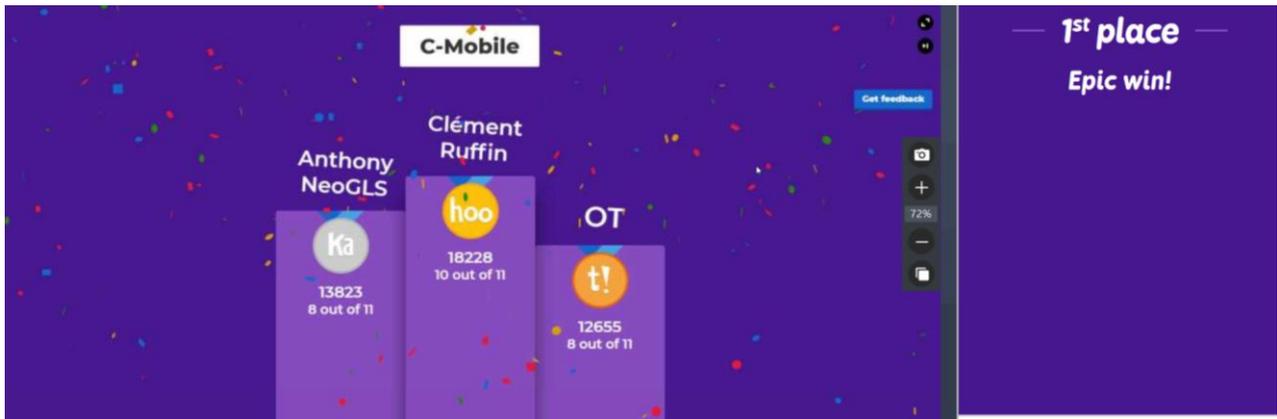


Figure 32: Results from the Kahoot-based quiz game in Bordeaux DS training

Question 2: With the RSU system there is a lot of hardware to deploy. Is it really valuable?

Answer 1: Yes, because the ITS-G5 technology is faster and uses standardized and secured messages.

Follow-up question: This represents a big cost for equipping a whole city. Are the cities interested in deploying C-ITS?

Answer 2: Yes, this represents a big cost but cities seem to understand the interest. For example, deploying a bus-priority system is better using ITS-G5 than existing technologies. Moreover, an RSU can be used for several use cases.

Follow-up question: What communication type is used?

Answer 3: It is ITS-G5 for equipped vehicles and 4G for smartphones. The RSU can do both. An OBU is not necessary to receive the information.

All in all, the feedback received from the participants was very positive. They felt that they have received a lot of useful information during the presentation and they seemed to have understood the purposes and characteristics of the application, because answers during the game were deemed satisfactory. There were some concerns with regards to the overlay above Waze of the Bordeaux's app since in some cases the information concerning direction provided by Waze is hidden. To this end, the size of messaging has been already reduced but an additional solution/enhancement might be explored. The audience also wondered about the price of an RSU and felt that equipping a whole city would be too expensive. To this end, it was indicated by the organizers that RSUs are often installed on specific corridors where necessary and not in a whole city but it is indeed correct that improved business models should be explored in the future.

4.2.4. Copenhagen Deployment Site training

Copenhagen's Deployment Site training was organized by the City of Copenhagen and took place on January 30th 2020. In this event, traffic managers and road operators of the City of Copenhagen were invited. During this event, Mr. Jos van Vlerken (Deployment Site Leader for Copenhagen in the C-MOBILE project), introduced the concept and potentials of urban Cooperative Intelligent Transport Systems (C-ITS), as well as the specific services such as Road Works Warning, Road Hazard Warning and especially GLOSA for cyclists, which will soon be launched for the road users in Copenhagen. The event had a face-to-face character (Figure 33). The agenda of the event included the following:

- / Introduction to C-ITS

- / C-ITS in Traffic Management
- / C-ITS architecture
- / Privacy and Security
- / C-ITS Architecture in Copenhagen
- / C-ITS services in Copenhagen
- / Apps from other deployment sites

The targeted audience were public authority Traffic Managers and Operators of the City of Copenhagen, who will continue the systems developed during the course of the C-MoBILE project and develop additional use cases and methods for the benefit of the road users – especially cyclists and public transport users – in Copenhagen. The reason for inviting them to the training session was to inform them about the deployment and potential of C-ITS and to inspire them to think for the future exploitation of the C-ITS services developed during the C-MoBILE project in relation to their current daily operations. In this way, the training was all about securing quick adoption of the systems and services.

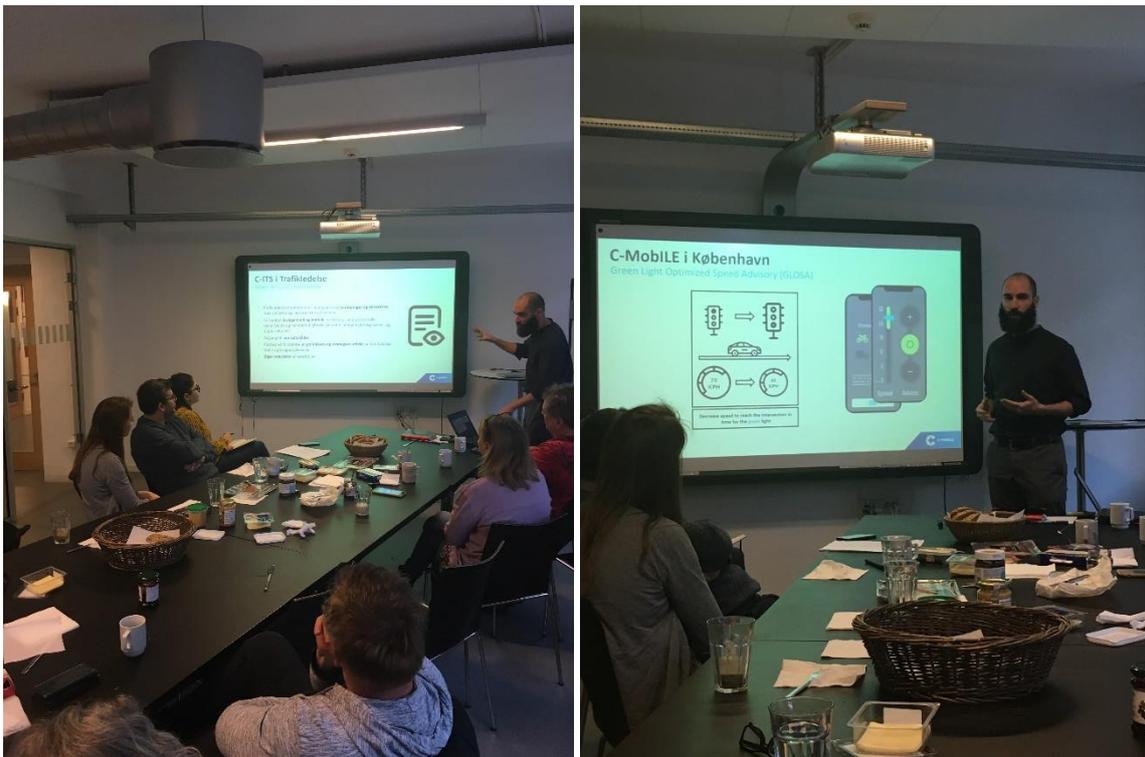


Figure 33: Snapshots from the Copenhagen deployment site training

The training was attended by 25 participants of varying scientific background and field of expertise, such as communication and traffic information, traffic engineering, contract management, etc. The training session ran for almost one hour including a small talk and breakfast in the beginning of the training session, as well as an interactive (Q&A) session after the completion of the presentation. Because of the delay in the actual deployments of the systems and app, the training was purely theoretical, though there was a minor demonstration with an app prototype as part of the Q&A.

The material utilized in this event is included in Annex 2, comprised of 15 slides written in the Danish language and based on the material developed by C-ITS for the needs of the event held in the 5th General Assembly in Vigo, corresponding to the 1st layer of the C-MoBILE training activities (“Train the Trainer”).

The reactions of participants to the training were positive. The more technically competent attendees found interesting the in-depth description of the system interfaces and messages, while the attendees specialized in communication and traffic information topics found interesting the initial presentation and description of the scope of C-ITS services and use cases before moving to a more detailed presentation of the systems and interfaces. Finally, it should be noted that the discussion heavily involved the issue of traffic safety.

4.2.5. Newcastle Deployment Site training

Newcastle’s Deployment Site training was organized by the Newcastle City Council in cooperation with the University of Newcastle and took place on 11th December of 2019 in the form power point-based presentations complemented by discussion with participants as a part of the agenda of the ITS Strategy Group meeting.

The training was attended by 7 participants, while 2 additional being unable to attend the event provided contribution in the form of training material. The audience was comprised of senior officers within their respective organizations (i.e. Sunderland City Council, Gateshead Council, North East Regional Road Safety Resource, Regional Traffic Signals Group, North East Transport Strategy Unit, North Tyneside Council, Northumberland County Council, and Durham County Council). Such a group was selected as they directly influence transport policy and implementation on transport systems regionally, thus being in position to exploit the C-ITS services developed during the course of project.

The purpose of this training was to raise awareness at a senior level of the C-MoBILE activities in Newcastle and the possibilities for further deployment opportunities across the wider geographic region. The presentation was given in two parts, the first concerned the relationship between Traffic Management and C-ITS and the second was specifically focused on the C-MoBILE project's achievements and how they relate to Newcastle city's needs. This was followed by a general Q&A session and informal discussion. The material upon which said presentations were based is included in Annex 2.

Participants' reaction to the training was very positive. Moreover, they seemed to have understood its content to a satisfactory degree. This may be attributed to the fact that said participants are already engaged in the field of C-ITS. For instance, Sunderland and South Tyneside Officers are already engaged with the UK National Highways England looking at a C-ITS Project across their networks and heavily interested for freight movements between the Nissan car plant and the Port of Tyne.

4.2.6. North Brabant Deployment Site training

North Brabant's Deployment Site training is discerned in two events. The first one took place in Helmond, while the second one in Eindhoven.

Helmond's training was held on July 1st 2019. Specifically, Mrs. Tamara Goldsteen from the City of Helmond made a presentation to the sole traffic engineer of the IBOR department within the city of Helmond, who is tasked with the management of technologies related to the concept of Traffic Management as a Service. The purpose of the training was to inform said traffic engineer about the scope and the objectives of the C-MoBILE project as well as about the definition, specifications, and requirements of the C-ITS services developed during the course of the C-MoBILE project. The agenda of the training included the following topics:

- / C-MoBILE C-ITS services
- / Architecture, communication technologies and interoperability
- / C-ITS applications
- / C-ITS Technologies for Traffic Management Centers
- / Data privacy and security
- / Benefits, costs and business cases for C-ITS deployment
- / Q&A

The presentation made to the aforementioned traffic engineer is based on the material utilized in the event corresponding to the first training layer. Moreover, the interactive - Q&A - session between the trainer and the trainee lead to the conclusion that it was really useful for the trainee to learn in more detail about the C-Mobile project and the specifications of its services. However, since the trainee is tasked with the application of the concept of Traffic Management as a Service in a small city without a traditional TMC resourced with a large number of traffic engineers, felt that the information oriented to the integration of C-ITS to the current practice of Traffic Management is less applicable for the city of Helmond.

On the other hand, Eindhoven's training was held on 12th February 2020. Specifically, Mr. Jan Josten from the City of Eindhoven made a presentation to the traffic department of Eindhoven. The participants were actors directly involved in the management of traffic, smart mobility, and traffic design in the city of Eindhoven. To this end, they were already familiar with C-ITS, including its various techniques and developments, as well as with the operation of a Mobility as a Service (MaaS) system in Eindhoven.

The purpose of the training was to showcase to the aforementioned participants the achievements and the scope of the C-MoBILE project and initiate a discussion on the identification of specific fields where the C-ITS services and the (mobile) application developed during the course of the project may be applied. The presentation of this training was based on the material utilized in the event corresponding to the first training layer.

The presentation was not followed by a structured interactive part in the form of a questionnaire or an interactive game, mainly due to the familiarity of the participants with C-ITS. However, participants declared that this presentation constitutes a very interesting reference work and that they were willing to identify synergies with other projects in which they were involved or willing to be involved in the future. This endeavor will be supported by the Eindhoven University of Technology and is expected to conclude to a practical exploitation of the C-MoBILE project's achievements within the city of Eindhoven.

4.2.7. Thessaloniki Deployment Site training

Thessaloniki's Deployment Site training was organized by the Centre for Research and Technology Hellas (CERTH) on April 6th 2020 and took the form of an on-line webinar. In contrary to the initial scheduling and organization plans to hold the event as a physical meeting, the option to have an online webinar was selected due to the COVID-19 situation and the restrictive measures which applied. This was the optimum solution, in order to secure participants' safety and to ensure that no rescheduling will be needed, avoiding this way any delays related to the performance of the training. Participants of the training were representatives and employees from the Region of Central Macedonia (RCM).

The targeted audience for this training phase was representatives from the public authorities of Thessaloniki. More specifically, the focus was on representatives and employees from the Region of Central Macedonia (RCM) which is the authority responsible for the operation of the Traffic Management Center in Thessaloniki and is also a C-MoBILE partner. The purpose of the training was to raise awareness and share the knowledge on C-ITS technologies with local public authorities' representatives of Thessaloniki. The objective was the Deployment Site Leader of Thessaloniki, who had participated in Training Phase 1, to communicate all the acquired experience to a local audience with expertise in traffic management operations and concepts. This way people would become familiar with the relation of C-ITS technologies/ services and traffic management, which could facilitate the smooth integration of such systems into traffic management processes and foster the deployment of C-ITS services.

The theoretical part of the deployment site training in Thessaloniki was based on a presentation comprised of 40 slides written in the Greek language. This presentation is included in Annex 2 and included information on: a) introductory concepts regarding C-ITS technologies, b) C-ITS services implemented in Thessaloniki, c) introductory concepts regarding traffic management, d) correlation of C-ITS technologies/services with traffic management, and e) processes on the integration of C-ITS services to daily traffic management.

The deployment site training in Thessaloniki also included an interactive part which enabled participants to pose questions, express their thoughts on the presented material and share their opinions on the relation of C-ITS services with traffic management.

All participants had very positive reactions on the training event and felt very pleased by the material that were presented to them and the knowledge they received. The information seemed very helpful to them and clarified many theoretical as well as technical issues related to C-ITS technologies and traffic management. Participants showed interest mainly for the integration of C-ITS services to traffic management and especially for the tool for traffic managers/operators which was presented and is currently developed by CERTH. They were really keen on receiving more information in the future and expressed their wish to participate in a meeting where the tool could be showcased to them.

4.2.8. Vigo deployment site training

Vigo's deployment site training was organized by the Automotive Technology Centre of Galicia (CTAG) on 21st May 2020. While it was initially planned to take the form of a face-to-face meeting, in response to COVID outbreak and the resulting restrictive measures it was rescheduled and took the form of a webinar based on Webex platform. The agenda of the training included the following:

- / Attendants reception and introduction | Presenter: Irene Saco (CTAG)
- / Introduction to C-MoBILE Project | Presenter: Irene Saco (CTAG)
- / Introduction to ITS and C-ITS technologies | Presenter: Jose Fernández (CTAG)
- / C-ITS services deployed in Vigo | Presenter: Jose Fernández (CTAG)
- / Presentation of the App & Targeted users | Presenter: David Rubio (CTAG)

Based on the aforementioned agenda, the main objective of the training was to introduce the C-MoBILE project and the C-ITS services that have been developed during the course of the project to the parties that will exploit such services. Such an approach was also deemed as an appropriate strategy of disseminating and promoting the outputs of the project, especially those relating with the city of Vigo (i.e. Vigo's application). It was also deemed that by making the project known and bringing it closer to the aforementioned groups, it would be possible to extend it to other cities and urban environments and to make an increased number of users aware of the benefits and advantages of these services.

The material utilized in Vigo DS training is included in Annex 2. This material was accompanied by the C-MoBILE videos, showcasing the objectives of the project, and a live demonstration of the application developed within Vigo DS. The meeting was attended by participants corresponding to the following categories:

- / Infrastructure companies
- / Transport authorities and policy-makers
- / Data providers

The webinar also included an interactive part, where the participants had the opportunity to ask any doubts and questions. The aim was to establish a dialogue between the attendees and to identify their impressions. Moreover, during the interaction part attendees were asked to fill out a small questionnaire based on AhaSlides survey platform. The current subsection will be updated to include the results of the aforementioned interactive part.

4.3. Phase III

This phase has been postponed due to the COVID-19 outbreak and the willingness of the C-MobILE project management structure to not put in danger the health of the members of the consortium. The event corresponding to this phase is expected to take place in June 2020 as an online meeting. Upon the completion of the event, the content of the current section will be updated.

5. Conclusions

This Deliverable 4.3 constitutes an attempt to provide an overview of training activities that have taken place in the context of the C-MoBILE project. Such training activities were both oriented towards increasing the understanding of the project partners or stakeholders involved in the ecosystem of the C-MoBILE Deployment Sites over the achievements of the project (e.g. developed C-ITS services and applications) and supporting the further uptake of said achievements and their practical exploitation in the current practice of Traffic Management. To this end, this deliverable included a detailed summary of the training approach followed in the C-MoBILE project, a detailed presentation of the material drafted for the first phase of the training events, which navigated to a great extent the content and the structured of the events corresponding to the next phases, as well as a reporting on the content and the outcomes of each event.

Results showcase an increased success rate of the training events held in the context of the project, both in terms of cultivating to actors involved in the ecosystem of the deployment sites the necessary skills and technical competencies to handle and exploit the developed services and applications, and also of promoting the further uptake of the project's outputs.

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Annex 1

Training material of the “Train the Trainer” event

C-MOBILE

**Train the Trainer:
Concepts and preparation
for a C-ITS training and
education plan**

Dr. Evangelos Mitsakis
Areti Kotsi
5th GA, Vigo, Spain
19/06/2019

Co-funded by the European Union

C-Mobile overview

- / Co-funded by the EU Framework Programme for Research and Technology “Horizon 2020”
- / Duration: 42 months (June 2017 – November 2020)

Vision and Goals

- / A congestion-free, sustainable and economically viable mobility in Europe, minimizing the environmental impact of road transport
- / Focus: Complex Urban Areas → 8 European Cities
- / Large-scale deployment of Cooperative Intelligent Transport Systems (C-ITS)
- / Interoperable and seamless provision of C-ITS services to the end users at acceptable prices
- / Cooperation of multiple actors



2 19/06/2019 C-Mobile, C-ITS Training for Public Authorities, 1st Phase- “Train the Trainer”, Vigo, Spain

Session Outline

1	Deployment Site Goals and Roles	
	Purpose of Training within Deployment Sites	2
3	Basics of Training Design	
	Training Methods	4
5	Training Evaluation Frameworks	

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1 / Deployment Site Goals and Roles

Deployment Site Goals

- / The integration of connected vehicle (C-ITS) research concepts into real-life implementation
- / Large-scale deployment and adoption of C-ITS by large groups of end-users
- / Enhancing existing operational capabilities to encourage partnerships of multiple stakeholders



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1 / Deployment Site Goals and Roles

Roles within Deployment Sites

- / Identification and profiling of stakeholders: performed within each deployment site → assess levels of responsibility



Classification of stakeholders: the ones to be kept informed/ the ones to be provided with specific instructions

- / Stakeholders categories
 1. **Participants:** directly involved with the provision of C-ITS services (e.g. agencies, operations/ maintenance staff, equipped drivers, equipped VRUs)
 2. **Trainers:** instruct participants on their roles
 3. **General public:** all travelers, possible end-users in the deployment site



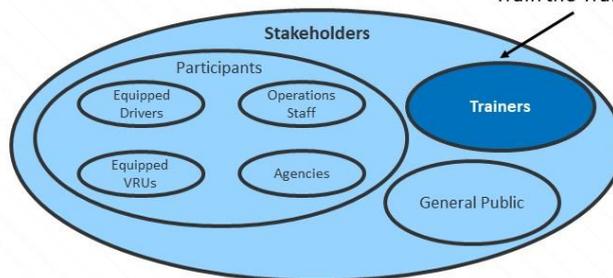
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1 / Deployment Site Goals and Roles

Roles within Deployment Sites

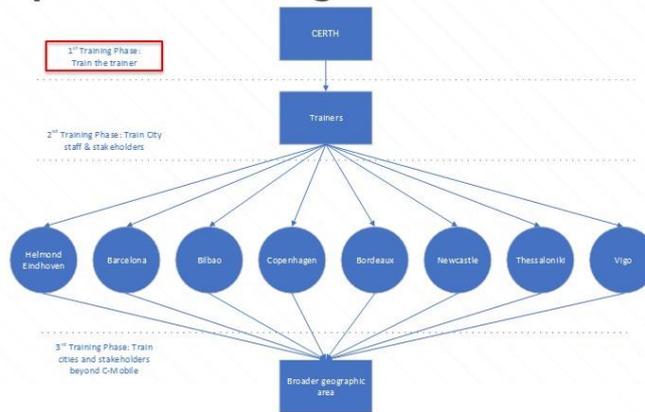
Focus of the 1st phase/ training layer:
"Train the Trainer"



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2 / Purpose of Training



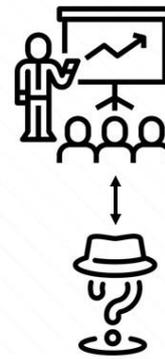
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2 / Purpose of Training

- / The purpose of training within Deployment Sites may vary based on the role and type of the trainees
- / These variations are due to the specific needs of each group

- Equipped Drivers
 - Fleet Managers
 - General Public
 - TMC Operators
 - Technical Staff
 - Maintenance Supervisors
- Public Authorities



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2 / Purpose of Training

Equipped Drivers

- / Become fully familiar with the Human Machine Interface (HMI) of C-ITS services
- / Be aware of the kind of messages they could receive (i.e. alert, advice)
- / Be able to interpret correctly the information and react timely-accordingly
- / Understand how to provide information via the HMI (e.g. report a crash)
- / Be able to provide feedback regarding the App (e.g. report bugs)
- / Be engaged with feedback provision procedures (e.g. surveys, DS website)
- / Know with whom to communicate in cases of malfunctions (helpdesk)



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2 / Purpose of Training

Fleet Managers

- / Have a basic understanding of C-Mobile project scope-goal-progress
- / Understand the features of provided C-ITS services and the nature of information they enclose
- / Be aware of new business opportunities



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2 / Purpose of Training

General Public

- / Have a basic understanding of the C-Mobile project scope-goals-progress
- / Understand the features of provided C-ITS services and the nature of information they enclose
- / Be aware of the benefits resulting from the use of C-ITS services



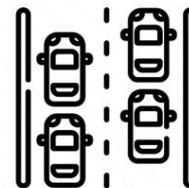
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2 / Purpose of Training

Public Authorities: TMC Operators

- / Understand how to interact with new/updated platforms (e.g. Bundling Operators View) to utilize C-ITS systems/components
- / Be able to identify and interpret any new information provided through the new/updated platforms
- / Be able to assess information accuracy/ liability
- / Be in position to provide limited troubleshooting
- / Be in position to better understand how to exploit vehicles connectivity capabilities (C-ITS)



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2 / Purpose of Training

Public Authorities: **Technical Staff**

- / Be able to install and uninstall equipment or software (or requirements thereof)
- / Learn how to effectively maintain the equipment or software, e.g. scheduled maintenance, emergency repairs
- / Be in position to provide full troubleshooting support



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2 / Purpose of Training

Public Authorities: **Maintenance Supervisors**

- / Clearly understand C-Mobile project scope-goals-progress
- / Be familiar with maintenance and repair procedures, in order to supervise and assess the performance of related tasks



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2 / Purpose of Training

Trainers

- / Fully understand the C-Mobile project scope-goals-progress
- / Fully understand the rationale of the overall training plan (including all phases and materials)
- / Their approach should be oriented towards fulfilling the individual needs of the trainee groups
- / Need to be equipped with a wide range of skills and play a variety of roles



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3 / Basics of Training Design

The roles and skills of a Trainer

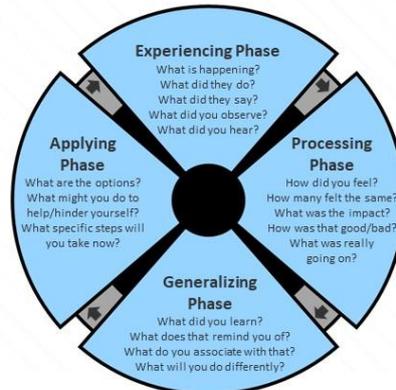
Designer <ul style="list-style-type: none"> Adapts the training programme to meet the needs of the trainees Knows and uses the principles of teaching adults Introduces adequate training methods Designs training manual and learning materials Delivers train-the-trainer workshops 	Organizer <p>Before training:</p> <ul style="list-style-type: none"> Learns about the participants and training location Prepares materials Arranges venue/hosting <p>During training:</p> <ul style="list-style-type: none"> Takes care of trainees and training resources <p>After training:</p> <ul style="list-style-type: none"> Removes sensitive materials developed during training Facilitates training evaluation
Leader <ul style="list-style-type: none"> Defines the training situation Manages the work of the training group Acts towards reaching the training goals Understands and controls the group process Reacts in difficult/unexpected situations 	Moderator <ul style="list-style-type: none"> Uses discussion as a learning method Know and uses methods of leading discussion Stimulates engagement of trainees Activates the process of sharing experiences
Presenter <ul style="list-style-type: none"> Defines presentation structure and delivers presentation Reinforces interest of the training group Facilitates understanding of the presentation Inspires and engages audience Uses appropriate tone, visual aids and body language Keeps contact with the audience 	Ally <ul style="list-style-type: none"> Takes care of good and friendly contact with the training group Promotes trainees' feeling of security Supports trainees in exercises/workshops Amplifies positive behaviors Facilitates good relations between participants
Expert <ul style="list-style-type: none"> Presents the subject Makes use of their expertise 	

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3 / Basics of Training Design

How do we learn?

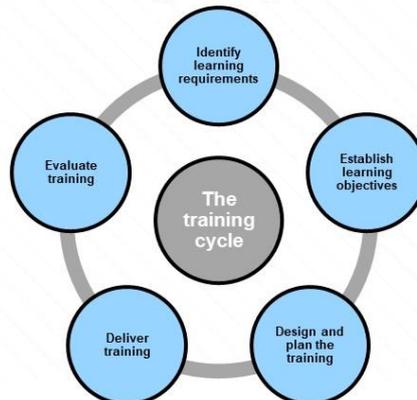


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3 / Basics of Training Design

The training cycle

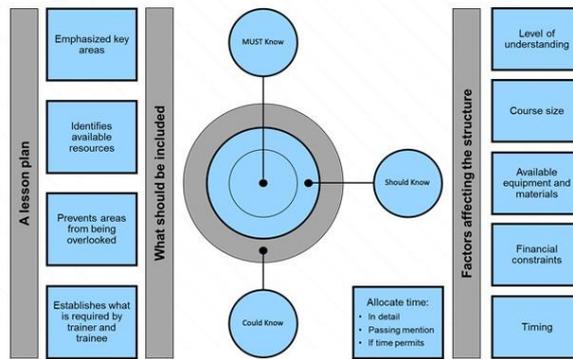


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3 / Basics of Training Design

Designing a training session



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4 / Training Methods

Comparing the various methods

Evaluation of the Effectiveness of Training Methods	1= High 8 = Low	Knowledge acquisition	Attitude change	Problem solving	Interpersonal skills	Participants acceptance	Knowledge retention
	Case Study	Medium 4	Medium 5	High 1	Medium 5	High 1	Medium 4
Workshop	High 1	Medium 3	Medium 4	Medium 4	Medium 5	High 2	
Lecture	Low 8	Low 7	Low 7	Low 8	Low 7	Medium 3	
Games	Medium 5	Medium 4	High 2	Medium 3	High 2	Low 7	
Films	Medium 6	Medium 6	Low 8	Medium 6	Medium 4	Medium 5	
Programmed Instruction	Low 3	Low 8	Medium 6	Low 7	Medium 8	High 1	
Role Playing	High 2	High 2	Medium 3	High 1	Medium 3	Medium 6	
Sensitivity Group	Low 7	High 1	Medium 5	High 2	Medium 6	Low 8	

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4 / Training Methods

Summary of training methods (1/4)

Method	Description	Advantages/ Disadvantage	Group Size
Case Study	Group presented with factual information based on a real situation and asked to discuss the problems, analyze the issues and provide recommendations	+ Simulates working reality + Risk free exercise - Time consuming to prepare - If not topical loses credibility	Limited
Workshop	Opportunity to discuss or discover practical approaches to handling a given situation. Emphasis on practical realities rather than theoretical input and very subject specific	+ Transferable training immediately applicable + Informality - Different learning requirements of participants	Limited

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4 / Training Methods

Summary of training methods (2/4)

Method	Description	Advantages/ Disadvantage	Group Size
Lecture	Verbal presentation of a single topic with or without the use of audiovisual aids. May include opportunities for feedback as means of increasing participation	<ul style="list-style-type: none"> + High level of control over time and content + Suitable for large groups - Lacks in interaction - Low retention 	Unlimited
Games	The form depends on the game or exercise in question. They generally involve an element of competition or change.	<ul style="list-style-type: none"> + Provides overview of training + Demonstrates interdependencies + May help in team building - Possible resistance to playing "games" - May feel unrealistic 	Varies

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4 / Training Methods

Summary of training methods (3/4)

Method	Description	Advantages/ Disadvantage	Group Size
Film	May provide a pre-recorded training film on the subject or be used as a means of showing a live contemporaneous action. May use documentary and/or dramatization styles.	<ul style="list-style-type: none"> + Entertaining + Memorable - Expensive to make - Requires equipment - Can be seen as "filling in" time 	Unlimited but best for smaller groups.
Programmed Instruction	Means of presenting information in a systematic way (by book or computer), so that after each segment (or "frame") of information the learner is required to test their understanding. If this response is correct the participant will continue. If incorrect either the right response is indicated or the information is repeated before re- checking understanding.	<ul style="list-style-type: none"> + Learning pace set by individual/ group + Instant feedback - Complicated to develop 	Unlimited

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4 / Training Methods

Summary of training methods (4/4)

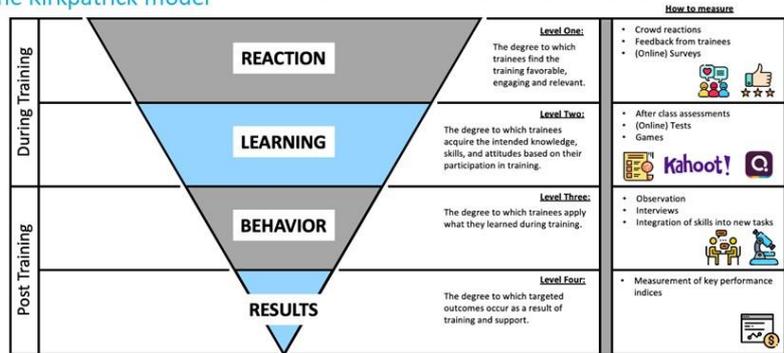
Method	Description	Advantages/ Disadvantage	Group Size
Role Playing	Enactment of selected situations related to the subject at hand allowing the group to explore variety of approaches to a given set of circumstances	<ul style="list-style-type: none"> + Enjoyable + Develops empathy and team spirit - Can become frivolous - Gauge of performance not problems 	Limited
Sensitivity Group	Means of gaining insight into the effect of behavior on others by encouraging members of the group to examine and comment upon both the behavior of the group and the individuals who go to make up the group	<ul style="list-style-type: none"> + Widens understanding of human behavior and responses + Increases personal development - Open and intensive nature can be intimidating - Needs special training to handle high risks involved 	Limited

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5 / Training evaluation frameworks

The Kirkpatrick model



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Thank you for your attention!

Dr. Evangelos Mitsakis
Areti Kotsi
5th GA, Vigo, Spain
19/06/2019

Co-funded by the European Union 

Train the Trainer: Building Trainer skills - Part I

Dr. Evangelos Mitsakis
Areti Kotsi
Vigo, Spain
19/06/2019

Session Outline /

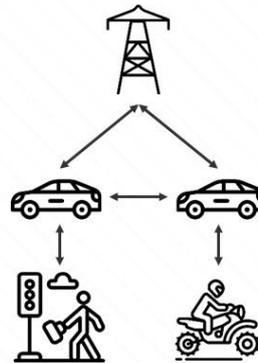
1	Introduction to C-ITS	
	C-ITS Architecture of C-Mobile	2
3	Communication Technologies & Interoperability	
	Data Privacy & Security	4
5	C-ITS Services in C-MOBILE	
	Applications Developed within C-MOBILE	6

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1 / Introduction to C-ITS

Cooperative Intelligent Transport Systems

- / C-ITS provide real time communication between vehicles, infrastructure and other road users
- / C-ITS may be understood as enhanced conventional ITS through:
 - the latest communications standards
 - the provision of tailored services that can provide benefits
 - Driver/traveler experience
 - Operational savings
 - Delivery of traffic management objectives
 - Policy goals (e.g. safety, reduced emissions)



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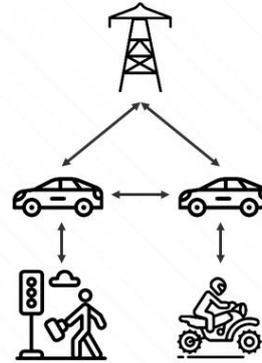
1 / Introduction to C-ITS

Cooperative Intelligent Transport Systems

/ Precise definitions include:

- ... a group of technologies and applications that allow effective **data exchange through wireless technologies among elements and actors of the transport system**, very often between vehicles (vehicle-to-vehicle or **V2V**) or between vehicles and infrastructure (vehicle-to-infrastructure or **V2I**) (but also with) vulnerable road users such as pedestrians, cyclists or motorcyclists
- Telematics and all types of communications in vehicles, between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure)

/ Due to the connectivity features that C-ITS encompass, they are sometimes referred to as **connected vehicle technology**



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1 / Introduction to C-ITS

Connected Vehicles

/ The term refers to applications, services, and technologies that connect a vehicle to its surroundings

/ Such vehicles are equipped with various communication devices that enable in-car connectivity with other devices present in the vehicle and/or enable connection of the vehicle to external devices, networks, applications, and services

/ Applications encompass areas such as traffic safety and efficiency, infotainment, parking assistance, roadside assistance, remote diagnostics, and telematics to autonomous self-driving vehicles and global positioning systems (GPS)

/ Vehicles that include interactive advanced driver-assistance systems (ADAS) and cooperative intelligent transport systems (C-ITS) can be regarded as connected

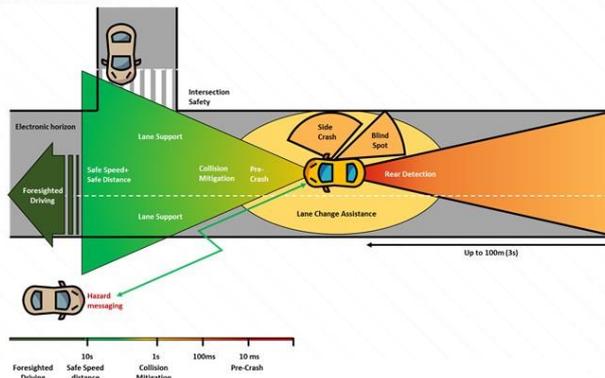


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1 / Introduction to C-ITS

C-ITS as an opportunity



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12

1 / Introduction to C-ITS

Evolution of C-ITS

- / C-ITS has developed quickly since the mid-2000s
- / Much of the development has come through EU-funded projects which refined the V2V and V2I communications and assessed the standards necessary for a wider uptake
- / Examples of early projects:
 - CVIS
 - COOPERS
 - SAFESPOT
 - COMeSafety
 - DRIVE C2X
 - FOTSis



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1 / Introduction to C-ITS

Evolution of C-ITS – Overview of European C-ITS projects and initiatives

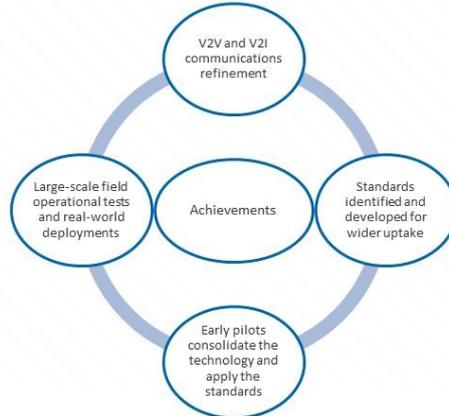


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1 / Introduction to C-ITS

Evolution of C-ITS

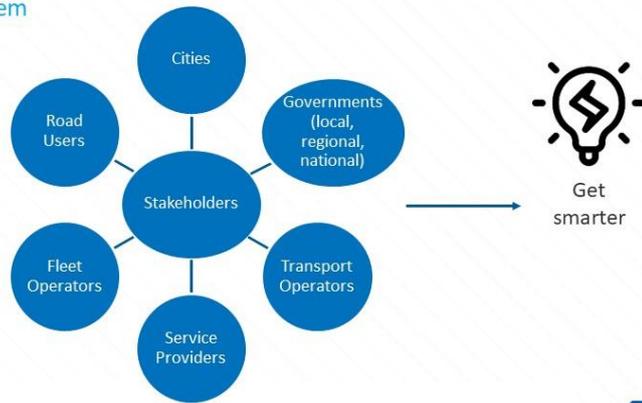


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1 / Introduction to C-ITS

C-ITS Ecosystem



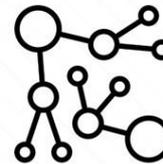
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1 / Introduction to C-ITS

Bundling concept

- / State-of-the-art perception on C-ITS services provision
- / Bundling is the coordinated provision of several C-ITS services
- / Service bundles are developed and provided in the form of open, modular and extendable applications bringing together a complete suite of C-ITS services under one common user environment
- / Benefits
 - Flexibility
 - Cost efficiency
 - Savings in infrastructure requirements



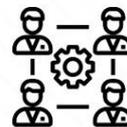
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2 / C-ITS Architecture

General notions

- / The definition of a comprehensive and consistent architecture framework
- / Valuable guidance to the development of complex systems such as C-ITS
- / Supports the communication and cooperation between different stakeholders during the whole life-cycle of the system
- / According to the ISO/IEC/IEEE 42010:2011 standard an architecture framework:
 - ... establishes a common practice for creating, interpreting, analyzing and using architecture descriptions within a particular domain of application or stakeholder community



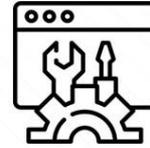
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2 / C-ITS Architecture

C-ITS design principles

- / **Interoperability:** degree to which two or more systems can exchange and utilize (exchanged) information
- / **Security:** degree to which the system protects information and data
- / **Performance efficiency:** balance between resource consumption and provided services
- / **Usability:** degree to which the system can be used in order to achieve specified goals
- / **Reliability:** ability of the system to perform the right functions under specified circumstances
- / **Availability:** the degree to which the system is accessible and operational
- / **Adaptability:** the degree to which the system can adapt efficiently and effectively to different or evolving hardware/ software/ environments

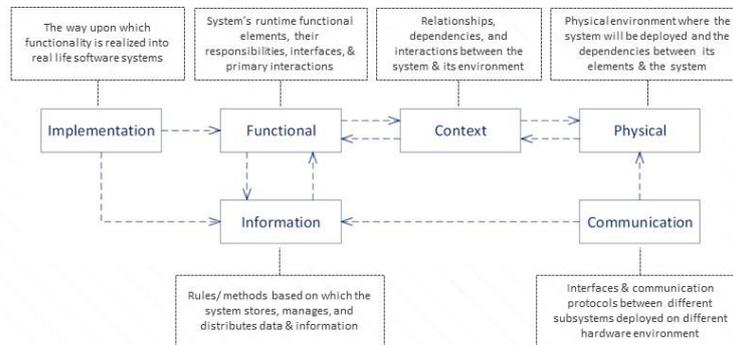


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2 / C-ITS Architecture

C-MOBILE architecture viewpoints



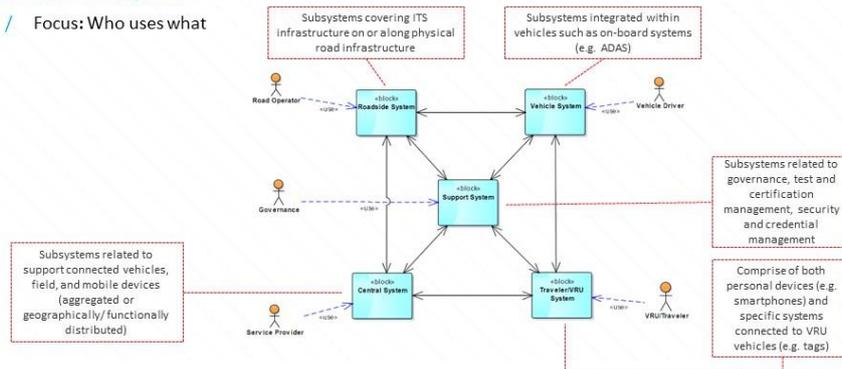
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2 / C-ITS Architecture

Context Viewpoint

- / Focus: Who uses what



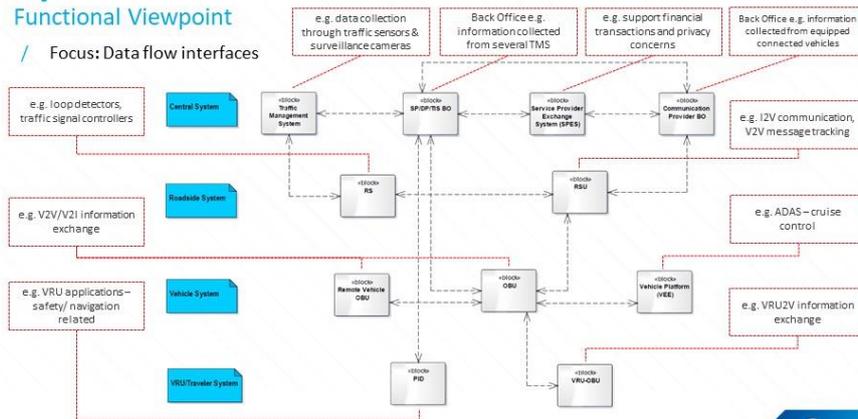
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2 / C-ITS Architecture

Functional Viewpoint

/ Focus: Data flow interfaces



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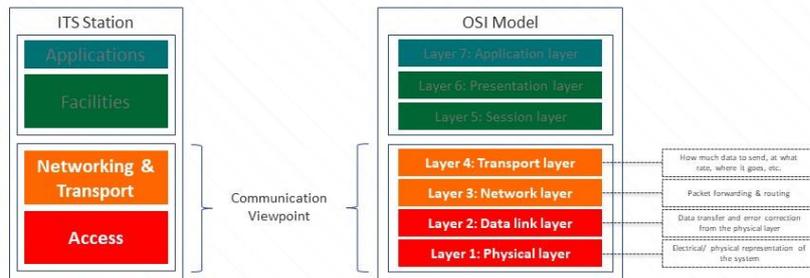


2 / C-ITS Architecture

Communication Viewpoint

/ Focus: Communication mode

/ This viewpoint can be matched to the first 4 layers of Open Systems Interconnection model



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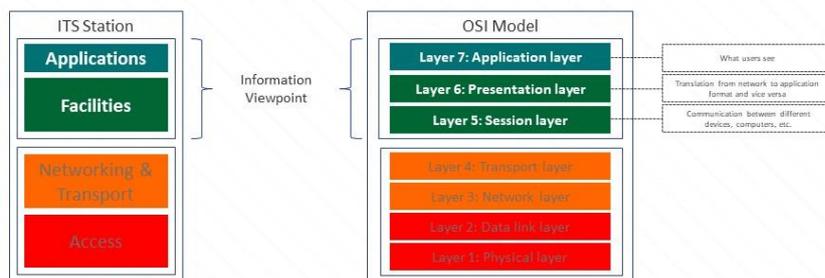


2 / C-ITS Architecture

Information Viewpoint

/ Focus: how data & information are stored, managed and distributed

/ This viewpoint can be matched to the last 3 layers of Open Systems Interconnection model



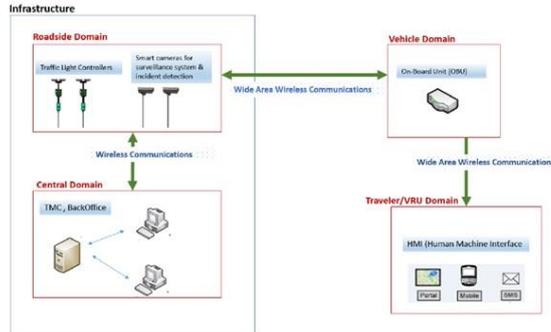
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2 / C-ITS Architecture

Physical Viewpoint

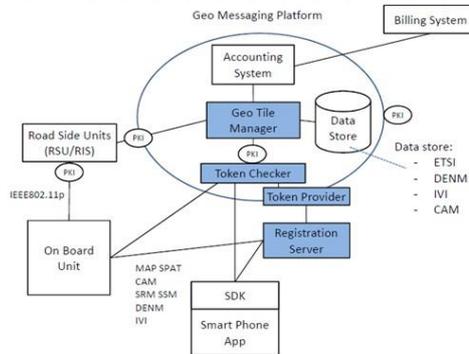
/ Focus: Connections between physical components



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2 / GeoMessaging Platform



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3 / Communication Technologies & Interoperability

C-ITS communication technologies

- / The communication technologies for C-ITS are based on standards which are developed by various organization such as:
 - the European Telecommunications Standards Institute (ETSI)
 - the European Committee for Standardization (CEN)
 - the International Organization for Standardization (ISO)
- / They can generally be classified as "short-range" and "long-range" technologies

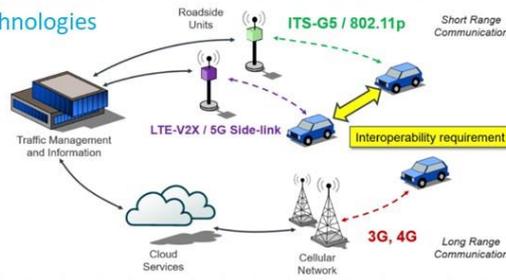


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3 / Communication Technologies & Interoperability

C-ITS communication technologies



- / ETSI ITS-G5 provides low latencies (useful for time-critical messages)
- / Cellular networks provide wider coverage and scalable access to a large number of devices

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3 / Communication Technologies & Interoperability

Using standards and interoperability

- / Standards should be aligned within the community of stakeholders who use them
- / Ensure interoperability and conformity
- / This alignment is achieved via **profiling**
- / A profile includes the minimum set of requirements for harmoniously utilizing the various standards
- / In addition to standards, there are various guidelines to help developers to implement interoperable and safe C-ITS apps & services (incl. ITS Deployment & HMI Guidelines)



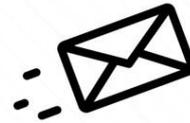
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3 / Communication Technologies & Interoperability

C-ITS standardized message sets

- / **Cooperative Awareness Message (CAM)**: a message ("I am here") sent by a vehicle one to ten times per second with data on vehicle position, direction, speed, etc.
- / **Distributed Environmental Notification Message (DENM)**: warning message (e.g. slippery road, crash) sent with high priority to a vehicle based on information from the vehicle or the infrastructure
- / **Signal Phase & Timing (SPaT)** : information to the vehicle on traffic light state and future state changes
- / **In-vehicle information (IVI)** : presentation of physical road sign information inside the vehicle
- / **MAP**: describes the physical geometry of an intersection



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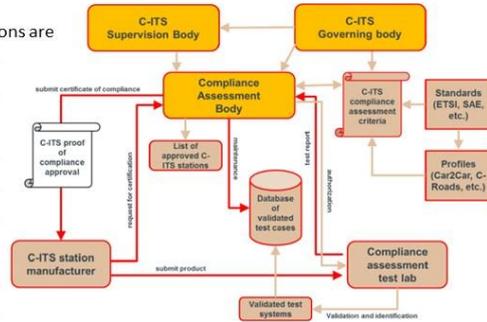


3 / Communication Technologies & Interoperability

Compliance assessment

/ Purpose: ensure that only valid ITS stations are deployed

- Safe
- Fit for purpose
- Interoperable
- Support an open vendor market

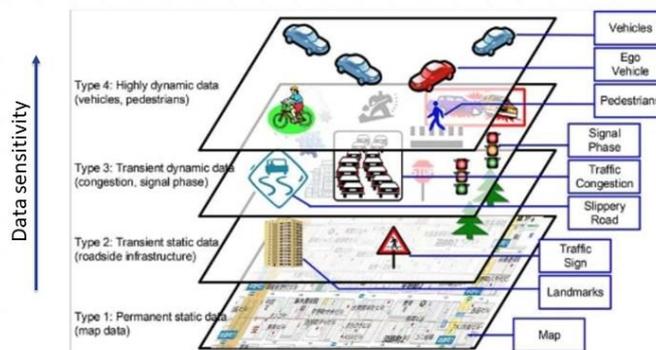


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4 / Data privacy and security

C-ITS data sensitivity



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4 / Data privacy and security

The six principles of GDPR

1. Lawfulness, fairness and transparency
2. Purpose limitation
3. Data minimization
4. Accuracy
5. Storage limitation
6. Integrity and confidentiality



/ Two principles are significantly challenging for C-ITS: **transparency** and **data minimization**

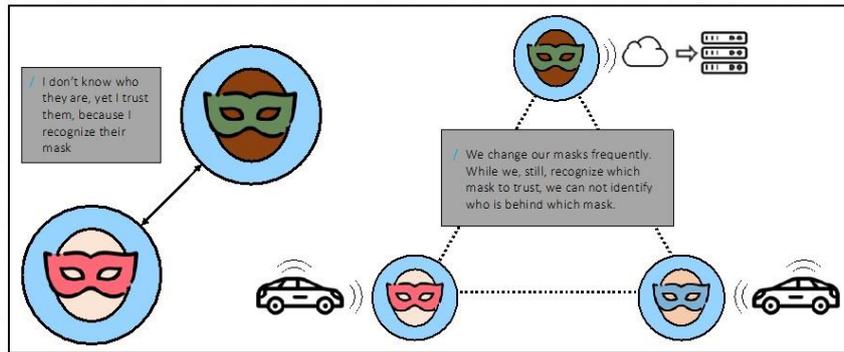
/ The GDPR introduces the concept of **pseudonymity** serving as a tool to relax the strict requirements for anonymization

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4 / Data privacy and security

Security PKI pseudonymization using authorization tickets

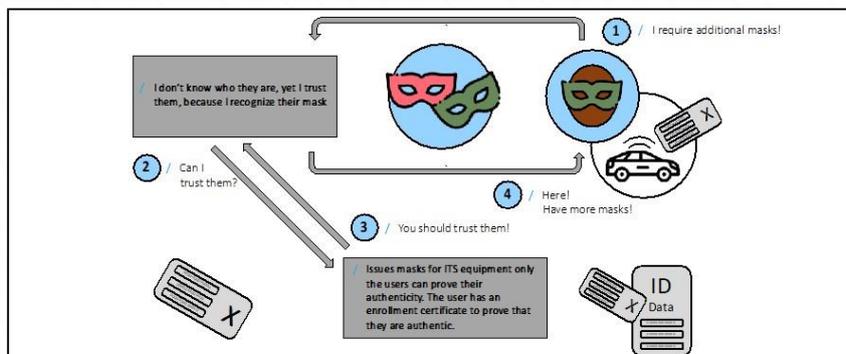


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4 / Data privacy and security

Relationship between the authorization and the enrollment authorities

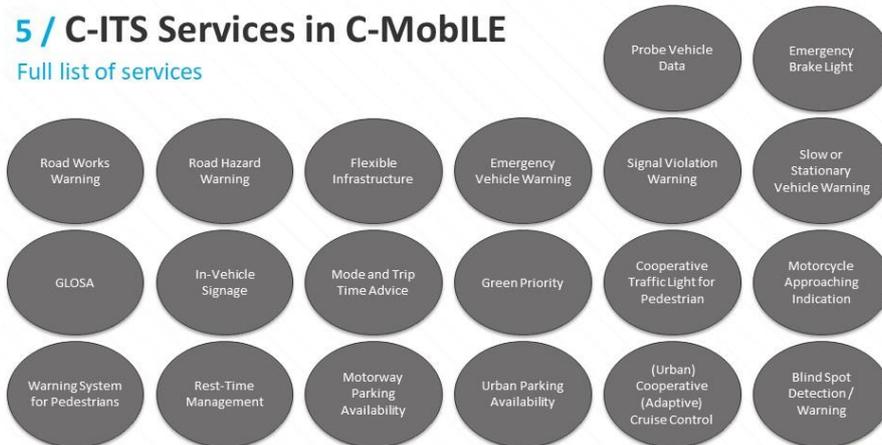


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5 / C-ITS Services in C-MOBILE

Full list of services



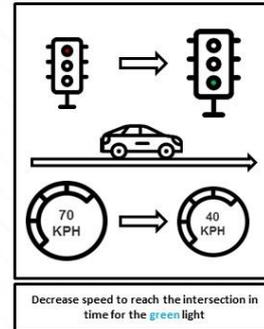
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5 / C-ITS Services in C-Mobile

Green Light Optimized Speed Advisory (GLOSA)

- / GLOSA provides drivers an optimal speed advice when they approach to a signalized intersection
- / This advice may involve maintaining actual speed, slowing down, or adapting to a specific speed
- / If a green traffic light cannot be reached in time, GLOSA may also provide time-to-green information when the vehicle is stopped in the stop bar
- / Application of GLOSA takes advantage of real-time traffic sensing and infrastructure information, which can then be communicated to a vehicle
- / It contributes to the reduction of fuel consumption and emissions.



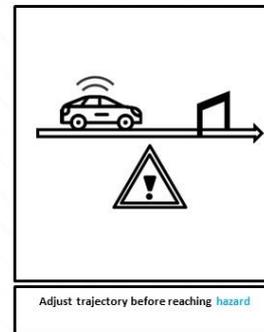
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5 / C-ITS Services in C-Mobile

Road Hazard Warning (including traffic jams)

- / The road hazard warning service aims to inform the drivers in a timely manner of upcoming, and possibly dangerous events and locations
- / This allows drivers to be better prepared for the upcoming hazards and make necessary adjustments and manoeuvres in advance
- / It is also known as "Hazardous location notification" or "Road hazard signaling"



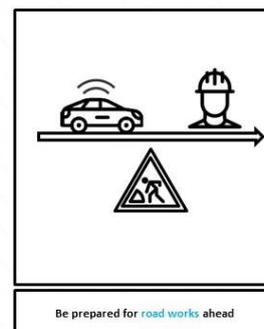
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5 / C-ITS Services in C-Mobile

Road Works Warning

- / Road works warning aims to inform the drivers in a timely manner about road works, restrictions, and instructions
- / This allows them to be better prepared for potential works downstream on the road
- / It therefore reduces the probability of collisions



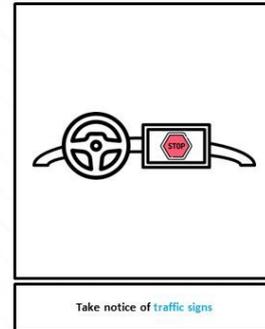
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5 / C-ITS Services in C-Mobile

In-Vehicle signage

- / In-vehicle signage aims to provide information to the driver about the road signs
- / It includes dynamic information (e.g. local conditions warnings identified by environmental sensors)
- / The purpose of this service is to increase the likelihood of drivers being aware of potentially dangerous conditions in case a roadside traffic sign is not noticed



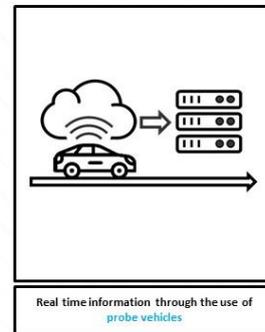
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5 / C-ITS Services in C-Mobile

Probe Vehicle Data

- / Probe Vehicle Data is data generated by vehicles
- / The collected traffic data can be used as input for operational traffic management
- / Examples include the determination of traffic speed, management of traffic flows, long term tactical/strategic purposes, and for traveler information services.
- / Also known as Floating Car Data (FCD)



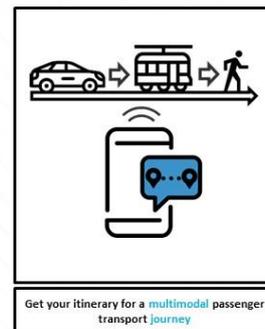
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Mode & Trip Time Advice

- / Mode & trip time advice (e.g. by incentives) aims to provide a traveler with an itinerary
- / The itinerary is for a multimodal passenger transport journey
- / It takes into account real-time and/ or static multimodal journey information



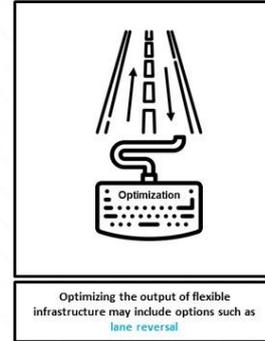
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Flexible Infrastructure

- / Flexible infrastructure aims to interchange information about the lanes provided to the traffic users according to the time of the day
- / It includes solutions such as reserved lane



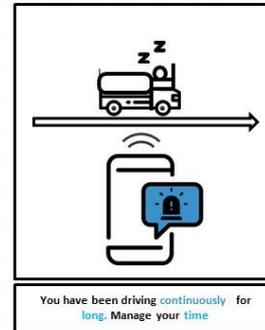
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Rest-Time Management

- / Rest time management supports managing the working hours of drivers engaged in the carriage of goods and passengers by road
- / The process is regulated by policies, laws or regulations that lay down the rules on driving times, breaks and rest periods for the drivers



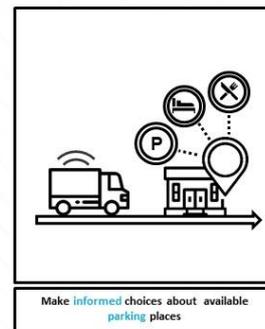
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Motorway Parking Availability

- / MPA provides motorway parking availability information and guidance for truck drivers to make informed choices about available parking places
- / Existing solutions provide information about the:
 - location of parks,
 - capacity,
 - available equipment,
 - facilities on site,
 - security equipment, and
 - information about dangerous goods parking



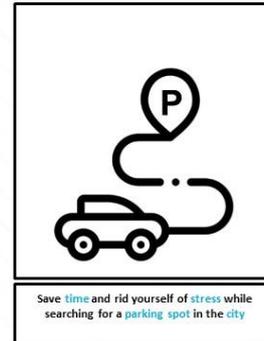
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Urban Parking Availability

- / UPA provides parking availability information and guidance for drivers to make informed choices about available parking places
- / This service aims to reduce:
 - congestion,
 - time loss,
 - pollution, and
 - stress caused by cruising for parking.



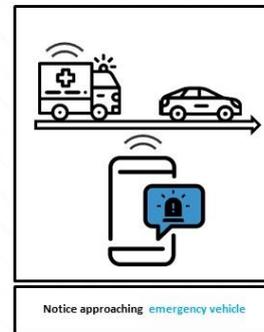
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5 / C-ITS Services in C-Mobile

Emergency Vehicle Warning

- / Emergency vehicle warning uses information provided by the emergency vehicle to inform a driver of another vehicle about an approaching emergency vehicle
- / It works even when the siren and light bar of the emergency vehicle may not yet be audible or visible
- / This is also known as "Emergency Vehicle Alert (EVA)", which alerts the driver about the location and the movement of public safety vehicles responding to an incident so the driver does not interfere with the emergency response
- / The service is enabled by receiving information about the location and status of nearby emergency vehicles responding to an incident



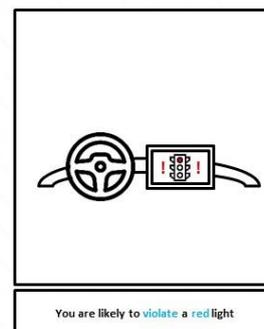
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5 / C-ITS Services in C-Mobile

Signal Violation Warning

- / Signal Violation Warning aims to reduce the number and severity of collisions at signalised intersections
- / This is achieved by warning drivers who are likely -due to high speed- to violate a red light
- / Also known as the "Signal violation / Intersection Safety" or "Red Light Violation Warning"



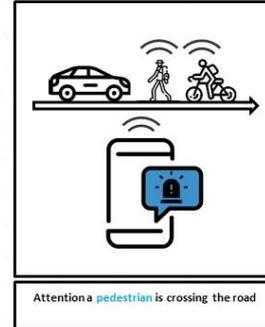
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5 / C-ITS Services in C-Mobile

Warning System for Pedestrians

- / Warning system for pedestrian aims to detect risky situations (e.g. road crossing) involving pedestrians
- / Allows the possibility to warn vehicle drivers
- / The warning is based on pedestrian detection
- / The scope of the service can be extended to cover other VRUs (e.g. cyclists)
- / The service is particularly valuable when the driver is distracted or visibility is poor
- / Also known as "Vulnerable road user Warning"



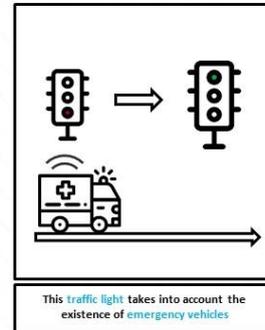
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5 / C-ITS Services in C-Mobile

Green Priority

- / Green priority aims to change the traffic signals status in the path of an emergency or high priority vehicle (e.g. public transportation vehicle)
- / It halts conflicting traffic and allows the emergency vehicle right-of-way, to help reduce response times and enhance traffic safety.
- / Different levels of priority can be applied, e.g. extension or termination of current phase to switch to the required phase.
- / The appropriate level of green priority depends on vehicle characteristics, such as type (e.g. HGV or emergency vehicle) or status (e.g. public transport vehicle on-time or behind schedule)
- / The vehicles request priority for an intersection, and the traffic light controller determines in what way it can and will respond the request



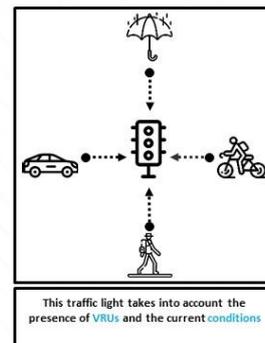
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Cooperative Traffic Light for Vulnerable Road Users

- / Cooperative traffic light for VRUs aims to increase the safety of pedestrians through warranting priority or additional crossing time (i.e. extending the green light phase or lessening the red phase)
- / It is based on pedestrian characteristics (or on special conditions, such as weather)
- / The service can also be extended to cover other VRUs such as cyclists
- / The service is also known as "Pedestrian Mobility" or "Traffic light prioritisation for designated VRUs"



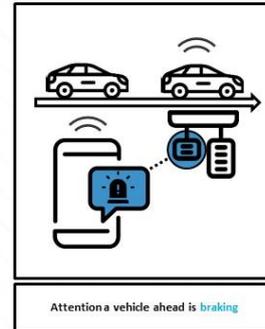
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5 / C-ITS Services in C-Mobile

Emergency Brake Light

- / Emergency Brake Light aims to avoid (fatal) rear end collisions
- / Such collisions can occur if a vehicle ahead suddenly brakes, especially in dense driving situations or in situations with decreased visibility
- / The driver is warned before s/he is able to realize that the vehicle ahead is braking hard
- / This is particularly important if s/he does not see the vehicle ahead directly (vehicles in between)



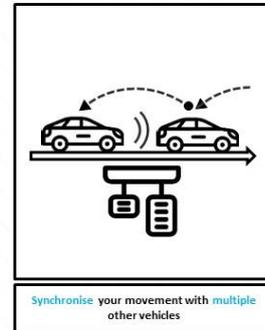
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Cooperative (Adaptive) Cruise Control

- / Cooperative Adaptive Cruise Control represents an evolutionary advancement of conventional cruise control (CCC) and adaptive cruise control (ACC)
- / It utilizes V2V communications to automatically synchronize the motion of many vehicles
- / While ACC uses Radar or LIDAR measurements to derive the range to the vehicle in front, CACC also takes the preceding vehicle's acceleration into account



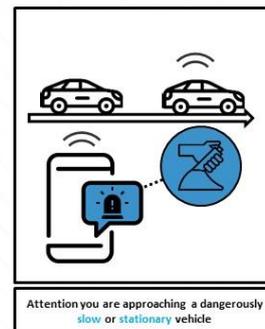
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Slow or Stationary Vehicle Warning

- / Slow or stationary vehicle warning aims to inform/ alert approaching vehicles of (dangerously) immobilized, stationary or slow vehicles that impose significant risk



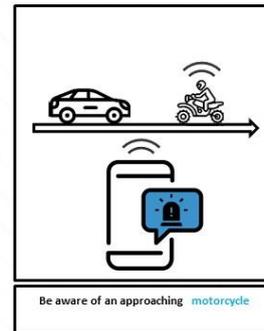
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5 / C-ITS Services in C-Mobile

Motorcycle Approaching Indication

- / Motorcycle approaching indication informs the driver of a vehicle that a motorcycle is approaching/passing.
- / The scope can be extended to cover other VRUs, such as cyclists and other Powered Two Wheelers (PTW).
- / The motorcycle could be approaching from behind or crossing at an intersection.



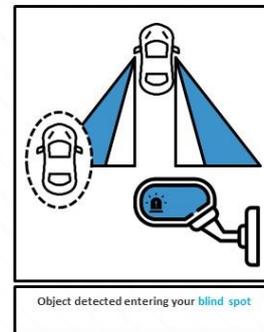
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5 / C-ITS Services in C-Mobile

Blind Spot Detection / Warning

- / Blind spot detection aims to detect and warn the drivers about other vehicles of any type located out of sight



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6 / Apps within C-Mobile

Barcelona DS

- / Based on cellular communications
- / Developed by IDIADA
- / Services: Road Works Warning, Road Hazard Warning, Emergency Vehicle Warning, GLOSA, Signal Violation Warning, Flexible Infrastructure, Mode and Trip Time Advice, Probe Vehicle Data, Warning System for Pedestrians, Approaching Motorcycle Indication
- / End-user can keep using their preferred navigation application (e.g. Google Maps, MAPS.ME, etc.)
- / App is working in the background



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6 / Apps within C-Mobile

Bordeaux DS

- / Orientation: increase road-safety, traffic efficiency and reduce environmental impacts
- / Free app developed by NeoGLS
- / Provides information for: Road Works Warning, Road Hazard Warning, Emergency Vehicle Warning, GLOSA, Red Light Violation Warning, In-Vehicle Signage, Parking Availability



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6 / Apps within C-Mobile

Bilbao DS

- / Orientation: increase road-safety, traffic efficiency and reduce environmental impacts
- / C-ITS services will be provided to the end-users via different apps developed by different partners
- / These apps will cover: Road Works Warning, Road Hazard Warning, Urban Parking Availability, Motorway Parking Availability, Blind Spot Detection



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6 / Apps within C-Mobile

Copenhagen DS

- / Orientation: increase road-safety, traffic efficiency and reduce environmental impacts
- / GreenCatch is a GLOSA app being repurposed to include additional services
- / These services include: Green Priority, Road Works Warning, Road Hazard Warning, Warning System for Pedestrians
- / Provides information to drivers and especially cyclists
- / Its purpose is to reduce the number of stops and the instances of acceleration and deceleration (further translated to reduced fuel consumption and emissions)



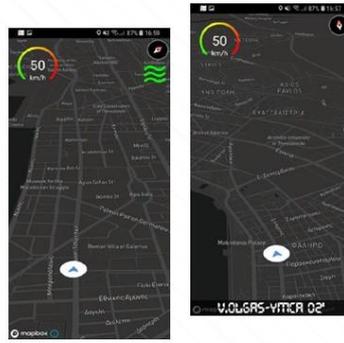
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6 / Apps within C-Mobile

Thessaloniki DS

- / One common app developed by CERTH-HIT
- / Integrated services include: Road Works Warning, Road Hazard Warning, GLOSA, In-Vehicle Signage, Flexible Infrastructure, Mode and Trip Time Advice, Probe Vehicle Data
- / Future versions will include additional services and functionalities



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6 / Apps within C-Mobile

Vigo DS

- / One common app developed by CTAG for all end-users
- / Users login and receive information relevant to their respective user type and profile

Road works warning	X	X	X	X	X
Road hazard warning	X	X	X	X	X
Emergency Vehicle warning	X	X	X	X	X
Signal violation warning			X	X	X
Warning system for pedestrian	X	X	X	X	X
Green Priority					X
GLOSA	X	X	X	X	
In-vehicle signage	X		X	X	X
Probe vehicle data	X	X	X	X	X
Emergency brake light	X				



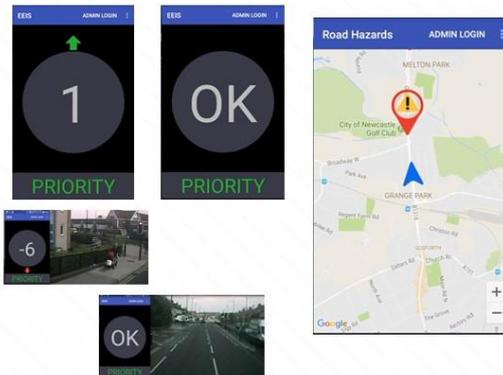
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6 / Apps within C-Mobile

Newcastle DS

- / C-ITS services implemented: GLOSA, Green Priority, RHW/RWW, Flexible Infrastructure, In-Vehicle Signage, Probe Vehicle Data, Blind Spot Detection
- / ITS G5 communication (RSUs, OBUs)



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Thank for your attention!

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19/06/2019

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Train the Trainer: Building Trainer skills - Part II

Dr. Evangelos Mitsakis
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19/06/2019

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Session Outline /

1	Introduction to Traffic Management	
	Traffic Management Centers (TMCs) in the C-ITS Environment	2
3	C-ITS Enabled Traffic Control Strategies	
	Impacts of C-ITS and Deployment Costs	4
5	Future Perspectives	

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1 / Introduction to Traffic Management

The scope

/ Traffic Management according to European Commission:

- ... provides **guidance** to the European **traveler** and **hauler** on the **condition** of the **road network**
- ... detects **incidents** and **emergencies**, implements **response strategies** to ensure **safe** and **efficient use** of the road network and **optimizes** the **existing** infrastructure, including across borders
- incidents can be **unforeseeable** or **planned**: accidents, road works, adverse weather conditions, strikes, demonstrations, major public events, holiday traffic peaks or other capacity overload

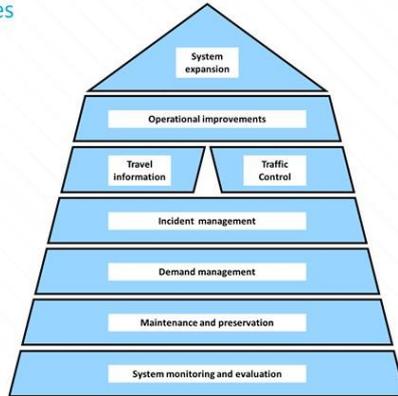


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1 / Introduction to Traffic Management

Overview of processes



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1 / Introduction to Traffic Management

Typical types of information utilized by Traffic Managers

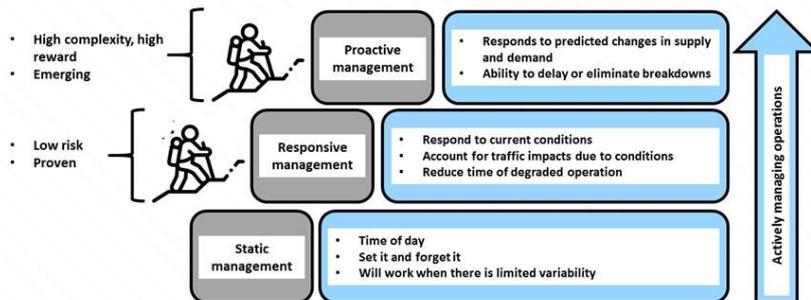


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1 / Introduction to Traffic Management

Traffic management approaches



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1 / Introduction to Traffic Management

A changing environment

- / Traffic management challenges:
 - handling congestion resulting from increased mobility
 - further reduction of road accidents
 - pressure to achieve agreed climate goals
 - changing composition of road traffic (e.g. due to the development of smart electric cars)
 - integration of new technological means into traditional processes
- / 4 pillars of the modern perception for Traffic Management:
 1. **exchange and use** of growing **data** streams
 2. development of **new assets** (e.g. smart roadside systems)
 3. **influence** the **behavior** of road users
 4. achieve **cooperation** among **all** involved parties



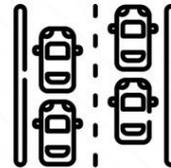
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1 / Introduction to Traffic Management

Road operators and road traffic

- / The actions of any road operator should conform to:
 - the safe use of road infrastructure
 - the smooth flow of traffic within the limits of quality of life
- / To this end road operators are responsible and should be competent and effective on:
 - imposing the appropriate **rules and prohibitions** for safety, quality of life, and traffic flow
 - providing **timely warnings** in cases of dangerous and abnormal situations
 - **informing and advising** road users about known events, alternative routes, etc.

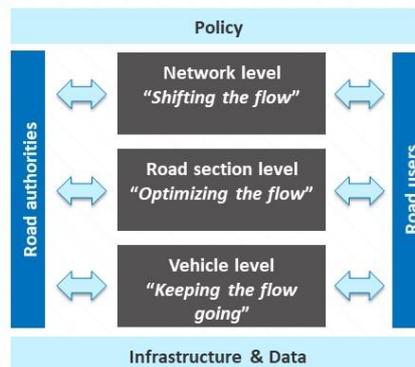


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1 / Introduction to Traffic Management

Governance framework



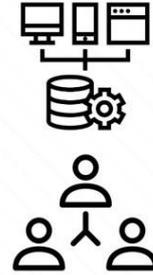
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1 / Introduction to Traffic Management

Enablers of network optimization

- / Road network optimization requires the close cooperation among a variety of involved actors
- / The supportive links may be:
 - **Hardware-based:** digital connections between the traffic centers and the roadside systems of the various road operators
 - **Software-based:** common platforms that provide a shared picture of the traffic situation in a geographical extent or network management systems for the coordinated deployment of traffic measures by the various road operators
 - **Organizational:** i.e. exchange of knowledge or products, adoption of common standards



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2 / TMCs in the C-ITS Environment

Factors affecting TMC operation

- / Served geographical area (regional, mega-region, statewide, multi-state)
- / Covered transportation systems (e.g. highways, urban freeways, arterial signal systems, etc.)
- / Equipment
- / Staffing and staffing models (in-house, contracted or hybrid)
- / Hours of operation
- / Provided services (e.g. coordination or dispatch of service patrols, public information, traveler information systems, special event management, work zone monitoring)



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2 / TMCs in the C-ITS Environment

Factors affecting TMC operation

- / Relationship to and coordination with other agency divisions or groups (such as maintenance, construction, district/region or headquarters)
- / Data sharing agreements with third parties
- / Staff digital competencies
- / Performance appraisal methodologies
- / Responsive or proactive orientation



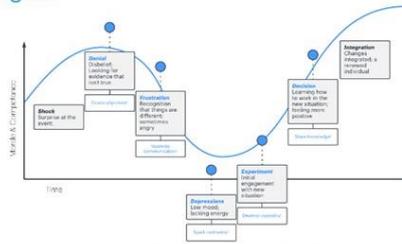
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2 / TMCs in the C-ITS Environment

Prerequisites for integrating C-ITS technologies

- / Availability and adequate density of real-time dynamic data
- / Willingness and ability to embrace new approaches
- / Appropriate business and partnerships models
- / Adequate perceived benefits for both TMC operational capabilities and transport network performance



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2 / TMCs in the C-ITS Environment

Envisioned characteristics of a "C-ITS enabled" TMC

- / TMC functions will continue to rely on engineering judgment and people but their role will be redefined and realigned
- / Increased situational awareness of the transport network including parts outside of the TMC own responsibility
- / Access to new data and information sources
- / Heightened awareness of the impact of traffic control strategies on traffic performance and user acceptance
- / Automated, targeted, and personalized information provision to road users
- / Increased capabilities for supporting long-term planning based on precise information of road user travel patterns
- / Increased accountability for activities, use of resources, coordination with external parties, and system & network reliability



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2 / TMCs in the C-ITS Environment

Changes to TMC operational processes per information type

Information type	Currently available information	Additional information (sources) enabled by C-ITS	Potential changes to TMC operational processes
 <p>Incident</p>	<ul style="list-style-type: none"> • Location • Start time/end time • Duration • Severity 	<ul style="list-style-type: none"> • Geo-locating capability for precise incident location • Real-time and specific impacts to network • Restricted lanes • Types of vehicles involved • Response status • Condition of potential detour routes 	<ul style="list-style-type: none"> • Better response by utilizing the appropriate resource and equipment • Network management that supports incident impact mitigation • Real-time information on incident clearance • Improved traveler notification (incl. nearby corridors) • Determination of cause/ improvements through before - and after - analysis • Improved predictive modeling/capabilities

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2 / TMCs in the C-ITS Environment

Changes to TMC operational processes per information type

Information type	Currently available information	Additional information (sources) enabled by C-ITS	Potential changes to TMC operational processes
Weather 	<ul style="list-style-type: none"> Road and pavement conditions Atmospheric conditions Forecasts Alerts Precipitation 	<ul style="list-style-type: none"> More precise pavement conditions More precise information about road conditions Network impacts Safety impacts Numbers of vehicles impacted Extent of impacts Vehicle metrics Prediction of impacts 	<ul style="list-style-type: none"> Immediate warnings on weather-related incidents and unsafe conditions Advanced warnings on impacts based on forecasting and proximity to weather event Better and up-to-date notifications to road users Enhanced decision support for the provision of road weather response teams

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2 / TMCs in the C-ITS Environment

Changes to TMC operational processes per information type

Information type	Currently available information	Additional information (sources) enabled by C-ITS	Potential changes to TMC operational processes
Speed 	<ul style="list-style-type: none"> Volume/ occupancy/ speed <ul style="list-style-type: none"> Spot locations Lane by lane Directional Moving/tracking data Robust historical data Freeway and arterial congestion 	<ul style="list-style-type: none"> Density context Broad coverage Continuous movement/ tracking Data accuracy Vehicle metrics Prediction 	<ul style="list-style-type: none"> Reporting and real-time monitoring of transportation state and performance Congestion warnings Real-time information on the impact of the application of traffic control strategies Ubiquitous probe coverage that allows the monitoring and managing of larger road networks

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2 / TMCs the C-ITS Environment

Changes to TMC operational processes per information type

Information type	Currently available information	Additional information (sources) enabled by C-ITS	Potential changes to TMC operational processes
Work zone 	<ul style="list-style-type: none"> Surveillance Lane restriction updates 	<ul style="list-style-type: none"> Adherence to speed restriction Monitoring of vehicle maneuvering Real-time lane restrictions Traffic control verification and violations 	<ul style="list-style-type: none"> Timely advisory warnings of work zone to travelers in proximity / surrounding areas Improved safety warnings when approaching or within work zone Dynamic speed and lane restriction Modification of work zone implementation strategies based on traffic response Traffic control violation notification

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2 / TMCs in the C-ITS Environment

Changes to TMC operational processes per information type

Information type	Currently available information	Additional information (sources) enabled by C-ITS	Potential changes to TMC operational processes
 <p>Event</p>	<ul style="list-style-type: none"> Day, time, and length Localized network impacts Lane restrictions Limited monitoring of images and signal timing changes during events 	<ul style="list-style-type: none"> Situational awareness of wider event location Broader network impacts Multi-modal traffic information 	<ul style="list-style-type: none"> Improved advanced traveler information systems to support area accessibility during events Active management of events Advanced network response to traffic alteration Real-time management of multiple transport modes and mode shifting support Reduction in required field resources to support event traffic management

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2 / TMCs in the C-ITS Environment

Changes to TMC operational processes per information type

Information type	Currently available information	Additional information (sources) enabled by C-ITS	Potential changes to TMC operational processes
 <p>Field device</p>	<ul style="list-style-type: none"> Status Control Deployment location 	<ul style="list-style-type: none"> Integration status Required system uptime New technology systems with new types of data Performance metrics 	<ul style="list-style-type: none"> Higher uptime and integration level of devices Performance reporting and management of field device state Automated alerts and troubleshooting Asset and issue tracking based on performance Improved equipment life-cycle management

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2 / TMCs in the C-ITS Environment

Potential new roles/ functions for a TMC



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2 / TMCs in the C-ITS Environment

New required skills for the exploitation of C-ITS technologies

Technical Discipline	Skill Sets and Credentials
Information Technologies and Data Management	<ul style="list-style-type: none"> • Hardware and software support for Big Data environment, and integrating data/information into TMC processes • Data warehousing, queries and support for data access and redistribution • Support data management and sharing policy development • Integrate new software and updates • Collaborate with system developers and integrators for new TMC systems and software
System Analytics and Processing	<ul style="list-style-type: none"> • Identify how to update TMC processes with new capabilities • Identify what types of analysis can lead to improved operations and decision support • Collaborate with other TMCs or other agency divisions to identify how new data can support their functions (i.e., safety, planning, programming, project development, etc.) • Aggregate and process data (if this function is completed in-house) to create useful information for system and operational performance metrics • Analyse system performance and recommend modifications based on the derived outcomes

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2 / TMCs in a the C-ITS Environment

New required skills for the exploitation of C-ITS technologies

Technical Discipline	Skill Sets and Credentials
Network and Device Maintenance	<ul style="list-style-type: none"> • Specialized training for maintaining new field devices to support C-ITS • Testing and deployment of new devices • Collaborate with device vendors for technical specifications and requirements • Collaborate with IT and operations management to integrate new devices into TMC processes
Operations Engineering Decision Making	<ul style="list-style-type: none"> • Specialized training for traffic engineering in presence of C-ITS • Skill sets to develop traffic signal timing plans and strategies, and to implement modifications to signal operations to optimize traffic flow and safety in presence of C-ITS • Authorize and/or implement changes in strategies based on real-time C-ITS data inputs, such as weather response strategies, balancing network demand, or multi-agency corridor operations • Support development and active monitoring of system performance metrics, and identify where strategies need to be implemented to achieve performance goals

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3 / C-ITS Enabled Traffic Control Strategies

A step-by-step approach

/ The process of integrating C-ITS services into Dynamic Traffic Management "control strategies" involves the following steps:

- **Definition of the traffic management policy:** a description of the importance and function of roads as well as quantitative thresholds for links and route parts
- **Discretization of the available road network:** the distinction of the various parts of the road network (incl. nodes, segments, links, route parts) with respect to their typological or topological characteristics
- **Definition of traffic control strategies:** the means of achieving policy objectives that may be applied in escalation phases
- **Association of C-ITS services with traffic control strategies:** definition of C-ITS services that can accomplish policy objectives via the realization of the appropriate traffic control strategies

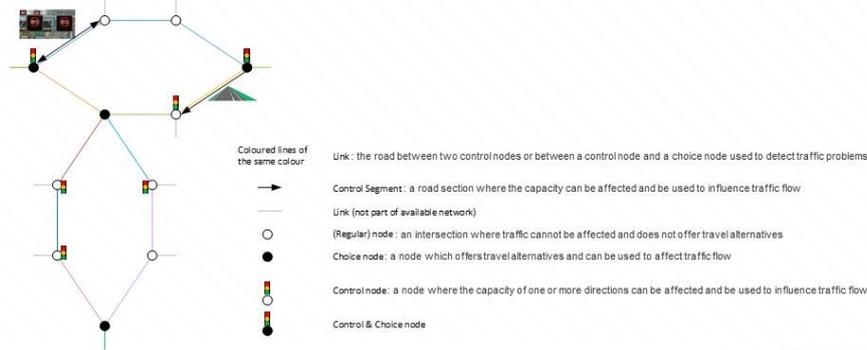


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3 / C-ITS Enabled Traffic Control Strategies

Road network discretization

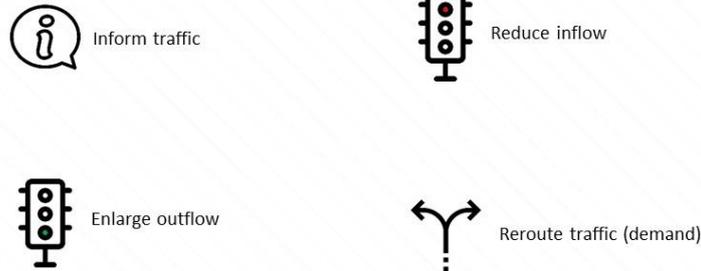


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3 / C-ITS Enabled Traffic Control Strategies

Traffic control strategies



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3 / C-ITS Enabled Traffic Control Strategies

Indicative association of C-ITS services with TCS

Smart mobility measure	Primary objective	Inform traffic	Enlarge the outflow	Reduce the inflow	Reroute traffic (demand)
Green Priority for Designated Vehicles	Reduce delay time at traffic light for designated vehicles	-	Enlarge the outflow of priority directions	-	-
Flexible Infrastructure (e.g. Peak-hour Lanes)	Control available road capacity	-	More road capacity increases the outflow	Less road capacity reduces the inflow	-
In-vehicle Signage Road Section	Present dynamic road sign information for road sections in the vehicle (personalized and extrapolated)	Inform about conditions, restrictions	e.g. speed harmonization increase outflow	e.g. speed harmonization reduces inflow	-
In-vehicle Signage Route	Present route and travel time information in the vehicle (personalized and extrapolated)	Inform about options	-	-	e.g. travel time information and route advice
Mode & Trip Time Advice (e.g. by Incentives)	Multi-modal travel and departure time advice (MaaS-like concept, by incentives)	Inform about conditions, restrictions and options	-	-	Delayed trips or trips by collective modes reduce demand

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4 / Impacts of C-ITS and Deployment Costs

Categorization of impacts

- / Identifying the impacts of C-ITS services is a crucial step in justifying any required investments
- / These impacts can generally be categorized into **five** groups
- / **Safety**-related:
 - Reducing the number of fatalities
 - Reducing the severity of collisions
- / **Operational efficiency**-related:
 - Reducing disruption due to incidents
 - Improving the Level of Service and convenience provided to travelers
 - Increasing infrastructure capacity (and postponing its physical expansion)



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4 / Impacts of C-ITS and Deployment Costs

Categorization of impacts

- / **Productivity**-related:
 - Reducing costs incurred by fleet operators
 - Reducing travel times
 - Improving transport planning and management
- / **Mobility & comfort**-related:
 - Providing access to pre-trip and on-trip information
 - Improving the safety and security of travel
 - Reducing traveler stress
- / **Environmental**-related:
 - Reducing harmful emissions
 - Reducing energy-fuel consumption



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4 / Impacts of C-ITS and Deployment Costs

Categorization of impacts

- / The exact assessment of the impacts falling under all of the aforementioned categories is sometimes **not possible**:
 - lack of data
 - difficulty in identifying the influence area of respective services in order to calculate reasonable indicators



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4 / Impacts of C-ITS and Deployment Costs

Warning-related services

Service	Safety	Accidents	Congestion	Efficiency	Comfort	Environment
Road Hazard Warning (RHW)	Less accidents	2.4-2.5% less injuries & 1.7-2.4% less fatalities (due to traffic jam related warnings) 4.1-4.2% less injuries and 3.1% less fatalities (due to hazardous location warnings)	Less congestion	-	-	-
Road Works Warning (RWW)	Positive impact	1.9% less fatalities & 1.5% less injuries	-	Low impact	-	Low impact
Emergency Vehicle Warning	Less accidents	2.5% less injuries & 2.7% less fatalities	-	Low impact	-	Low impact

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4 / Impacts of C-ITS and Deployment Costs

Warning-related services

Service	Safety	Accidents	Congestion	Efficiency	Comfort	Environment
Slow or Stationary Vehicle Warning	Less accidents	0.7-1.1% less fatalities & injuries	-	Low impact	-	Low impact
Blind Spot Detection / Warning	No reliable estimates	Less side collisions	-	-	-	?
Signal Violation Warning	Improved safety	1-4% less fatalities & 2-7% less injuries	-	Low impact	-	Low impact
Emergency Brake Light	Improvement of safety and driver's awareness	2.5% less injuries & 2.7% less fatalities	-	Low impact	-	Low impact

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4 / Impacts of C-ITS and Deployment Costs

Signage-related services

Service	Safety	Accidents	Congestion	Efficiency	Comfort	Environment
In-Vehicle Signage	Less accidents	0.5-1% less fatalities and injuries through the use of "children" and "pedestrian crossing ahead" signs 2.7% less fatalities & injuries (due to signage related to speed limits)	-	Low impact	-	1.4% less speed and 2.3-3.5% less fuel consumption (due to signage related to speed limits)
Probe Vehicle Data		2.4-2.8% less fatalities & injuries	-	Low impact	-	0.001-0.006% less fuel consumption and emissions

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4 / Impacts of C-ITS and Deployment Costs

Signage-related services

Service	Safety	Accidents	Congestion	Efficiency	Comfort	Environment
GLOSA	-	0.1-0.3% less fatalities & injuries	-	-	-	0.1-0.7% less fuel consumption & 0.0-0.8% less emissions
Green Priority	Low impact	-	-	Improved	-	Less

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4 / Impacts of C-ITS and Deployment Costs

Cost categories (1/2)

C-ITS components may be categorized into **five** types:

- Traffic Management Center Integration:** integrating the C-ITS supporting technology, responsible for managing the C-ITS services for an entire city/ a road operator/ a national highway system into an existing TMC
 - Costs arise from the additional equipment or services required to: integrate the RSUs into the TMC, update or develop new interfaces from RSUs to local traffic controllers, operate and maintain the TMC back office and the local controller interfaces, update or develop and maintain software applications
- Roadside Units (RSUs) – Dedicated Short-Range communications (DSRCs):** the components of the C-ITS services' deployment (e.g. beacons on gantries or poles)
 - For providing ITS-G5 communication, the delivery of the C-ITS systems may occur through the upgrade of the existing RSUs or the installation of new ones
 - Upgrades are more likely to take place in urban areas, while new installations are more relevant to interurban areas
 - Installation costs include equipment/hardware costs and mounting costs (depending on the complexity of the installation)
 - Operation and maintenance costs include activities like realigning the antennas, rebooting hardware, checking system operational status and other routine checks
 - Costs for power consumption, data and secure communications (i.e. development and implementation of a security credentials management system) should also be taken into account.

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4 / Impacts of C-ITS and Deployment Costs

Cost categories (2/2)

C-ITS components may be categorized into **five** types:

- In-vehicle devices (OBUs):** devices attached to the vehicles' communication buses, enabling both V2V and V2I communications.
 - Upfront costs include a number of in-vehicle components (e.g. two DSRC transmitter/ receivers, two DSRC antennas, an electronic control unit, and additional wiring)
 - Costs associated to C-ITS technologies' integration, development and testing, and to vehicles' software development constitute also parts of the upfront costs
 - Ongoing costs are composed of maintenance, secure communications and OEM maintenance of in-vehicle software (updates), with cellular data costs to be added for the case of vehicles with ITS-G5 and cellular technology.
- Personal devices:** mobile phones, tablets, PNDs and other handheld devices, not attached to the vehicle's information bus.
 - Costs associated to end-users' charges could be expressed within three types of business models:
 - subscription based model (charges would be incurred by an annual subscription fee for using the C-ITS services)
 - app store/ online marketplace based model (charges would come from downloading the applications)
 - free model (the applications could be provided for free by a public transport authority or a road operator)
 - Elements comprising the upfront costs include the equipment, the applications and the software development, while operation and maintenance costs typically arise from data usage, subscription fees and applications' updates.
- Data collection:** traffic data collection along a suitably equipped road network (either through the infrastructure or through 3rd parties)
 - Data collection is associated with initial capital costs and annual recurring costs

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4 / Impacts of C-ITS and Deployment Costs

Cost breakdown of C-ITS services deployment

C-ITS Services components	Cost category	Stakeholder	Communication technology	Units
TMC integration	<ul style="list-style-type: none"> Installation Operation & maintenance 	<ul style="list-style-type: none"> Road Operator 	<ul style="list-style-type: none"> V2V V2I 	<ul style="list-style-type: none"> Per deployment area per year
RSU-DSRCs	<ul style="list-style-type: none"> Installation Operation & maintenance 	<ul style="list-style-type: none"> Road operator OEMs End-user 	<ul style="list-style-type: none"> V2V V2I 	<ul style="list-style-type: none"> Per intersection Per RSU per year Per km of road per year Per license per year
In-vehicle devices	<ul style="list-style-type: none"> Installation Operation & maintenance 	<ul style="list-style-type: none"> OEMs End-user 	<ul style="list-style-type: none"> V2V V2I 	<ul style="list-style-type: none"> Per vehicle per year
Personal devices	<ul style="list-style-type: none"> Installation Operation & maintenance 	<ul style="list-style-type: none"> End-user Equipment provider 	<ul style="list-style-type: none"> V2V V2I 	<ul style="list-style-type: none"> Per user per year
Data collection	<ul style="list-style-type: none"> Installation Operation & maintenance 	<ul style="list-style-type: none"> Data provider End-user 	<ul style="list-style-type: none"> V2V V2I 	<ul style="list-style-type: none"> Per centerline km per year

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5 / Future Perspectives

The need for collaboration

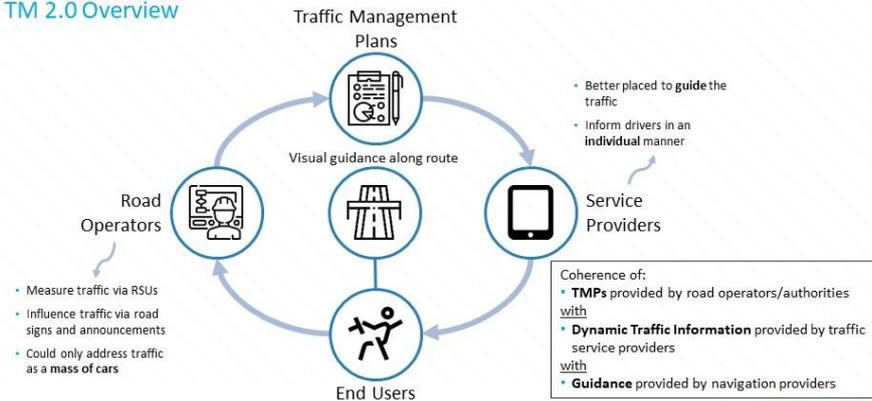
- / The further development of C-ITS technologies is expected to bring significant benefits in terms of road safety, traffic flow efficiency and emission reduction
- / Before concepts such as proactive traffic management can become a reality it is important to understand that there will be a long period during which various types of vehicles (non-semi-full automated) will coexist
- / The aforementioned benefits can be realized only under the premise that the various involved players will collaborate and cooperate with each other by following innovative business models
- / An example is the TM2.0 Platform that promotes the concept of **"Cooperative Traffic Management"** (i.e. a connected, decentralized, traffic management system in which all stakeholders can act collaboratively, either to provide individually, high quality, profiled services or to preserve the collective's best interest, as for safety, flow efficiency and emission reduction)

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5 / Future Perspectives

TM 2.0 Overview

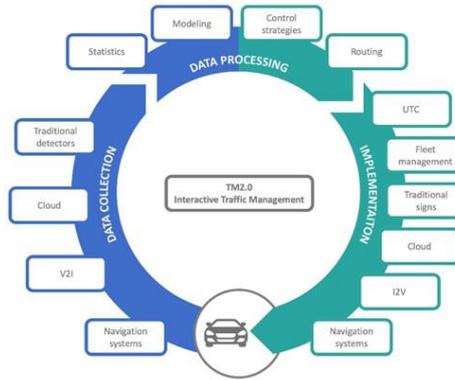


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5 / Future Perspectives

What is needed



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5 / Future Perspectives

TM 2.0 added value

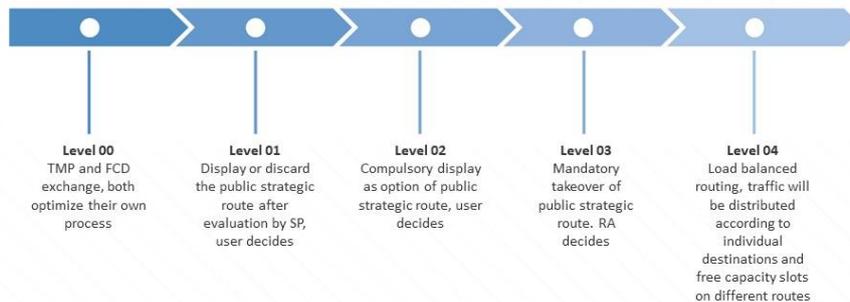
City administrators & Traffic Managers	Drivers	Traffic Information Service Providers
Avoid congestion and traffic collapse	Avoid congestion: more relaxed driving	Provide best route option for the destination (not only fastest)
Avoid unnecessary emissions	Receive relevant regional information in-vehicle	Provide information that goes beyond congestion
Improve TMP complementing or replacing loop detectors and enhancing accuracy	Improved road safety through smoother traffic flow	Provide solution (best route option) not the problem (congestion info) well in advance
TMP measures reach driver directly	Best route options aligned with TMPs	Regional information becomes part of an integrated service
FCD-enabled TM even in roads with no ITS (scalable)		

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5 / Future Perspectives

TM cooperation levels



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C-MOBILE

Thank you for your attention!

Dr. Evangelos Mitsakis
Areti Kotsi
Vigo, Spain
19/06/2019

Co-funded by the European Union

Annex 2

Material of Barcelona DS training



Contenidos /

1	Proyecto C-Mobile y objetivos de la formación
2	Introducción a C-ITS
3	Arquitecturas C-ITS
4	Servicios C-ITS
5	Aplicaciones C-ITS
6	Preguntas

2 06/05/2020 C-Mobile, Phase II Training for Public Authorities



1 / Acerca de C-Mobile

Accelerating C-ITS Mobility Innovation and deployment in Europe

- / Proyecto cofinanciado por el Programa Marco de la UE "Horizon 2020"
- / Duración: 42 meses (Junio 2017 – Noviembre 2020)
- / Despliegue a gran escala de servicios cooperativos de ITS (C-ITS) en ocho regiones europeas de forma interoperable
- / Despliegue de servicios C-ITS para:
 - / Aumentar la seguridad viaria
 - / Mejorar la eficiencia del tránsito
 - / Reducir el impacto medioambiental en las ciudades
- / ¿Qué tipo de servicios?
 - / Ayuda a la conducción
 - / Usando solo un smartphone



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1 / El rol de los Deployment Sites

- / Integrar los avances de investigación de C-ITS en las infraestructuras actuales y los vehículos conectados.
- / El despliegue y adopción a gran escala de C-ITS a grandes grupos de usuarios finales.
- / Mejorar las capacidades operativas existentes para fomentar la colaboración de los stakeholders.

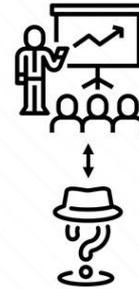


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1 / Objetivos del training

- / Conocimiento básico del proyecto C-Mobile.
- / Conocer y entender las características de los servicios de C-ITS y el tipo de información que proporcionan.
- / Comprender la utilidad de los servicios de C-ITS y como explotar sus potencialidades.
- / Identificar posibles aplicaciones en las organizaciones y nuevas oportunidades de negocio.



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1 / Objetivos del Training

- / Audiencia
 - **Técnicos y gestores de la administración pública**
 - **Operadores de tráfico**
 - **Gestores de carreteras y red viaria**
 - **Managers de flotas de vehículos**
 - **Conductores profesionales**
 - **Público en general (potenciales usuarios)**



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2 / Introducción al C-ITS

Cooperative - Intelligent Transport Systems (C-ITS)

- / ITS: Intelligent Transport Systems:
 - Sistemas convencionales de ingeniería aplicada a la movilidad
 - Semáforos conectados al centro de control
 - Contadores de coches con espiras o sensores



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2 / Introducción al C-ITS

Cooperative - Intelligent Transport Systems (C-ITS)

- / C-ITS: **Cooperative** - Intelligent Transport Systems:
 - Comunicación infraestructura – vehículo (obras, semáforos, carriles cortados/reversibles, etc.)
 - Comunicación vehículo – vehículo (congestiones, frenadas, accidentes, cambios de carril, etc.)

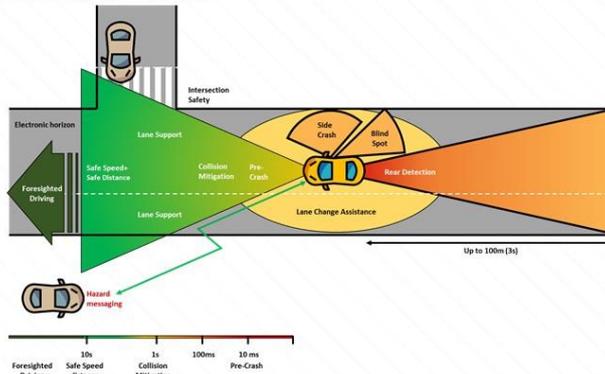


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2 / Introducción al C-ITS

Vehículo autónomo y conectado

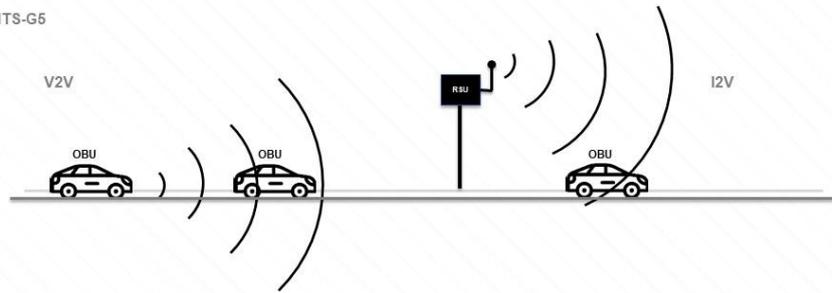


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2 / Tecnologías de comunicación e interop.

ITS-G5



- / ITS-G5 proporciona bajas latencias (útil para la comunicación de mensajes críticos)
- / Mayor coste de despliegue y cobertura limitada (~600m)

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2 / Tecnologías de comunicación e interop.

Celular



- / Las redes celulares proporcionan una cobertura mayor para llegar a un mayor número de vehículos
- / Latencias mas altas (4G/LTE) pero despliegues mas baratos y flexibles

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3 / Arquitectura C-ITS



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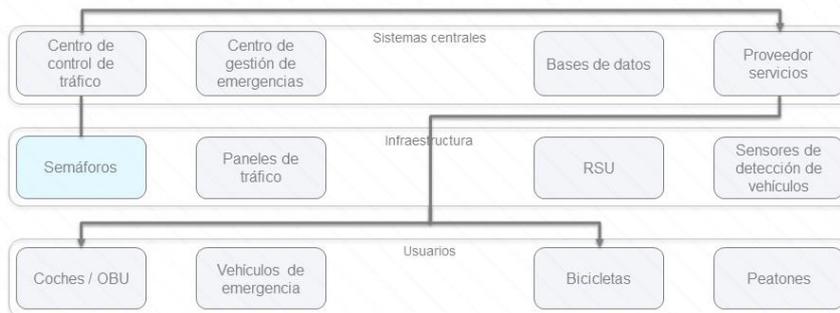
3 / Arquitectura C-ITS



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3 / Arquitectura C-ITS



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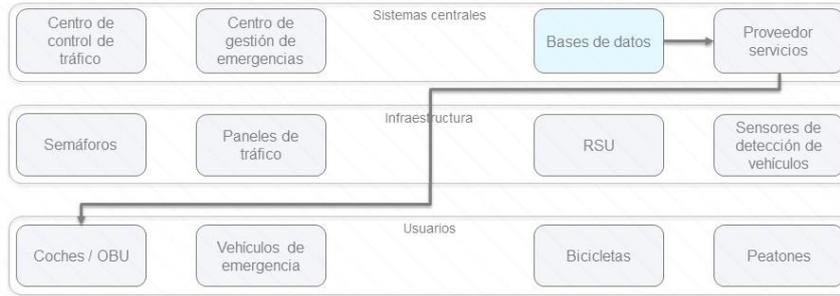
3 / Arquitectura C-ITS



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3 / Arquitectura C-ITS



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3 / Arquitectura C-ITS

G5

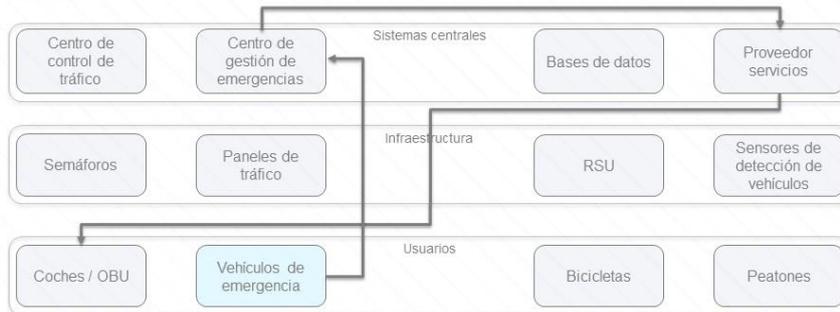


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3 / Arquitectura C-ITS

Celular



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4 / Servicios C-ITS en C-Mobile

Eficiencia del tráfico

Aviso de incidencias	Prioridad semafórica
GLOSA	Disponibilidad de parking
Infraestructura flexible	Recolección de datos
Información de señales	ACC urbano
Gestión de tiempos de descanso	Consejos de ruta intermodal

Seguridad vial

Aviso de presencia de usuarios vulnerables	Aviso de vehículo parado en la calzada
Prioridad verde	Aviso de ángulos muertos
Presencia de vehículo de emergencia	Salto de semáforos en rojo
Aviso de frenada de emergencia	

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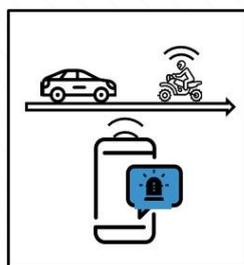


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4 / Servicios C-ITS en C-Mobile

Presencia de motocicletas



Aviso de presencia de motocicletas en zonas de riesgo de accidente



Aumento de la percepción en zonas de visibilidad limitada
Reducción y mitigación de accidentes con motocicletas

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4 / Servicios C-ITS en C-Mobile

Presencia de usuarios vulnerables



Aviso de presencia de usuarios vulnerables (peatones y bicicletas) en la vía



Aumento de la percepción en zonas de visibilidad limitada
Reducción y mitigación de accidentes con usuarios vulnerables

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4 / Servicios C-ITS en C-Mobile

Presencia de usuarios vulnerables



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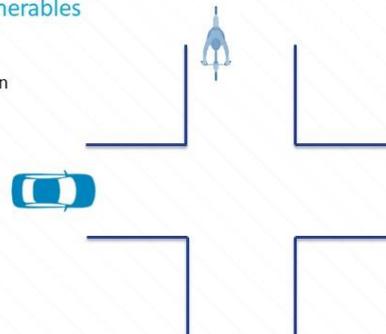
Caso de estudio: seguridad para usuarios vulnerables

Problema:

- / Alta tasa de accidentes con bicicletas involucradas en intersecciones sin visibilidad

Reto:

- / Disminuir el número de accidentes en dichas intersecciones



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Caso de estudio: seguridad para usuarios vulnerables

Problema:

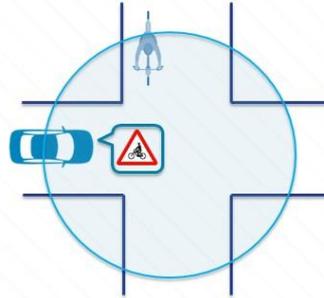
- / Alta tasa de accidentes con bicicletas involucradas en intersecciones sin visibilidad

Reto:

- / Disminuir el número de accidentes en dichas intersecciones

Solución:

- / Notificar a los usuarios de la presencia de bicicletas al llegar a la intersección, antes de tener línea de visión
→ Servicio C-ITS: aviso de usuarios vulnerables



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4 / Servicios C-ITS en C-Mobile

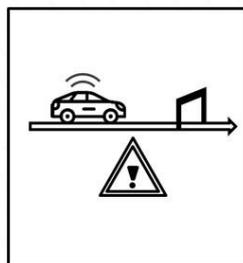


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4 / Servicios C-ITS en C-Mobile

Aviso de incidencias



Información de incidencias próximas: congestión, accidente, etc.



Anticipación a eventos potencialmente peligrosos
Reducción del riesgo de accidente

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4 / Servicios C-ITS en C-MOBILE

Aviso de obras



Información de obras próximas



Anticipación a eventos potencialmente peligrosos
Reducción del riesgo de accidente

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4 / Servicios C-ITS en C-MOBILE

Aviso de obras

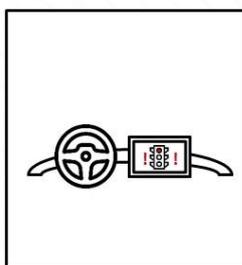


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4 / Servicios C-ITS en C-MOBILE

Salto de semáforo en rojo



Aviso a conductores que estén (potencialmente) a punto de saltarse un semáforo



Reducción y mitigación de accidentes en intersecciones señalizadas

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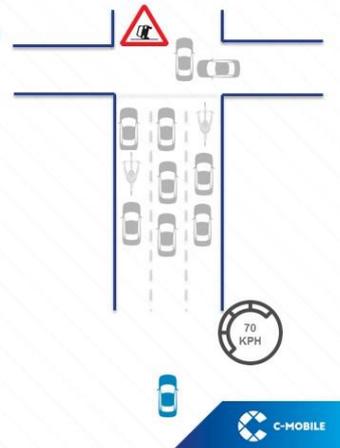
Caso de estudio: aproximación a zona de congestión

Problema:

- / Riesgo de colisión con otros vehículos debido a congestiones repentinas.

Reto:

- / Llamar la atención del conductor para adecuar progresivamente la velocidad antes de llegar a la zona de congestión.



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Caso de estudio: aproximación a zona de congestión

Problema:

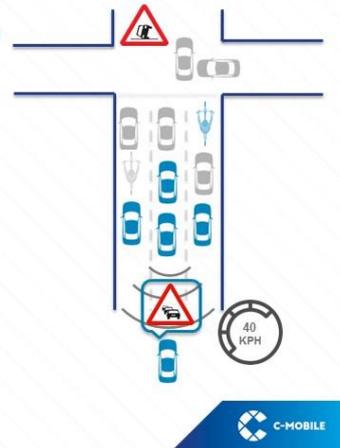
- / Riesgo de colisión con otros vehículos debido a congestiones repentinas.

Reto:

- / Llamar la atención del conductor para adecuar progresivamente la velocidad antes de llegar a la zona de congestión.

Solución:

- / Notificar anticipadamente al usuario de la zona de congestión a la que se acerca para que pueda adecuar la velocidad.



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Caso de estudio: aproximación a zona de congestión

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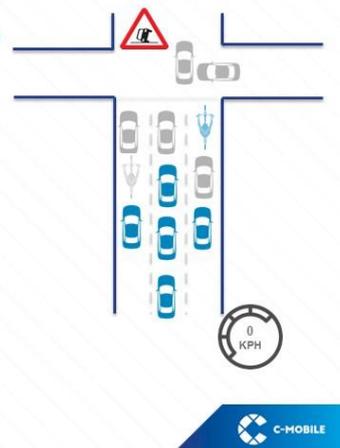
Reto:

- / Llamar la atención del conductor para adecuar progresivamente la velocidad antes de llegar a la zona de congestión.

Solución:

- / Notificar anticipadamente al usuario de la zona de congestión a la que se acerca para que pueda adecuar la velocidad.

Servicios C-ITS: Aviso de incidencias



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Presencia de vehículo en emergencia



Aviso de presencia de vehículos en emergencia
Distancia y dirección



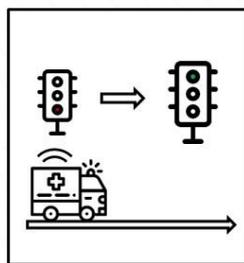
Reacción anticipada para ceder el paso
Reducción de los tiempos de ruta de las emergencias

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4 / Servicios C-ITS en C-Mobile

Prioridad semafórica



Cambio de semáforos a verde ante la presencia de un vehículo de emergencia o transporte público



Reducción de tiempos de ruta de las emergencias
Reducción de tiempos de ruta del transporte público

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4 / Servicios C-ITS en C-Mobile

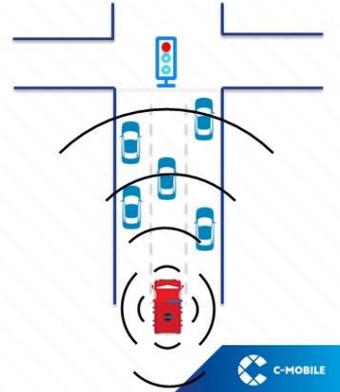
Caso de estudio: optimización de servicios prioritarios

Problema:

- / Tiempos de respuesta de emergencias afectados por alta densidad de tráfico.

Reto:

- / Disminuir eventos de ralentización a causa del tráfico, mejorando así el tiempo de respuesta.



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Caso de estudio: optimización de servicios prioritarios

Problema:

- / Tiempos de respuesta de emergencias afectados por alta densidad de tráfico.

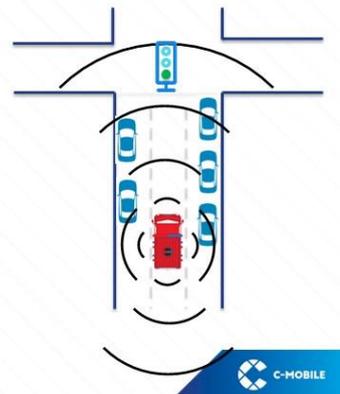
Reto:

- / Disminuir eventos de ralentización a causa del tráfico, mejorando así el tiempo de respuesta.

Solución:

- / Notificar a los usuarios de la presencia de vehículos en emergencia y dar prioridad semafórica.

- Servicios C-ITS:
Presencia de vehículo de emergencia + Prioridad semafórica



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4 / Servicios C-ITS en C-Mobile

Caso de estudio: optimización de servicios prioritarios



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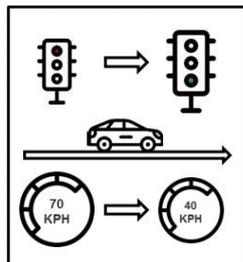


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Aviso de Velocidad Óptima para Semáforo Verde (GLOSA)



Recomendación de velocidad óptima para cruzar un semáforo en verde



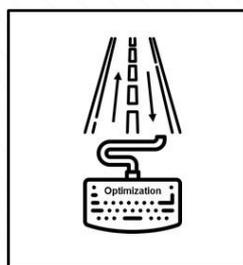
Reducción de consumos y emisiones
Aumento de la fluidez de la intersección

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4 / Servicios C-ITS en C-Mobile

Infraestructura flexible



Estado de carriles reversibles



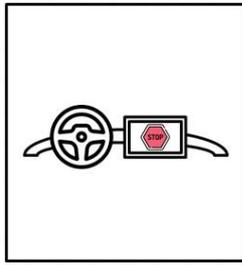
Anticipación en el uso de carriles reversibles
Reducción de la congestión

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4 / Servicios C-ITS en C-Mobile

Información de señales de tráfico



Información de limitaciones de velocidad y paneles de tráfico



Aumento de la concienciación del conductor
Reducción del riesgo de accidente

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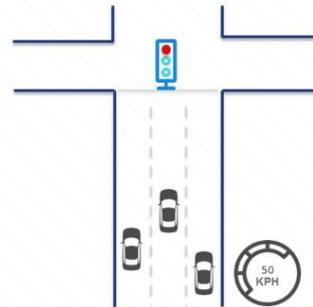
Caso de estudio: mejora de la eficiencia del tráfico en las intersecciones

Problema:

- / Ineficiencia de paso por las intersecciones
- / Problema de seguridad por frenazos
- / Mayor contaminación por comportamientos más bruscos

Reto:

- / Incrementar la fluidez del tráfico en las intersecciones



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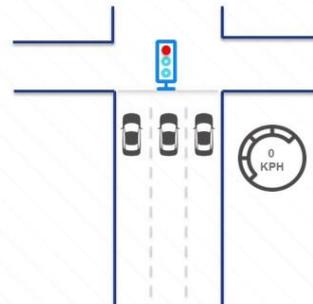
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Reto:

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4 / Servicios C-ITS en C-Mobile

Caso de estudio: mejora de la eficiencia del tráfico en las intersecciones

Problema:

- / Ineficiencia de paso por las intersecciones
- / Problema de seguridad por frenazos
- / Mayor contaminación por comportamientos mas bruscos

Reto:

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Caso de estudio: mejora de la eficiencia del tráfico en las intersecciones

Problema:

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- / Problema de seguridad por frenazos
- / Mayor contaminación por comportamientos mas bruscos

Reto:

- / Incrementar la fluidez del tráfico en las intersecciones

Solución:

- / Dar a los usuarios una velocidad recomendada para pasar en verde → Servicio C-ITS: Información semafórica (GLOSA)



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4 / Servicios C-ITS en C-Mobile

Caso de estudio: mejora de la eficiencia del tráfico en las intersecciones

Problema:

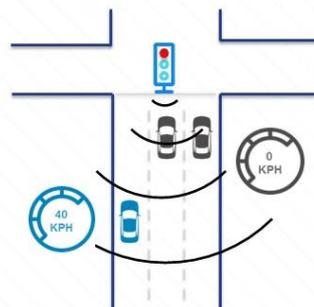
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4 / Servicios C-ITS en C-Mobile

Caso de estudio: mejora de la eficiencia del tráfico en las intersecciones

Problema:

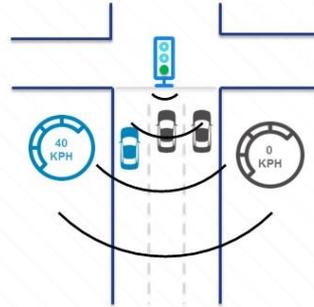
- / Ineficiencia de paso por las intersecciones
- / Problema de seguridad por frenazos
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Reto:

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4 / Servicios C-ITS en C-Mobile

Caso de estudio: mejora de la eficiencia del tráfico en las intersecciones

Problema:

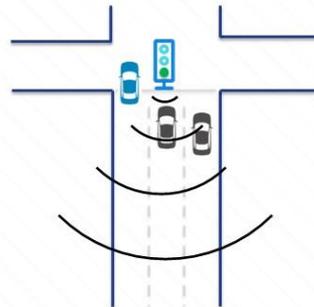
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- / Problema de seguridad por frenazos
- / Mayor contaminación por comportamientos mas bruscos

Reto:

- / Incrementar la fluidez del tráfico en las intersecciones

Solución:

- / Dar a los usuarios una velocidad recomendada para pasar en verde → Servicio C-ITS: Información semafórica (GLOSA)

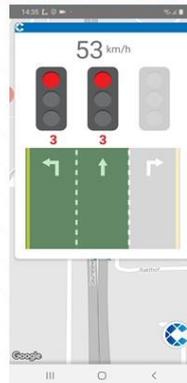


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Caso de estudio: mejora de la eficiencia del tráfico en las intersecciones



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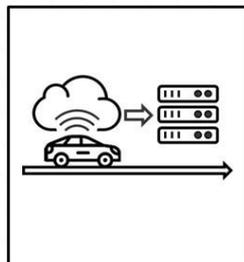


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4 / Servicios C-ITS en C-Mobile

Recolección de datos



Recolección de datos para su uso posterior, por ejemplo, en centros de control de tráfico



Mejora de estrategias de gestión del tráfico y la movilidad

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4 / Servicios C-ITS en C-Mobile

Caso de estudio: detección de incidencias/anomalías de tráfico

Problema:

- / Retraso en la detección y respuesta de incidencias

Reto:

- / Incrementar la velocidad de detección sin desplegar hardware por toda la red de carreteras



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Caso de estudio: detección de incidencias/anomalías de tráfico

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Reto:

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4 / Servicios C-ITS en C-Mobile

Caso de estudio: detección de incidencias/anomalías de tráfico

Problema:

/ Retraso en la detección y respuesta de incidencias

Reto:

/ Incrementar la velocidad de detección sin desplegar hardware por toda la red de carreteras

Solución:

/ Recopilar datos de los vehículos en tiempo real (localización, velocidad, etc.) para sacar métricas del comportamiento del tráfico. Servicio C-ITS: Recolección de datos



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Project partners:



Associated partners:



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 729311

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5 / App C-ITS de C-Mobile Barcelona DS



GET IT ON
Google Play

C-Mobile Barcelona



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Preguntas

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Alex Vallejo
Monica Lores

cmobile@idiada.com



C-MOBILE

06/05/2020 C-Mobile Phase II Training, Barcelona



C-MOBILE

¡Muchas gracias
por la atención!

AppIus+ IDIADA
06/05/2020

Co-funded by
the European Union



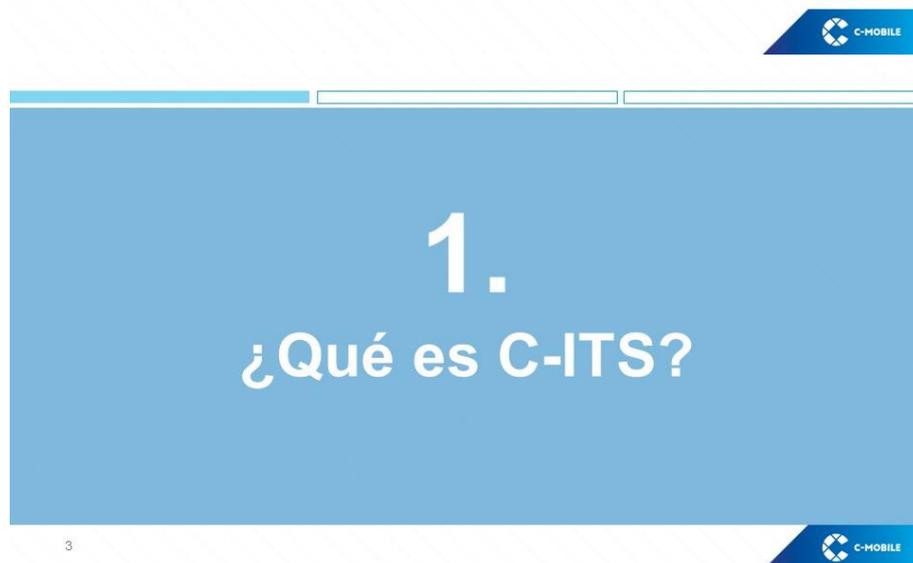
C-MOBILE



1. ¿Qué es C-ITS? | Evolución de los ITS
Ejemplos C-ITS

2. Proyecto C-Mobile | Arquitectura C-Mobile
Local Partners

3. Servicios desarrollados en Bilbao



Evolución de los Sistemas de Transporte Inteligente

Señalización tradicional

ITS
Sistemas de
Trasporte
Inteligente

C- ITS
ITS del
Futuro
(cooperativo, conectado
y automatizado)

4



Evolución de los Sistemas de Transporte Inteligente

Señalización tradicional

Fijas
No inteligentes



5



Evolución de los Sistemas de Transporte Inteligente

Señalización tradicional

Fijas
No inteligentes



ITS
Sistemas de
Trasporte
Inteligente

Dinámica y adaptable
Inteligencia basada
en datos



C- ITS
ITS del
Futuro
(cooperativo, conectado
y automatizado)

6



Evolución de los Sistemas de Transporte Inteligente

Señalización tradicional

Fijas
No inteligentes



ITS Sistemas de Transporte Inteligente

Dinámica y adaptable
Inteligencia basada en datos



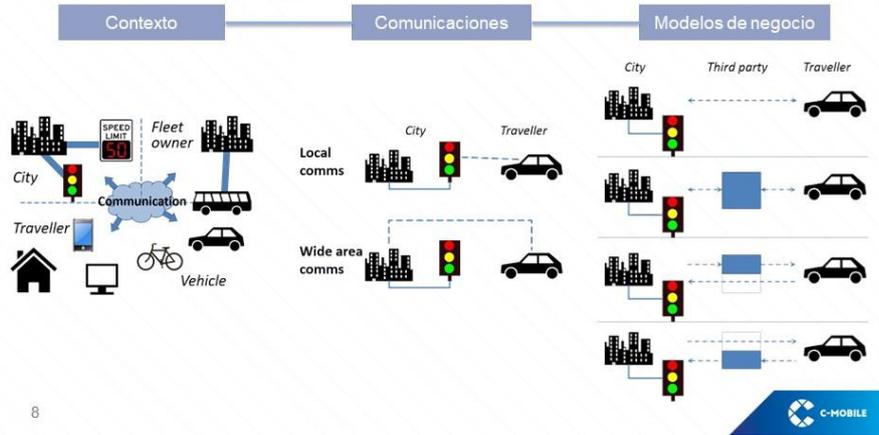
C- ITS ITS del Futuro

(cooperativo, conectado y automatizado)
Avisos individualizados
Mejor uso de la información
Interacción con el usuario



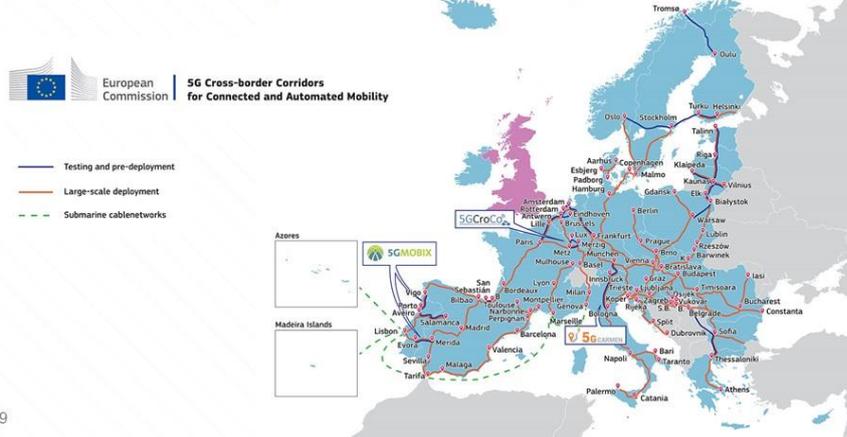
7

Modelos de negocio C-ITS



8

Corredores Cooperativos en Europa



9

¿QUÉ ES C-ITS?

Algunos ejemplos:

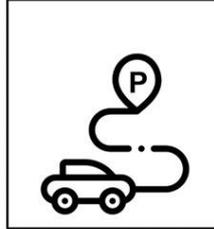


10

URBAN PARKING AVAILABILITY

This service provides parking availability information and guidance for drivers to make informed choices about available parking places. This service aims to reduce congestion, time loss, pollution, and stress caused by cruising for parking.

- ✓ Information about a vehicle parking space released by another user
- ✓ Reservation of a vehicle parking space released by another user
- ✓ Loading zone availability information for urban freight
- ✓ On-street parking availability information



Save time and rid yourself of stress while searching for a parking spot in the city



Kahoot!



11

¿Crees que el servicio UPA (Urban Parking Availability) resulta útil para ti?

18

0 Answers

Totalmente inútil	Bastante útil
Poco útil	Me gusta, podría incluso pagar por usarlo

kahoot!k Game ID: 168902

¿QUÉ ES C-ITS?

Algunos ejemplos:

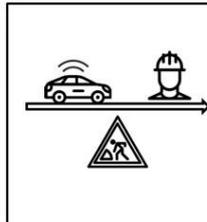


12

ROAD WORKS WARNING

This service provides in-vehicle information and warnings about road works and changes to the road layout, reducing accident risk for drivers and workers.

- ✓ Road Works Warning: provides awareness messages and instructions to adjust speed, change lanes, etc. using mobile internet or 802.11p

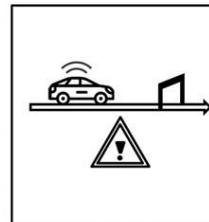


Be prepared for road works ahead

ROAD HAZARD & TRAFFIC JAMS WARNING

Provides advance warnings about dangerous situations such as objects on the road, potholes, traffic jams, or extreme weather.

- ✓ Hazardous Location Notification
- ✓ Traffic Conditions Warning
- ✓ Weather Conditions Warning

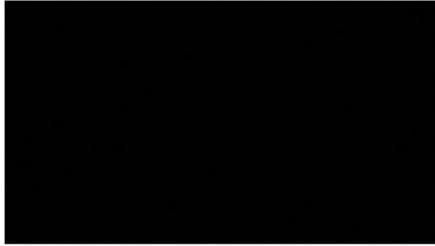


Adjust trajectory before reaching hazard



¿QUÉ ES C-ITS?

Algunos ejemplos:

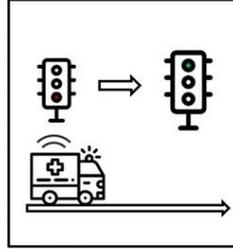


13

GREEN PRIORITY FOR DEDICATED VEHICLES

Green Priority aims to increase punctuality and response time for public transportation and service and emergency vehicles, holding off conflicting traffic and ensuring continued right-of-way.

✓ Green Priority for Dedicated Vehicles



This traffic light takes into account the existence of emergency vehicles



¿QUÉ ES C-ITS?

Algunos ejemplos:



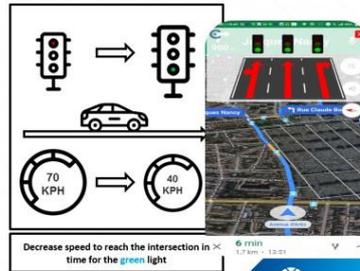
Green Light Optimal Speed Advice (GLOSA):
Speed advice to drive through traffic lights

14

GREEN LIGHT OPTIMAL SPEED ADVICE (GLOSA) / 'DYNAMIC ECO-DRIVING'

Provides drivers with an optimal speed advice when they approach a controlled intersection equipped with traffic lights, ensuring a smoother traffic flow and reducing unnecessary stops, fuel consumption and noise pollution.

✓ Optimized Driving Experience with GLOSA



Decrease speed to reach the intersection in time for the green light



GLOSA. A "Day 2" Application?



Motorcycle
V2X Applications
Roadmap

Day 1 Basic Systems

- Slow/Stationary Vehicle Warning
- Traffic Jam Ahead Warning
- Road Works Warning
- Emergency Brake Light
- Emergency Vehicle Warning

Day 1.5 Simplified Implementation

MAI – Motorcycle Approach Indication 'BEACONING'
Basic requirements
Lower market penetration rate

Day 2 Advanced Systems

Intersection Violation Warning

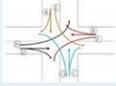
Green Light Optimal Speed Advisory (GLOSA)

Left Turn Assistance



15

GLOSA Pre-requirements

Aspect	Standard
Road Network 	
Intersection Layout 	MAP
Signal Split on/line 	SPaT

16



¿QUÉ ES C-ITS?

Algunos ejemplos:

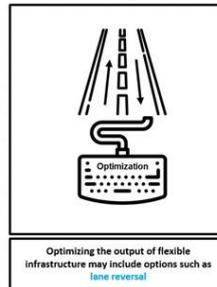


17

FLEXIBLE INFRASTRUCTURE (PRIORITY LANES)

Informs drivers about the status of reserved lanes throughout the day.

- ✓ **Dynamic Lane Management - Lane Status**
Information allows operators to open and close traffic lanes and notify users.
- ✓ **Dynamic Lane Management - Reserved Lane** (with or without use of vehicle probe data) notifies users about upcoming reserved lanes and whether or not their vehicle is allowed in.



2. Proyecto C-Mobile

18



PROYECTO C-MOBILE



ACCELERATING C-ITS MOBILITY INNOVATION AND DEPLOYMENT IN EUROPE

19 <https://www.youtube.com/watch?v=ajwPrrHycY&t=>

PROYECTO C-MOBILE

APPROACH

CONNECTIVITY

Enabling C-ITS services to support applications both in-vehicle and on personal nomadic devices (smartphones) and two-way communication with the road infrastructure (such as traffic lights or VMS), based on appropriate data access and sharing

INTEROPERABILITY

Full interoperability across Deployment Sites will provide a seamless user experience for supported services. Interoperability testing will be conducted by the consortium to ensure end-to-end compatibility and functionality

DEPLOYMENT

Demonstrating, assessing and evaluating the benefits of C-ITS services for urban mobility

PROYECTO C-MOBILE

THE BUNDLE APPROACH

PARKING EFFICIENCY

- Urban Parking Availability
- Motorway Parking Availability

INFRASTRUCTURE-TO-VEHICLE SAFETY

- Road Works Warning
- Road Hazard Warning

TRAFFIC EFFICIENCY

- GLOSA
- Green Priority
- Flexible Infrastructure

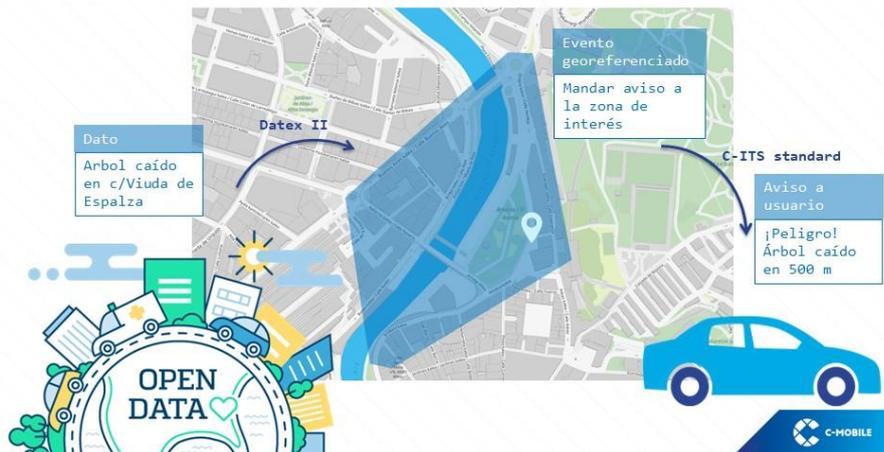
VEHICLE-TO-VEHICLE SAFETY

- Blind Spot Detection

21



ARQUITECTURA C-MOBILE



LOCAL PARTNERS C-MOBILE



23



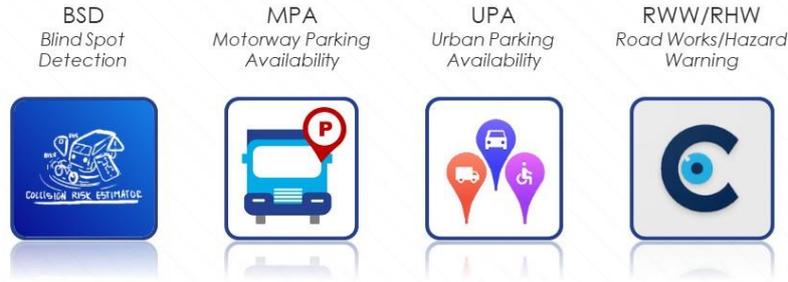
3.

Servicios desarrollados en Bilbao

24



SERVICIOS DESARROLLADOS EN BILBAO



25



SERVICIOS DESARROLLADOS EN BILBAO

BSD – Blind Spot Detection



<https://labur.eus/0Y2C0>

El servicio de detección de puntos ciegos (BSD) tiene como objetivo **avisar al ciclista** (Usuario Vulnerable de Carretera) sobre un **riesgo de colisión**. Este servicio contempla el caso en el que un bus está aproximándose a un punto ciego de la ciudad. Hay dos niveles de advertencia, en amarillo si el usuario se acerca a una zona de relevancia o peligro y en rojo cuando el riesgo de colisión es inminente.



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SERVICIOS DESARROLLADOS EN BILBAO

MPA – Motorway Parking Availability



<https://labur.eus/q821A>

El servicio de disponibilidad de aparcamiento de vehículos industriales (MPA) informa (**número de plazas disponibles**) y orienta al conductor profesional (**instalaciones disponibles, vehículos permitidos** etc.) para tomar mejores decisiones en la planificación de su ruta. El servicio MPA ha sido implementado en el parking CTVi, que tiene una capacidad de 180 plazas en Vitoria-Gasteiz. CTVi completa la red intermodal del Norte Peninsular (E-5, E-80). Esta aplicación también funciona para otros aparcamientos en toda Europa.



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SERVICIOS DESARROLLADOS EN BILBAO

UPA – Urban Parking Availability



<https://labur.eus/48L50>

El servicio de disponibilidad de aparcamiento en superficie (UPA) informa del **número de plazas de aparcamiento disponibles y su localización en tiempo real**. En concreto, el servicio informa al usuario de las plazas de aparcamiento disponibles en superficie de OTA, carga – descarga y PMR (personas de movilidad reducida).

El servicio se ha implementado en Bilbao y Burdeos dentro del proyecto C-Mobile.



¿Para quién?

Conductores particulares de coche y camión.

Entorno

Urbano

Principales beneficios

- Estará alerta ante de la disponibilidad de parking cercano en ciudad.
- Podrá ver la naturaleza de cada plaza (OTA, movilidad reducida, carga/descarga).
- Reducirá el estrés y tiempo de buscar aparcamiento y el consumo de fuel.

Estado actual

Actualmente el servicio funciona como Prueba de Concepto (PoC) con datos simulados. Este servicio estará disponible en la app oficial del ayuntamiento en un futuro.

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Queremos saber tu opinión



<https://labur.eus/E9lgy>

30



Eskerrik asko zuen arretagatik!
¡Gracias por vuestra atención!

Co-funded by
the European Union





C-MOBILE TRAINING
27 juin 2020 - Bordeaux

Systèmes de Transports Intelligents Coopératifs



Les C-ITS
Cooperative Intelligent Transport Systems
Systèmes de Transports Intelligents Coopératifs



Ces solutions permettent **aux véhicules de communiquer entre eux (V2V)**, mais également de **communiquer avec l'infrastructure (V2X)**.

Il s'agit d'interconnecter les véhicules, les infrastructures, les données et les personnes entre elles.

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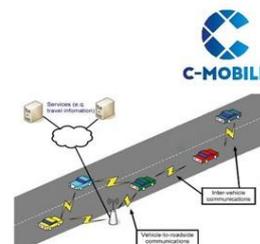
- Améliorer la sécurité routière
- Réduire les impacts environnementaux
- Réduire les coûts énergétiques
- Offrir des services innovants



Que sont les C-ITS?

Cooperative Intelligent Transport Systems:
Systèmes de Transports Intelligents Coopératifs:

- Les C-ITS sont des systèmes permettant l'échange de données en s'appuyant sur des technologies sans-fil
- Les véhicules peuvent connecter entre eux, avec l'infrastructure et avec les autres utilisateurs routiers
- Cas d'usages permettant d'améliorer la sécurité et l'environnement



- Communications:
- Véhicule vers véhicule (V2V)
 - Véhicule vers infrastructure (V2I)
 - Infrastructure vers véhicule (I2V)
 - Véhicule vers tout (V2X)

Équipement nécessaire

- Les services C-ITS peuvent être fournis en (4G) pour une communication longue distance ou en wifi (IEEE 802.11p, ITS-G5)

Véhicule

- OBU – On Board Unit à installer dans un véhicule et à connecter à la batterie, E/S et/ou CANBUS
- Antenne magnétique ou fixe sur le toit
- IHM – (Interface Homme Machine) affichant les cas d'usages

Infrastructure

- RSU – Road Side Unit
- Sur PMV, mat ou feu tricolore
- Connectée au SAGT



Notion de bundling de services

Défini par la Commission Européenne et expérimenté dans C-Mobile

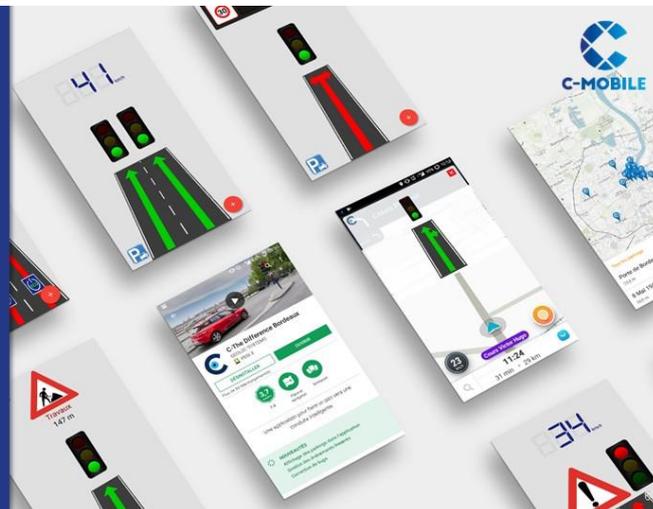


Urban Efficiency	I2V Safety
Rest time management Motorway parking availability Urban parking availability	Road work warning Road hazard warning Emergency vehicle warning Signal violation warning <i>Warning system for pedestrians</i>
Traffic Efficiency	V2V Safety
Green Priority GLOSA Cooperative traffic light for pedestrian <i>Flexible infrastructure</i> In vehicle signage Mode and trip time advice Probe vehicle data	Emergency brake light Adaptive cruise control Slow or stationary vehicle warning Motorcycle approaching indication Blind spot detection (VRU)

5

Application mobile d'aide à la conduite

CTD Mobilité Connectée disponible sur Google Play pour Smartphone Android





Interface Homme Machine

- Android 5,1+
- IOS : 2^{ème} semestre

Caractéristiques

- Superposition sur navigateur du marché
- Fourni des informations trafic en temps réel
- Popup lorsqu'il y a une information
- Sélection de services (bundling)
- 3 langages (FR, EN, ES)



7



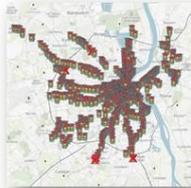
LES CAS D'USAGES C-ITS



8

GLOSA

Conseil de vitesse optimale au feu vert

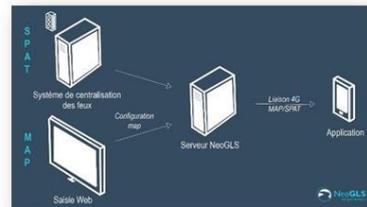


Le service fourni par l'application **CTD Mobilité Connectée** est déployé sur **589 intersections** à Bordeaux (environ **2300 feux** de circulation).



DEPLOIEMENT

- Information GLOSA disponible en 4G
- Connexion Gertrude



10

GLOSA

Conseil de vitesse optimale au feu vert

2 sources de données standardisées sont essentielles au bon fonctionnement de la solution GLOSA :



MAP

La cartographie de l'intersection (MAP) : Ce dispositif permet d'obtenir les **voies de circulation** employées par le conducteur. C'est-à-dire qu'il permet à l'application GLOSA de déterminer lorsque le conducteur arrive à **proximité d'une zone de feux** de route et notamment de savoir **lesquels d'entre eux sont concernés**.



SPAT

L'état des feux (SPAT) : Ce dispositif permet à l'application de connaître la **couleur des feux** à un moment précis (rouge, orange, vert) et la **durée** exact de leur état.

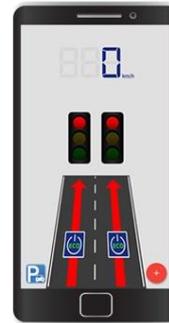
11

Arrêt moteur



Prévient le conducteur qu'il **peut couper le moteur de son véhicule**. Ce sera le cas seulement si le temps d'arrêt est **supérieur à 7 secondes**.

Fonctionne de la même manière que GLOSA : avec la **vitesse**, la **position** et l'état des feux de route.



12

Evenements routiers

Avertissement d'événements routiers dangereux

- Accidents
- Incidents (véhicule arrêté/en panne)
- Bouchons
- Conditions météo

Les messages provenant du SAGT sont transmises par le biais des **DENM (Messages de Notification Environnementaux Décentralisés)** en 3G/4G ou UBR G5.

- Avertissement 500 mètres avant l'événement (paramétrable)
- Affichage de la distance et de la longueur de l'événement



13

Travaux routiers

Travaux statiques

- Chantiers
- Route/voie fermée
- Basculement de chaussée

Travaux mobiles

- Chantier mobile
- Patrouilleur
- Déneigement

Les travaux provenant du SAGT sont transmises par le biais des

DENM (Messages de Notification Environnementaux Décentralisés) en 3G/4G ou UBR G5.



14

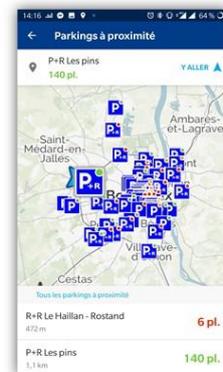
Informations Parking

Urbain

- Position géographique des parking
- Nombre de places disponibles
- Distance au parking
- Guidage
- Opendata Bordeaux Métropole

Autoroute

- Information sur aires de repos
- Ouvert/fermé/saturé
- Facilite l'organisation du trajet et de l'organisation des pauses
- SAGT Atlantes



15

Mode and Trip-Time Advice (MTTA)

Informations Parking

Relais

Ce cas d'usage notifie l'utilisateur qu'un parking relais se trouve proche de sa position. Il lui fournit le nombre de places disponibles et celles disponibles au prochain parking relais, lui permettant de mieux gérer son itinéraire.

Les données sont récupérées à partir de l'Open Data de Bordeaux Métropole.



16

Signalisation embarquée



In-Vehicle Signage (IVS)

- Panneaux à messages variable physiques ou virtuels
- Vitesse dynamique
- Temps de parcours
- Situations dangereuses (accident,...)
- Infrastructure partagée
- Zone 30
- ...

Les données sont créées à partir de **messages PMV** ou **opendata** diffusés par la plateforme C-ITS ou une **UBR**.



17

Priorité pour véhicules désignés aux feux tricolores

Le feu rouge est forcé de passer au vert lorsqu'un **véhicule prioritaire** arrive sur une intersection.

- L'**UEV** présent dans le véhicule envoie **sa position, vitesse et demande de priorité**
- L'**UBR** détecte ainsi le véhicule prioritaire et envoie la demande de priorité vers le contrôleur de feu ou le **système de centralisation des feux**
- Passage du feu au rouge ou réduction congestion



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Approche d'un véhicule d'urgence

Ce cas d'usage notifie l'utilisateur de la **présence d'un véhicule d'urgence** proche de sa **position**, même s'il ne le voit ni ne l'entend, ce qui lui permet d'adapter sa conduite.

Le véhicule d'urgence diffuse des **messages CAM** aux **UBR** à l'arrivée des intersections.



19

Avertissement de passage au feu rouge

Ce cas d'usage notifie l'utilisateur de son **comportement dangereux** s'il est sur le point de **passer le feu au rouge**.

Fonctionne de la même manière que **GLOSA** : avec la **vitesse**, la **position** et l'**état des feux de route**.



20

Flexible infrastructure

Information concernant les **voies réservées, partagées ou fermées**

- BAU réservée au bus
- Co-voiturage sur voie bus
- ...

Transmission d'une information dynamique en temps réel

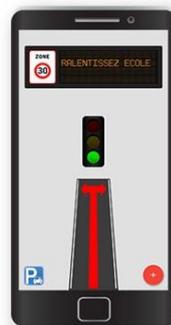


21

Signalisation embarquée Zone 30

Ce cas d'usage avertit le conducteur s'il **dépasse la vitesse limite** dans une **zone à 30km/h** ou dans une **zone proche d'une école**.

Les données sont récupérées à partir de l'**Open Data** de Bordeaux Métropole.



22



MERCI POUR VOTRE ATTENTION



23



C-ITS og C-Mobile projektet i Københavns Kommune

Jos van Vlerken
30/01/2020

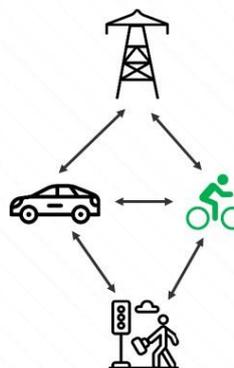
Co-funded by the European Union



Introduktion til C-ITS

Cooperative Intelligent Transport Systems

- / C-ITS muliggør real time kommunikation mellem infrastruktur og trafikanter, samt trafikanter indbyrdes
- / Derfor kan C-ITS forstås som en forbedring af konventionel ITS ved hjælp af:
 - De seneste kommunikationsstandarder
 - Udbud af flere funktioner der kan forbedre
 - rejseoplevelsen som trafikant
 - Driftsbesparelser for myndigheder
 - Værktøjer for trafikledelse
 - Politiske målsætninger (trafiksikkerhed, miljø osv.)



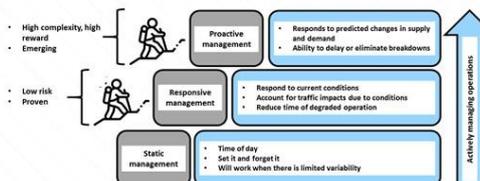
2



C-ITS i Trafikledelse

En tjekliste

- / Integrationen af C-ITS i dynamisk trafikledelse indebærer de følgende elementer:
 - Definerede politikker, retningslinjer eller planer for trafikledelse
 - Definerede trafikledelsesstrategier og værktøjer
 - Overblik over netværket i lyset af de forskellige transportformer
 - Sammenhæng mellem målsætninger og C-ITS funktioner/værktøjer



3



C-ITS i Trafikledelse

Vision for C-ITS i trafikledelse

- / Trafiklederes funktioner vil stadig bero på **vurderinger og ekspertise**, men rollerne og værktøjerne vil forfines
- / Forbedret **årvågenhed og indblik** i trafikken, samt potentielle samarbejde og handlemuligheder på tværs af myndighedsgrænser og organisationer
- / Adgang til **nye datakilder**
- / Forbedret forståelse af **politikkers og strategiers effekt** på den faktiske trafik og brugeroplevelse
- / **Øget præcision** af værktøjer



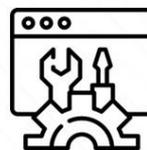
4



C-ITS arkitektur

Principper bag C-ITS arkitektur

- / **Interoperabilitet:** systemer fra forskellige lande og udviklere skal kunne tale sammen
- / **Sikkerhed:** Systemer skal beskytte data
- / **Performance og effektivitet:** balancegang mellem besvær/omkostninger og fordele
- / **Nytte!:** systemerne skal opfylde behov enten for trafikledelse eller brugere
- / **Pålidelighed:** brugere skal være trygge ved brugen af systemernes funktioner
- / **Tilgængelighed:** systemerne skal være tilgængelige og nemme at bruge
- / **Tilpasningsdygtighed:** systemerne skal kunne tilpasse sig til forskellige omstændigheder



5



Privatliv og sikkerhed

“6” GDPR principper

1. Lovlig, fair og transparent
2. Formålsorienteret
3. Data minimering
4. præcision
5. Lagringsbegrænsning
6. Integritet og fortrolighed

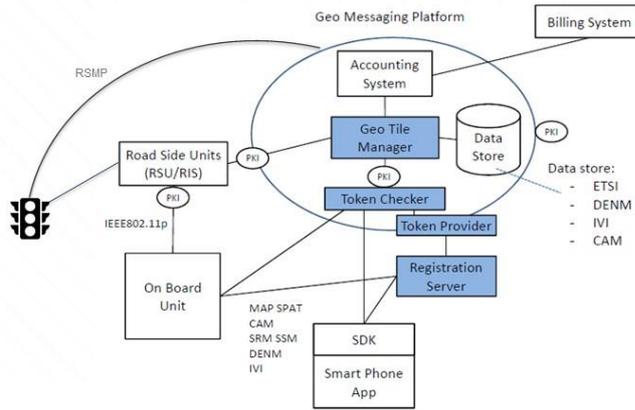
- / I GDPR findes et begreb om pseudonymitet som et redskab til at lempe lidt på kravene til databehandling



6



C-ITS arkitektur i København



7



Typer af beskeder

Standardiserede C-ITS beskeder

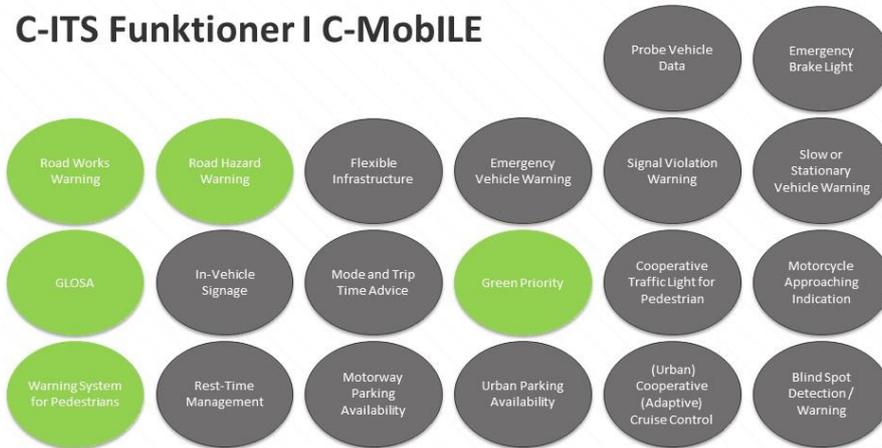
- / Cooperative Awareness Message (CAM): a message ("I am here") sent by a vehicle one to ten times per second with data on vehicles position, direction, speed, etc.
- / Distributed Environmental Notification Message (DENM): warning message (e.g. slippery road, crash) sent with high priority to a vehicle based on information from the vehicle or the infrastructure
- / Signal Phase & Timing (SPaT) : information to the vehicle on traffic light state and future state changes
- / In-vehicle information (IVI) : presentation of physical road sign information inside the vehicle
- / MAP: describes the physical geometry of an intersection



8



C-ITS Funktioner I C-Mobile



9

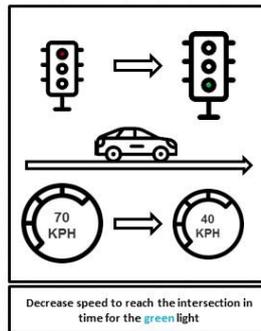
19/06/2019

C-Mobile, C-ITS Training for Public Authorities, 1st Phase- "Train the Trainer", Vigo, Spain



C-Mobile i København

Green Light Optimized Speed Advisory (GLOSA)



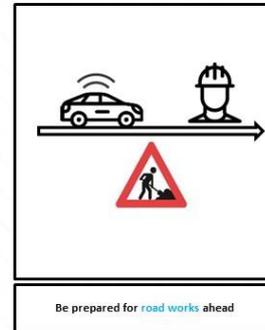
10



C-Mobile i København

Advarsler om vejarbejde

- / Advarer trafikanterne (mest bilisterne) om vejarbejde forude.
- / Henter data fra Gravetilladelser via Bydatas portal (tak for GPS lokationerne!).
- / Men! Vi har ca. 1200 vejarbejder i byen uden særlig mulighed for at rangordne den trafikale påvirkning.



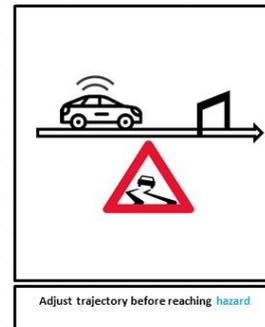
11



C-Mobile i København

Glatføre

- / Informerer trafikanterne om lave temperaturer på vejene og potentielt glatføre.
- / Data fra vores målestationer via Vejdirektoratets NAP (National Access Point).
- / Men! Måske bliver glat føre ikke aktuelt fremover pga. global opvarmning.



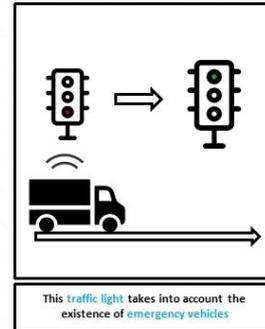
12



C-MOBILE i København

Grøn Prioritet

- / Tillader udvalgte biler at modtage prioritet i udvalgte trafiksignaler.
- / Direkte og hurtig kommunikation mellem køretøjer og trafiksignaler.
- / Sydøstlige del af O2 fra Folehaven til Nordhavn.
- / Klassificering af køretøjer og differentiering af prioritet.
- / Men! Køretøjerne skal have tilsvarende kommunikationsudstyr og **hvad med EU Kommissionen?**

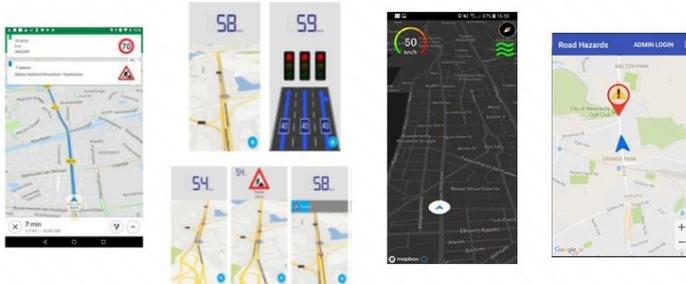


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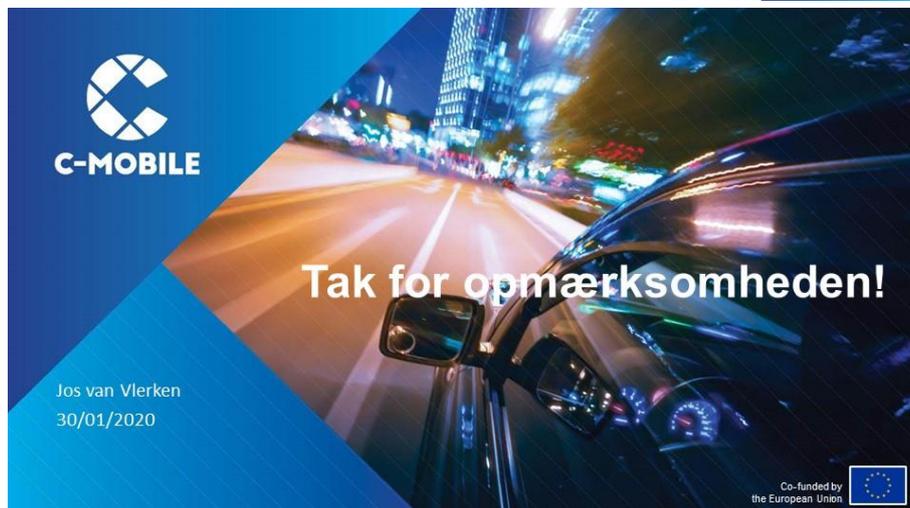


6 / Apps fra de andre C-MOBILE byer

Barcelona, Bordeaux, Thessaloniki, New Castle osv...



14





Session Outline /

1	Introduction to Traffic Management	
	Traffic Management Centers (TMCs) in the C-ITS Environment	2
3	C-ITS Enabled Traffic Control Strategies	
	Impacts of C-ITS and Deployment Costs	4
5	Future Perspectives	

2



1 / Introduction to Traffic Management

The scope

/ Traffic Management according to European Commission:

- ... provides **guidance** to the European **traveler** and **hauler** on the **condition** of the **road network**
- ... detects **incidents** and **emergencies**, implements **response strategies** to ensure **safe** and **efficient use** of the road network and **optimizes the existing** infrastructure, including across borders
- incidents can be **unforeseeable** or **planned**: accidents, road works, adverse weather conditions, strikes, demonstrations, major public events, holiday traffic peaks or other capacity overload

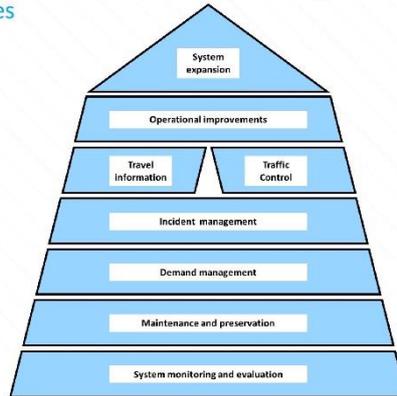


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1 / Introduction to Traffic Management

Overview of processes

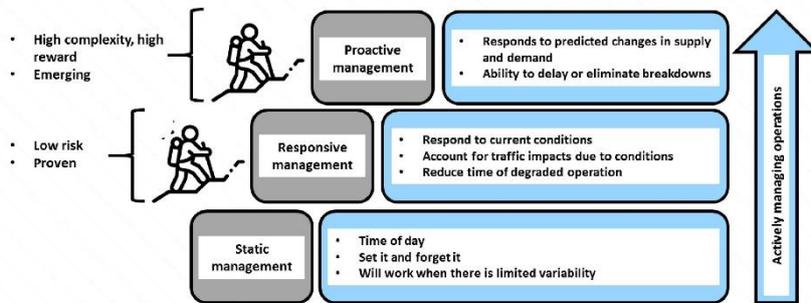


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1 / Introduction to Traffic Management

Traffic management approaches



5



1 / Introduction to Traffic Management

A changing environment

- Traffic management challenges:
 - handling congestion resulting from increased mobility
 - further reduction of road accidents
 - pressure to achieve agreed climate goals
 - changing composition of road traffic (e.g. due to the development of smart electric cars)
 - integration of new technological means into traditional processes
- 4 pillars of the modern perception for Traffic Management:
 - exchange and use of growing data streams
 - development of new assets (e.g. smart roadside systems)
 - influence the behavior of road users
 - achieve cooperation among all involved parties



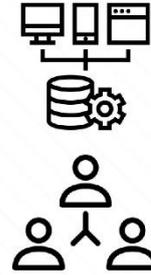
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1 / Introduction to Traffic Management

Enablers of network optimization

- / Road network optimization requires the close cooperation among a variety of involved actors
- / The supportive links may be:
 - **Hardware-based:** digital connections between the traffic centers and the roadside systems of the various road operators
 - **Software-based:** common platforms that provide a shared picture of the traffic situation in a geographical extent or network management systems for the coordinated deployment of traffic measures by the various road operators
 - **Organizational:** i.e. exchange of knowledge or products, adoption of common standards



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2 / TMCs in the C-ITS Environment

Factors affecting TMC operation

- / Relationship to and coordination with other agency divisions or groups (such as maintenance, construction, district/region or headquarters)
- / Data sharing agreements with third parties
- / Staff digital competencies
- / Performance appraisal methodologies
- / Responsive or proactive orientation



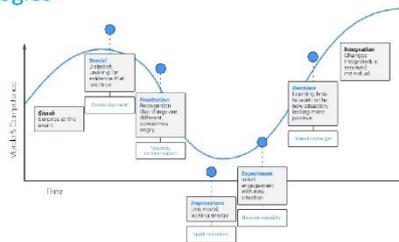
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2 / TMCs in the C-ITS Environment

Prerequisites for integrating C-ITS technologies

- / Availability and adequate density of real-time dynamic data
- / Willingness and ability to embrace new approaches
- / Appropriate business and partnerships models
- / Adequate perceived benefits for both TMC operational capabilities and transport network performance



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2 / TMCs in the C-ITS Environment

New required skills for the exploitation of C-ITS technologies

Technical Discipline	Skill Sets and Credentials
Information Technology and Data Management	<ul style="list-style-type: none"> • Hardware and software support for Big Data environment, and integrating data/information into TMC processes • Data warehousing, queries and support for data access and redistribution • Support data management and sharing policy development • Integrate new software and updates • Coordinate with system developers and integrators for new TMC systems and software
System Analytics and Processing	<ul style="list-style-type: none"> • Identify how to update TMC processes with new capabilities • Identify what types of analysis can lead to improved operations and decision support • Coordinate with other TMCs or other agency divisions to identify how new data can support their functions (i.e., safety, planning, programming, project development, etc.) • Aggregate and process data (if this function will be completed in-house) to create useful information for system and operational performance metrics • Analyse system performance and recommend modifications based on outcomes

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2 / TMCs in a the C-ITS Environment

New required skills for the exploitation of C-ITS technologies

Technical Discipline	Skill Sets and Credentials
Network and Device Maintenance	<ul style="list-style-type: none"> • Specialized training for maintaining new field devices to support C-ITS • Testing and deployment of new devices • Coordinate with device vendors for technical specifications and requirements • Coordinate with IT and Operations to integrate new devices into TMC processes
Operations Engineering Decision Making	<ul style="list-style-type: none"> • Specialized training for traffic engineering in presence of C-ITS • Skill sets to develop traffic signal timing plans and strategies, and to implement modifications to signal operations to optimize traffic flow and safety in presence of C-ITS • Authorize and/or implement changes in strategies based on real-time C-ITS data inputs, such as weather response strategies, balancing network demand, or multi-agency corridor operations • Support development and active monitoring of system performance metrics, and identify where strategies need to be implemented to achieve performance goals

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3 / C-ITS Enabled Traffic Control Strategies

A step-by-step approach

/ The process of integrating C-ITS services into Dynamic Traffic Management “control strategies” involves the following steps:

- **Definition of the traffic management policy:** a description of the importance and function of roads as well as quantitative thresholds for links and route parts
- **Discretization of the available road network:** the distinction of the various parts of the road network (incl. nodes, segments, links, route parts) with respect to their typological or topological characteristics
- **Definition of traffic control strategies:** the means of achieving policy objectives that may be applied in escalation phases
- **Association of C-ITS services with traffic control strategies:** definition of C-ITS services that can accomplish policy objectives via the realization of the appropriate traffic control strategies

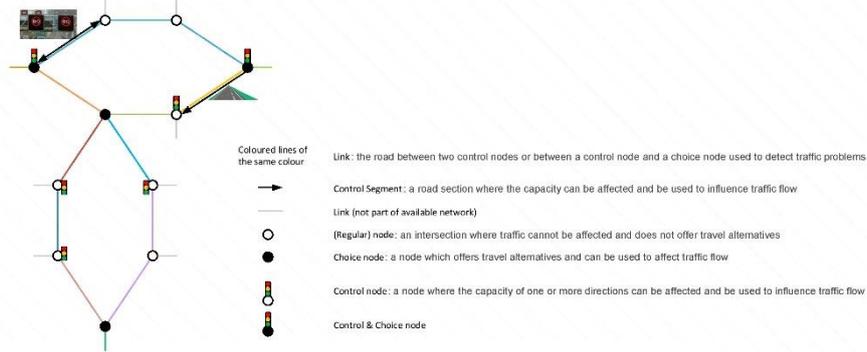


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3 / C-ITS Enabled Traffic Control Strategies

Road network discretization

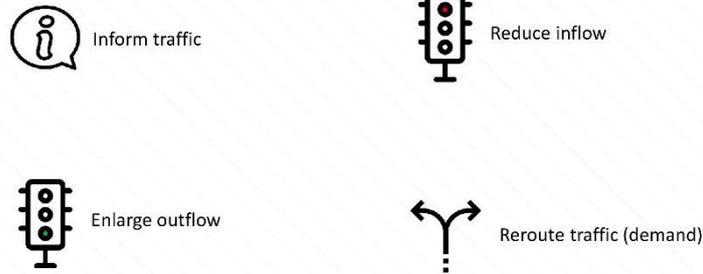


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3 / C-ITS Enabled Traffic Control Strategies

Traffic control strategies



14



3 / C-ITS Enabled Traffic Control Strategies

Indicative association of C-ITS services with TCS

Smart mobility measure	Primary objective	Inform traffic	Enlarge the outflow	Reduce the inflow	Reroute traffic (demand)
Green Priority for Designated Vehicles	Reduce delay time at traffic light for designated vehicles	-	Enlarge the outflow of priority directions	-	-
Flexible Infrastructure (e.g. Peak-hour Lanes)	Control available road capacity	-	More road capacity increases the outflow	Less road capacity reduces the inflow	-
In-vehicle Signage Road Section	Present dynamic road sign information for road sections in the vehicle (personalized and extrapolated)	Inform about conditions, restrictions	e.g. speed harmonization increase outflow	e.g. speed harmonization reduces inflow	-
In-vehicle Signage Route	Present route and travel time information in the vehicle (personalized and extrapolated)	Inform about options	-	-	e.g. travel time information and route advice
Mode & Trip Time Advice (e.g. by Incentives)	Multi-modal travel and departure time advice (MaaS-like concept, by incentives)	Inform about conditions, restrictions and options	-	-	Delayed trips or trips by collective modes reduce demand

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4 / Impacts of C-ITS and Deployment Costs

Categorization of impacts

- / Identifying the impacts of C-ITS services is a crucial step in justifying any required investments
- / These impacts can generally be categorized into **five** groups
- / **Safety**-related:
 - Reducing the number of fatalities
 - Reducing the severity of collisions
- / **Operational efficiency**-related:
 - Reducing disruption due to incidents
 - Improving the Level of Service and convenience provided to travelers
 - Increasing infrastructure capacity (and postponing its physical expansion)



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4 / Impacts of C-ITS and Deployment Costs

Categorization of impacts

- / **Productivity**-related:
 - Reducing costs incurred by fleet operators
 - Reducing travel times
 - Improving transport planning and management
- / **Mobility & comfort**-related:
 - Providing access to pre-trip and on-trip information
 - Improving the safety and security of travel
 - Reducing traveler stress
- / **Environmental**-related:
 - Reducing harmful emissions
 - Reducing energy-fuel consumption



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4 / Impacts of C-ITS and Deployment Costs

Categorization of impacts

- / The exact assessment of the impacts falling under all of the aforementioned categories is sometimes **not possible**:
 - lack of data
 - difficulty in identifying the influence area of respective services in order to calculate reasonable indicators



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5 / Future Perspectives

The need for collaboration

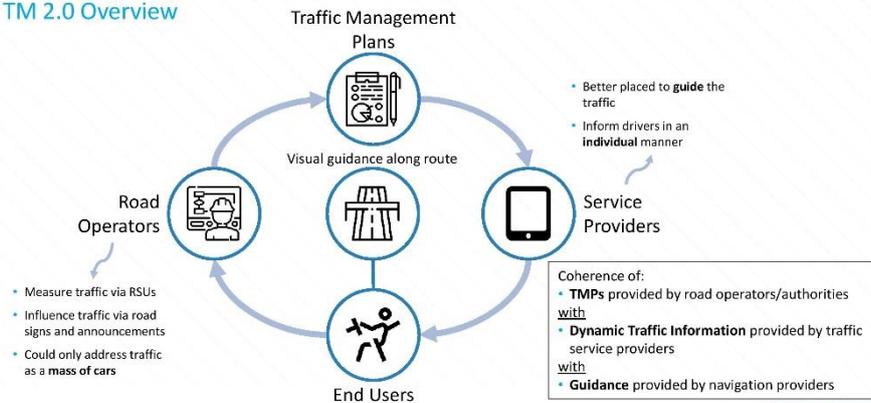
- / The further development of C-ITS technologies is expected to bring significant benefits in terms of road safety, traffic flow efficiency and emission reduction
- / Before concepts such as proactive traffic management can become a reality it is important to understand that there will be a long period during which various types of vehicles (non-semi-full automated) will coexist
- / The aforementioned benefits can be realized only under the premise that the various involved players will collaborate and cooperate with each other by following innovative business models
- / An example is the TM2.0 Platform that promotes the concept of **“Cooperative Traffic Management”** (i.e. a connected, decentralized, traffic management system in which all stakeholders can act collaboratively, either to provide individually, high quality, profiled services or to preserve the collective's best interest, as for safety, flow efficiency and emission reduction)

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5 / Future Perspectives

TM 2.0 Overview

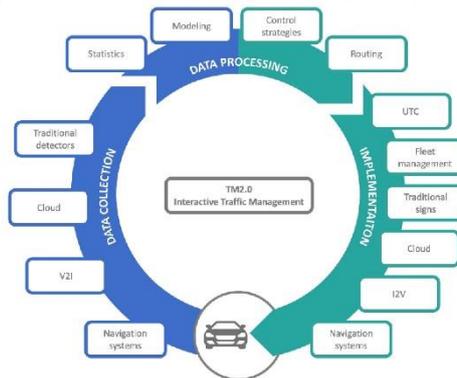


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5 / Future Perspectives

What is needed



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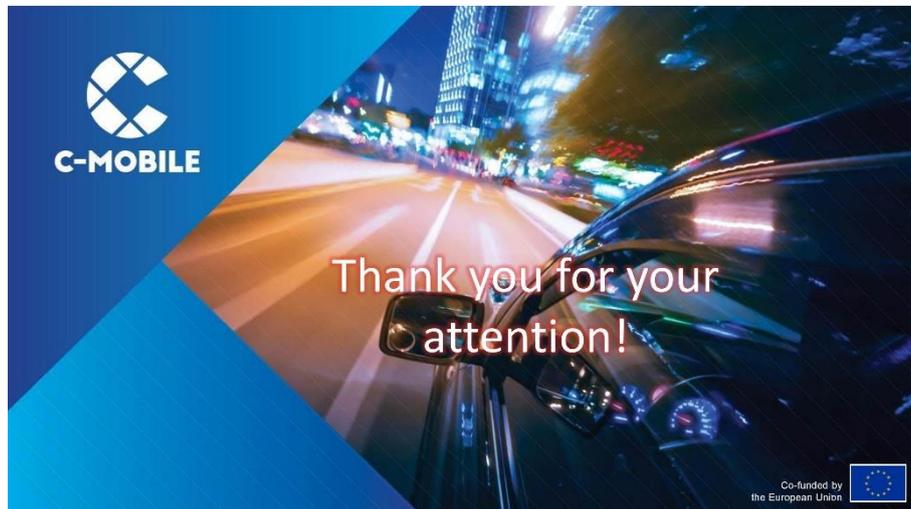
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- / This presentation used icons made by [Dave Gandy; Eucalyp; Freepik; Good Ware; mynamepong; Smashicons; pongsakornRed] from www.flaticon.com

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Session Outline /

1	Introduction to C-ITS	
	C-ITS Architecture of C-Mobile	2
3	Communication Technologies & Interoperability	
	Data Privacy & Security	4
5	C-ITS Services in C-MOBILE	
	Applications Developed within C-MOBILE	6

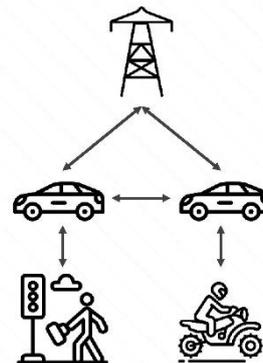
2 19/06/2019 C-Mobile, C-ITS Training for Public Authorities, 1st Phase - "Train the Trainer", Vigo, Spain



1 / Introduction to C-ITS

Cooperative Intelligent Transport Systems

- / C-ITS provide real time communication between vehicles, infrastructure and other road users
- / C-ITS may be understood as enhanced conventional ITS through:
 - the latest communications standards
 - the provision of tailored services that can provide benefits
 - Driver/traveler experience
 - Operational savings
 - Delivery of traffic management objectives
 - Policy goals (e.g. safety, reduced emissions)



3



1 / Introduction to C-ITS

Connected Vehicles

- / The term refers to applications, services, and technologies that connect a vehicle to its surroundings
- / Such vehicles are equipped with various communication devices that enable in-car connectivity with other devices present in the vehicle and/or enable connection of the vehicle to external devices, networks, applications, and services
- / Applications encompass areas such as traffic safety and efficiency, infotainment, parking assistance, roadside assistance, remote diagnostics, and telematics to autonomous self-driving vehicles and global positioning systems (GPS)
- / Vehicles that include interactive advanced driver-assistance systems (ADAS) and cooperative intelligent transport systems (C-ITS) can be regarded as connected



IEEE

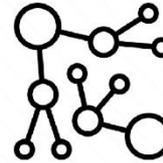
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C-MOBILE

1 / Introduction to C-ITS

Bundling concept

- / State-of-the-art perception on C-ITS services provision
- / Bundling is the coordinated provision of several C-ITS services
- / Service bundles are developed and provided in the form of open, modular and extendable applications bringing together a complete suite of C-ITS services under one common user environment
- / Benefits
 - Flexibility
 - Cost efficiency
 - Savings in infrastructure requirements



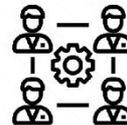
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C-MOBILE

2 / C-ITS Architecture

General notions

- / The definition of a comprehensive and consistent architecture framework
- / Valuable guidance to the development of complex systems such as C-ITS
- / Supports the communication and cooperation between different stakeholders during the whole life-cycle of the system
- / According to the ISO/IEC/IEEE 42010:2011 standard an architecture framework:
 - ... establishes a common practice for creating, interpreting, analyzing and using architecture descriptions within a particular domain of application or stakeholder community



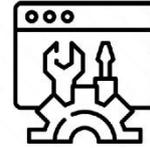
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C-MOBILE

2 / C-ITS Architecture

C-ITS design principles

- / **Interoperability:** degree to which two or more systems can exchange and utilize (exchanged) information
- / **Security:** degree to which the system protects information and data
- / **Performance efficiency:** balance between resource consumption and provided services
- / **Usability:** degree to which the system can be used in order to achieve specified goals
- / **Reliability:** ability of the system to perform the right functions under specified circumstances
- / **Availability:** the degree to which the system is accessible and operational
- / **Adaptability:** the degree to which the system can adapt efficiently and effectively to different or evolving hardware/ software/ environments



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3 / Communication Technologies & Interoperability

C-ITS communication technologies

- / The communication technologies for C-ITS are based on standards which are developed by various organization such as:
 - the European Telecommunications Standards Institute (ETSI)
 - the European Committee for Standardization (CEN)
 - the International Organization for Standardization (ISO)
- / They can generally be classified as “short-range” and “long-range” technologies

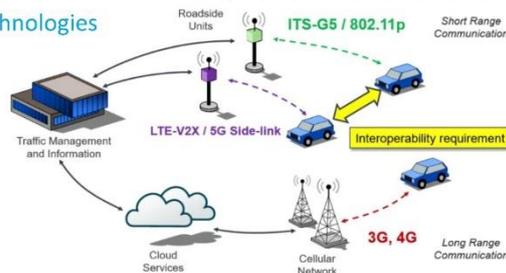


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3 / Communication Technologies & Interoperability

C-ITS communication technologies



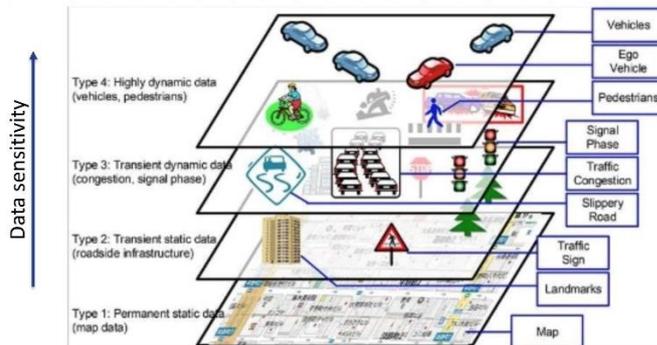
- / ETSI ITS-G5 provides low latencies (useful for time-critical messages)
- / Cellular networks provide wider coverage and scalable access to a large number of devices

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4 / Data privacy and security

C-ITS data sensitivity



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4 / Data privacy and security

The six principles of GDPR

1. Lawfulness, fairness and transparency
2. Purpose limitation
3. Data minimization
4. Accuracy
5. Storage limitation
6. Integrity and confidentiality



/ Two principles are especially relevant for C-ITS: **transparency** and **data minimization**

/ The GDPR introduces the concept of **pseudonymity** serving as a tool to relax the strict requirements for anonymization

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5 / C-ITS Services in C-Mobile

Full list of services



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6 / Apps within C-Mobile

Barcelona DS

- / Based on cellular communications
- / Developed by IDIADA
- / Services: Road Works Warning, Road Hazard Warning, Emergency Vehicle Warning, GLOSA, Signal Violation Warning, Flexible Infrastructure, Mode and Trip Time Advice, Probe Vehicle Data, Warning System for Pedestrians, Approaching Motorcycle Indication
- / End-user can keep using their preferred navigation application (e.g. Google Maps, MAPS.ME, etc.)
- / App is working in the background



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6 / Apps within C-Mobile

Bordeaux DS

- / Orientation: increase road-safety, traffic efficiency and reduce environmental impacts
- / Free app developed by NeoGLS
- / Provides information for: Road Works Warning, Road Hazard Warning, Emergency Vehicle Warning, GLOSA, Red Light Violation Warning, In-Vehicle Signage, Parking Availability



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6 / Apps within C-Mobile

Bilbao DS

- / Orientation: increase road-safety, traffic efficiency and reduce environmental impacts
- / C-ITS services will be provided to the end-users via different apps developed by different partners
- / These apps will cover: Road Works Warning, Road Hazard Warning, Urban Parking Availability, Motorway Parking Availability, Blind Spot Detection



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6 / Apps within C-Mobile

Copenhagen DS

- / Orientation: increase road-safety, traffic efficiency and reduce environmental impacts
- / GreenCatch is a GLOSA app being repurposed to include additional services
- / These services include: Green Priority, Road Works Warning, Road Hazard Warning, Warning System for Pedestrians
- / Provides information to drivers and especially cyclists
- / Its purpose is to reduce the number of stops and the instances of acceleration and deceleration (further translated to reduced fuel consumption and emissions)



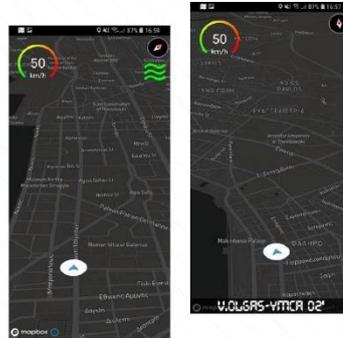
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6 / Apps within C-Mobile

Thessaloniki DS

- / One common app developed by CERTH-HIT
- / Integrated services include: Road Works Warning, Road Hazard Warning, GLOSA, In-Vehicle Signage, Flexible Infrastructure, Mode and Trip Time Advice, Probe Vehicle Data
- / Future versions will include additional services and functionalities



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6 / Apps within C-Mobile

Vigo DS

- / One common app developed by CTAG for all end-users
- / Users login and receive information relevant to their respective user type and profile

Road works warning	X	X	X	X	X
Road hazard warning	X	X	X	X	X
Emergency Vehicle warning	X	X	X	X	X
Signal violation warning			X	X	X
Warning system for pedestrian	X	X	X	X	X
Green Priority					X
GLOSA	X	X	X	X	
In-vehicle signage	X		X	X	X
Probe vehicle data	X	X	X	X	X
Emergency brake light	X				



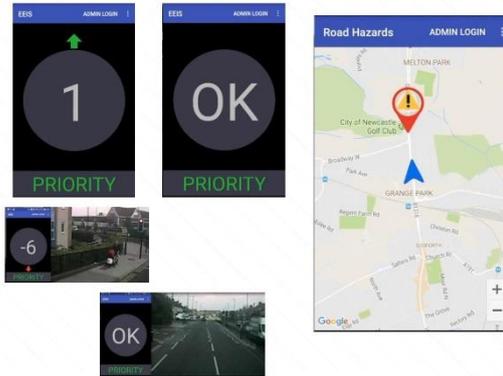
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6 / Apps within C-MOBILE

Newcastle DS

- / C-ITS services implemented: GLOSA, Green Priority, RHW/RWW, Flexible Infrastructure, In-Vehicle Signage, Probe Vehicle Data, Blind Spot Detection
- / ITS G5 communication (RSUs, OBU)



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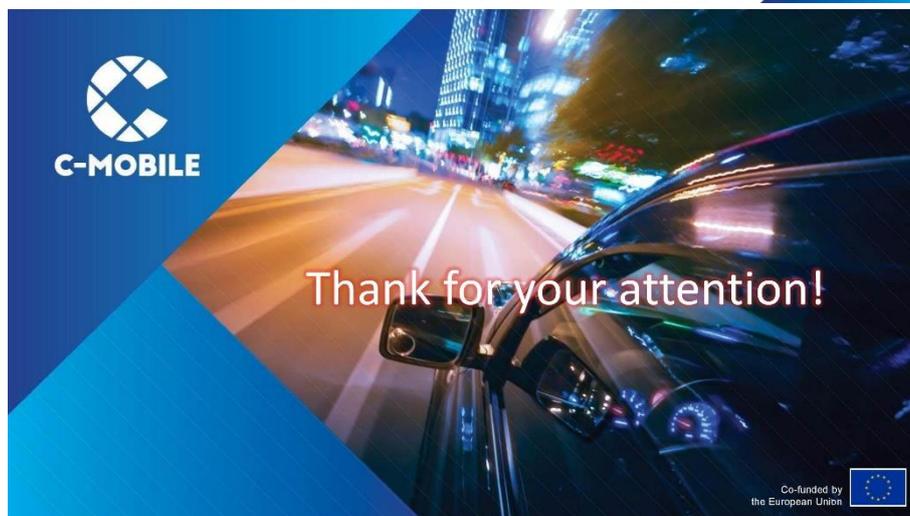
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C-ITS in Newcastle 2013-2020

Simon Edwards, Newcastle University

North East Ambulance Service

11th Dec 2019

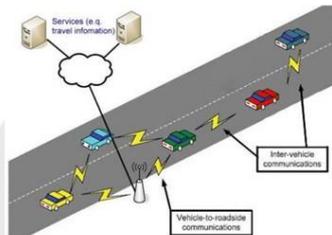
School of
Engineering

Refresher - What are C-ITS?



Cooperative Intelligent Transport Systems:

- *C-ITS are systems that allow data exchange through wireless technologies*
- *Vehicles can connect with each other, with the road infrastructure and with other road users*
- *Can deliver a range of efficiency, safety and environmental services*



Communications:

- Vehicle-to-vehicle (V2V)
- Vehicle-to-infrastructure (V2I)
- Infrastructure-to-vehicle (I2V)
- Vehicle-to-anything (V2X)

School of
Engineering

What can C-ITS do for Newcastle?



- **Air Quality** - Parts of Newcastle have significant pollution, e.g. NO_2
- **Congestion & Road Safety** - Falling traffic speeds in the morning peak and increasing delays to bus services
- **Economic Growth and Innovation** – To support the local economy with more efficient travel
- **Accessibility, Sustainability and Equity** – More ‘active’ travel and public transport journeys

School of
Engineering

What can C-ITS do for Operators?



- **Energy saving** – smoother journeys through junctions with reduced braking can lead to reduced fuel use
- **Improved journey time reliability** – smoothing traffic flow through complex routes can make it easier to stick to timetables
- **Passenger comfort** – smoother journeys with reduced braking improves the passenger experience
- **Priority** – the C-ITS services in Newcastle are designed to optimise the road network to prioritise non-car transport modes

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Equipment Needed

- C-ITS services can be delivered by cellular (4G) for long range communication, or wifi (IEEE 802.11, aka ITS-G5) for short range
- ITS-G5
 - OBU – On Board Unit to be fitted in the vehicle and powered by cigarette lighter or fully wired in
 - Antenna – Magnetic, cabled and connected to OBU. Does not need to be external to the vehicle
 - HMI – Human Machine Interface – Smartphone display on dash



Previous C-ITS Projects

Compass4D (EU) 2013-16

- ITS-G5
- Chillingham Road, Benton Road, Coast Road
- Aimed to improve energy efficiency at junctions:
 - ✓ Green Light Optimal Speed Advisory (GLOSA)
 - ✓ Green Priority
- Siemens UK (roadside units) & Commsignia (onboard units/display)
- North East Ambulance Service (NEAS)

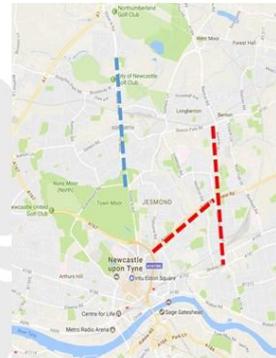


C-ITS Smart Corridor (DfT) 2015-19

- ITS-G5
- Great North Road
 - ✓ Green Light Optimal Speed Advisory (GLOSA)
 - ✓ Green Priority
 - ✓ Blind spot detection for cyclists
- Siemens UK, Dynniq UK (OBU), & Zircon (display)
- Arriva express and local buses



- Builds on existing deployments
- 'Large scale' (users)
- Interoperability/ harmonisation
- Bundling of services
- Business case
- Siemens UK, Dynniq UK, Zircon, Cohda/Reece
- Arriva, NEAS, plus freight and taxis



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C-MOBILE: Bundling of Services

Urban Efficiency	I2V Safety
Rest time management Motorway parking availability Urban parking availability	Road work warning Road hazard warning Emergency vehicle warning Signal violation warning <i>Warning system for pedestrians</i>
Traffic Efficiency	V2V Safety
Green Priority GLOSA Cooperative traffic light for pedestrian <i>Flexible infrastructure</i> In vehicle signage Mode and trip time advice Probe vehicle data	Emergency brake light Adaptive cruise control Slow or stationary vehicle warning Motorcycle approaching indication Blind spot detection (VRU)

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GLOSA (ITS-G5)

- Deployed on 39 roadside units (RSU) across the two routes
- Corridors selected based on city policies to prioritise traffic
- Includes pedestrian crossings as well as standard priority traffic lights
- Uses the programmed traffic signal plan (UTMC) and the speed / location of the vehicle (with OBU) to work out what the optimal speed would be to get through green light
- Communicates this to driver via the display
- Can be used with or without Green Priority



Green Priority (ITS-G5)

- OBU is programmed to be a vehicle (e.g. NEAS vehicle)
- OBU sends a request known as a 'hurry call' when vehicle arrives on the MAP relating to traffic signal
- Map needs to be specific enough to understand what lane vehicle is in
- Signals receive hurry call request and make an assessment as to whether this vehicle should be granted priority (i.e. by type of vehicle or time of day)
- Close proximity of some junctions means that equipped vehicles will have a 'green wave' through the area



RHW/RWW (Cellular)

- Available on all vehicles equipped with a smartphone (in practice this is likely to be the same as the HMI display used for G5 services)
- Development of service following feedback from previous projects – need to keep user engaged (rather than just a logo)
- Data provided through North East UTMC Open Data Service which collects data from across the region
- Uses standard protocols – DATEX II and open data service
- As part of C-MOBILE, these messages are converted to DENM messages and made available via 4G cellular service
- Available throughout region (not just equipped zone)



User Engagement

Bus (express)

- ✓ 35 vehicles to be equipped
- ✓ 42-120 bus drivers (42 regular drivers, but all drivers are eligible to drive the route)
- ✓ NCC in regular contact with management and engineers

North East Ambulance Service (non emergency)

- ✓ 13 non-emergency vehicles will be equipped
- ✓ Number of drivers TBC
- ✓ Engineering contact TBC

Taxi

- ✓ 10 vehicles will be equipped
- ✓ Number of drivers TBC
- ✓ NCC has monthly liaison meetings

Public authority

- ✓ Vehicles and drivers TBC (10 vehicles max)

Will We See Real Benefits?

Vehicle Data:

- Measure improvements through monitoring GPS traces, journey timings, fuel consumption
- Lots of easy to measure data from good sources

Talking to Drivers:

- Examine things like user acceptance and use of services
- Reliant on self reporting. Might be difficult to give fully reliable answers

Air Quality:

- Measure the air quality near the routes through precision and low cost monitors
- Lots of data, but the quality of sensors is variable

Simulations:

- Simulate expected results and compare them to our real measurements
- Lots of good quality data but it isn't "real". How applicable is it to the real world?

Status/ Next Steps

- Cellular services (RWW/RHW) are expected to be available from January 2020, and will be available via App
- GLOSA and GP are being deployed firstly on Arriva buses from this month, using Dynniq OBUs
- NEAS OBUs will be Cohda. These are being adapted to be interoperable by REECE and integrated by Siemens (early 2020)
- User acceptance questionnaires ('before') are available
- When the vehicles are equipped, a baseline (services off) will be run for a few weeks prior to activation of the services

What we will need (NCC/NU)

- Contact for an engineer to discuss technical installation
- Contact of a driver rep to arrange training/ user acceptance evaluation

Thank you for your attention!



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<https://c-mobile-project.eu/>



CMobile Project

C-ITS Scenario Demonstrations

Scenario Demonstrations

- What areas are we researching through the CMobile project?
- How does this actually work in real life and what are the practical considerations?

What are we researching?

Bundle 1 – Urban Efficiency	Bundle 2 – Infrastructure-to-vehicle Safety
Rest time management Motorway parking availability Urban Parking availability	Road work warning Road hazard warning (including traffic jams) Emergency Vehicle Warning Signal Violation Warning Warning system for pedestrian (not limited to crossing)
Bundle 3 – Traffic Efficiency	Bundle 4 – Vehicle-to-vehicle Safety
Green priority Green Light Optimal Speed Advisory (GLOSA) / Dynamic eco-driving Cooperative traffic light for pedestrian <i>Flexible infrastructure</i> In-vehicle signage Probe Vehicle Data	Emergency Brake Light Adaptive Cruise Control Slow or stationary vehicle warning Motorcycle approaching indications Blind spot detection / warning

Equipment Needed

- OBU – On Board Unit to be fitted in the vehicle and powered by in vehicle power source (e.g cigarette lighter)
- Antenna – Magnetic, cabled and connected to OBU. Does not need to be external to the vehicle
- HMI – Human Machine Interface – Mobile Phone App on dash

Signal Plan – Great North Rd / Hollywood Av In normal circumstances



- Great North Rd – North and South 35 seconds
 - *Great North Rd – North and Right Arrow into Hollywood Ave = 10 seconds*
 - Hollywood Ave and Regent Centre = 12 seconds
 - *Hollywood Ave and Right Arrow onto Great North Rd = 6 seconds*
 - *Great North Rd south and Bus Right filter to Regent Centre = 6 seconds*
- Total time including closing each stage down = 120 seconds

Green Light Priority

- OBU programmed to be a vehicle – taxi, bus, freight vehicle
- OBU sends a request known as a 'hurry call'
- Signals receive hurry call request and make an assessment as to whether this vehicle should be granted priority
- If accepted, the signals redirect the scheduled plan to arm requesting the hurry call



Green Light Priority cont....

- Some junctions are so close together on Great North Road priority may be granted for more than one junction at a time
- Not selective enough to restrict vehicles – so if you're behind (or in front) of a bus that's been granted priority, you will also benefit
- In longer term – competing hurry calls from different directions could negate priority

Flexible Infrastructure

- Buses
 - Day time priority
 - Most frequent services
 - Regularity of number of services through junction for trial (based on NEAS feedback)
- Taxis
 - Evening / Night time priority
 - Night time economy
 - Unnecessary waiting at some signals
- Freight
 - Early Morning priority
 - Unnecessary waiting at some signals

Green Light Optimal Speed Advisory (GLOSA)

- Uses the signal plan programmed and the speed / location of the vehicle to work out what the optimal speed would be to get through green light
- Communicates this to driver (See in-vehicle signage)
- Can be used with or without green light priority
- Also communicates time to red light change

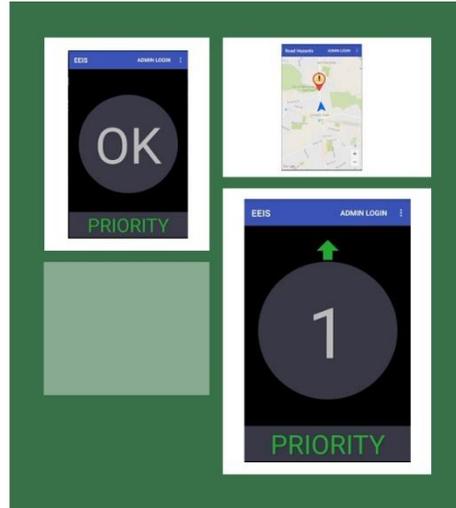
In-vehicle Signage User Interface

Features of HMI User Interface:

- Speed increase / decrease only
- OK to illustrate optimal speed
- Informs driver when priority isn't granted with count down to change from red
- Road Works / Hazard Warning when not in corridor
- Sound on / off

Feedback from Arriva:

- Need to avoid glare – colours reflect this
- Simplified information – only show vital information
- Easier to read
- Simple, identifiable icons for Road Works / Road Hazard Warning



Road Work Warning / Road Hazard Warning

- Tyne and Wear UTMIC collects data from across the region on Traffic Incidents, Accidents and Events
- Publishes these as open data for anyone to use in apps / research / radio updates etc



The accident feed includes any confirmed major accidents on the UTMIC system.

- The System Code Number or unique ID.
- Type of traffic event
- Accident Type Description
- A Short Description – Short Name
- A Long Description – Full description of works
- Geo-reference of the Location, in Easting/Northing & Latitudo/Longitude
- Location Description of where the works are located
- Creation Date of the Roadwork on the UTMIC system
- Data Source Type Reference that updates the UTMIC system
- Confirmed Date when Roadwork was created & confirmed
- Modified Date when/if modified
- Severity Type Reference Description – either Low, Medium or High
- Lanes Affected Type Reference Description
- Direction in Force – either 'Y' or 'N'
- Phase Type Reference – Static, Current or Future
- Accident Start or End Time

Example of an event from Traffic Accident

Traffic Accident

COLLISION

Location: A167 Tyne Bridge, Gateshead

Details: Collision A167 Tyne Bridge northbound involving 2 vehicles is currently blocking lane 1.

Lanes Affected: T 1

Diversion: None

Start: 10-01-2018 10:17

End: 10-01-2018 12:30

- Categorises all events / incidents / accidents into series of headings, with a simple icon for each
- Uses GPS from HMI and distance user setting e.g 3km radius to display upcoming hazards
- Currently road works are disabled due to over complexity of map
- Provides driver with useful information outside of corridors and enables better decision making about routes / journey times / likely congestion



Probe Vehicle Data

- Using vehicles as a data source – OBU sends data to cloud server hosted by Newcastle University
- Project collects:
 - Type of vehicle (programmed)
 - Time of vehicle
 - Location of vehicle
 - Speed of vehicle
 - Priority requests sent
 - Priority requests granted
- ONLY ON TRIAL CORRIDOR and ONLY FOR THE PROJECT



Air Quality

- Gosforth AQMA
- Air Quality Modelling by University
- In conjunction with Urban Observatory – fitted Air Quality monitors to the corridor
- Baseline readings before
- Collect readings after



Εκπαιδευτικό σεμινάριο στα Συνεργατικά Ευφυή Συστήματα Μεταφορών (C-ITS) για Δημόσιους Φορείς

Δρ. Ευάγγελος Μητσάκης
Αρετή Κώστη
Webinar
06/04/2020

Co-funded by the European Union 

Έργο C-Mobile Accelerating C-ITS Mobility Innovation and deployment in Europe

- / Συγχρηματοδοτούμενο από το Πρόγραμμα Πλαίσιο της ΕΕ για την Έρευνα και την Καινοτομία “Horizon 2020”
- / Διάρκεια: 42 μήνες (Ιούνιος 2017 - Νοέμβριος 2020)

Όραμα και Στόχοι

- / Αύξηση της βιωσιμότητας και μείωση της κυκλοφοριακής συμφόρησης και του αρνητικού περιβαλλοντικού αντίκτυπου των οδικών μεταφορών στην Ευρώπη
- / Σύνθετα αστικά οδικά δίκτυα → 8 Ευρωπαϊκές πόλεις
- / Ανάπτυξη εφαρμογών Συνεργατικών Ευφυών Συστημάτων Μεταφορών (Cooperative Intelligent Transport Systems, C-ITS) σε ευρεία κλίμακα
- / Διαλειτουργικές υπηρεσίες C-ITS για τους χρήστες του οδικού δικτύου
- / Συνεργασία μεταξύ πολλαπλών φορέων



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Περιεχόμενα

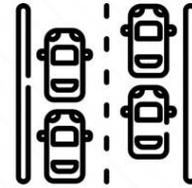
1	Σκοπός εκπαιδευτικού σεμιναρίου
2	Εισαγωγή στα συστήματα C-ITS
3	Υπηρεσίες C-ITS στη Θεσσαλονίκη
4	Εισαγωγή στη Διαχείριση της Κυκλοφορίας
5	Κέντρα Ελέγχου Κυκλοφορίας και συστήματα C-ITS
6	Ενσωμάτωση συστημάτων C-ITS στη Διαχείριση της Κυκλοφορίας

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Σκοπός εκπαιδευτικού σεμιναρίου

Δημόσιοι Φορείς: Διαχειριστές Κέντρων Ελέγχου Κυκλοφορίας (ΚΕΚ)

- / Εξοικείωση με νέα συστήματα απαραίτητα για την λειτουργία των υπηρεσιών C-ITS
- / Αναγνώριση και κατανόηση των νέων πληροφοριών/ δεδομένων που θα προέρχονται από τα νέα συστήματα
- / Αξιολόγηση της ακρίβειας και της αξιοπιστίας των νέων πληροφοριών/ δεδομένων
- / Καθοδήγηση για την επίλυση προβλημάτων
- / Κατανόηση των δυνατοτήτων και των ωφελειών των υπηρεσιών C-ITS



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Σκοπός εκπαιδευτικού σεμιναρίου

Δημόσιοι Φορείς: Τεχνικό προσωπικό

- / Εγκατάσταση και απεγκατάσταση εξοπλισμού, υλισμικού (hardware) και λογισμικού (software)
- / Συντήρηση εξοπλισμού-υλισμικού-λογισμικού, π.χ. τακτικές εργασίες συντήρησης, έκτακτες επισκευές
- / Επίλυση προβλημάτων - διορθωτικές ενέργειες



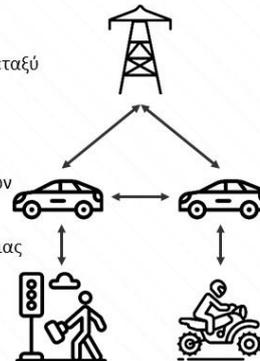
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Εισαγωγή στα Συστήματα C-ITS

Συνεργατικά Ευφυή Συστήματα Μεταφορών
(Cooperative Intelligent Transport Systems, C-ITS)

- / Τα συστήματα C-ITS παρέχουν επικοινωνία σε πραγματικό χρόνο μεταξύ των οχημάτων, της υποδομής και των χρηστών του οδικού δικτύου
- / Τα συστήματα C-ITS αποτελούν εξέλιξη των συστημάτων ITS:
 - Τελευταία πρότυπα επικοινωνιών
 - Προσαρμοσμένες υπηρεσίες με στόχο την παροχή ειδικών ωφελειών
 - ✓ Οδηγική εμπειρία, π.χ. έγκαιρη πληροφόρηση, άνεση
 - ✓ Οικονομική οδήγηση, π.χ. εξοικονόμηση καυσίμων και ενέργειας
 - ✓ Βελτιστοποίηση διαχείρισης της κυκλοφορίας
 - ✓ Επίτευξη στόχων (π.χ. οδική ασφάλεια, μείωση εκπομπών ατμοσφαιρικών ρύπων)

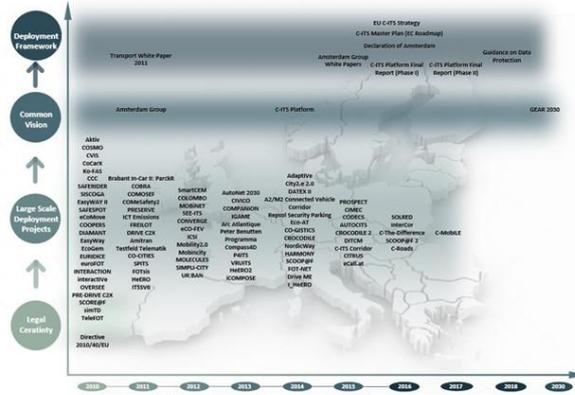


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Εξέλιξη των Συστημάτων C-ITS

Ευρωπαϊκά έργα και πολιτικές



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Υπηρεσίες C-ITS στο έργο C-Mobile



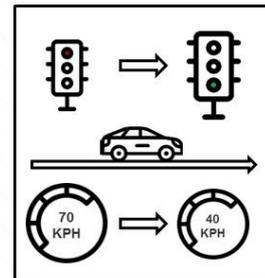
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Υπηρεσίες C-ITS στη Θεσσαλονίκη

Green Light Optimized Speed Advisory (GLOSA)

- / Η υπηρεσία παρέχει οδηγίες για τη βέλτιστη ταχύτητα που πρέπει να έχουν οι οδηγοί καθώς πλησιάζουν μια σηματοδοτούμενη διασταύρωση, προκειμένου να τη διασχίσουν με πράσινο
- / Η οδηγία μπορεί να αφορά στη διατήρηση της ταχύτητας, σε μείωση ή αύξηση αυτής
- / Η υπηρεσία βασίζεται σε δεδομένα σε πραγματικό χρόνο, τα οποία παρέχονται από την υποδομή και στέλνονται στα οχήματα
- / Η υπηρεσία συμβάλει στη μείωση της κατανάλωσης καυσίμων και των εκπομπών ατμοσφαιρικών ρύπων



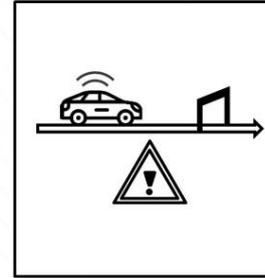
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Υπηρεσίες C-ITS στη Θεσσαλονίκη

Road Hazard Warning

- / Η υπηρεσία ενημερώνει έγκαιρα τους οδηγούς για πιθανούς κινδύνους στο οδικό δίκτυο
- / Οι οδηγοί είναι καλύτερα προετοιμασμένοι για τις επικείμενες επικίνδυνες τοποθεσίες και έχουν το χρόνο να προσαρμόσουν κατάλληλα την οδηγική συμπεριφορά τους



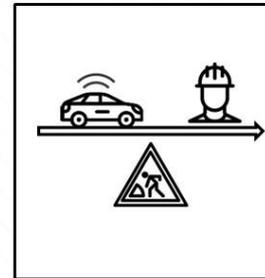
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Υπηρεσίες C-ITS στη Θεσσαλονίκη

Road Works Warning

- / Η υπηρεσία ενημερώνει έγκαιρα τους οδηγούς για τοποθεσίες οδικών έργων σε εξέλιξη
- / Οι οδηγοί μπορούν να προσαρμόσουν κατάλληλα την οδηγική συμπεριφορά τους και να αποφύγουν πιθανά ατυχήματα



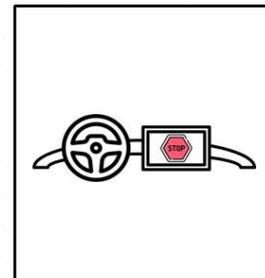
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Υπηρεσίες C-ITS στη Θεσσαλονίκη

In-Vehicle Signage

- / Η υπηρεσία παρέχει ενημέρωση στους οδηγούς σχετικά με την οδική σήμανση στο δίκτυο
- / Οι πληροφορίες μπορεί να αφορούν σε στατικές πινακίδες αλλά να περιέχουν και δυναμικές πληροφορίες, π.χ. περιεχόμενο από πραγματικών πινακίδων μεταβλητών μηνυμάτων (Variable Message Signs, VMS) ή και virtual VMSs.
- / Στόχος της υπηρεσίας είναι να αυξήσει το επίπεδο ενημέρωσης των οδηγών σχετικά με την οδική σήμανση ακόμη και σε περιπτώσεις που αυτή δεν είναι εύκολα ορατή



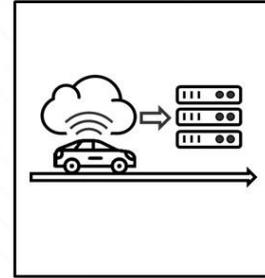
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Υπηρεσίες C-ITS στη Θεσσαλονίκη

Probe Vehicle Data

- / Η υπηρεσία αφορά σε δεδομένα κινούμενων οχημάτων (επίσης γνωστή ως Floating Car Data, FCD)
- / Τα δεδομένα κινούμενων οχημάτων που συλλέγονται μπορούν να χρησιμοποιηθούν για σκοπούς διαχείρισης της κυκλοφορίας
 - Παραδείγματα αποτελούν ο προσδιορισμός/εκτίμησης της πραγματικής τρέχουσας μέσης ταχύτητας κυκλοφορίας, η υποστήριξη της διαχείρισης των κυκλοφοριακών ροών, η προσαρμογή στρατηγικών ελέγχου της κυκλοφορίας, και η παροχή ενημέρωσης προς στους μετακινούμενους



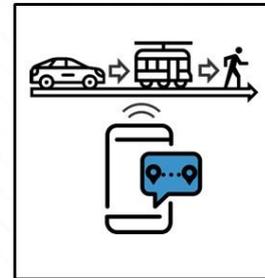
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Υπηρεσίες C-ITS στη Θεσσαλονίκη

Mode & Trip Time Advice

- / Η υπηρεσία παρέχει στους μετακινούμενους πληροφορίες σχετικές με το δρομολόγιό τους
- / Οι πληροφορίες μπορούν να αφορούν σε πολλαπλά μέσα μετακίνησης
- / Οι πληροφορίες βασίζονται σε δεδομένα πραγματικού χρόνου καθώς και σε στατικές πληροφορίες



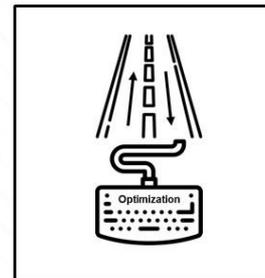
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Υπηρεσίες C-ITS στη Θεσσαλονίκη

Flexible Infrastructure

- / Η υπηρεσία παρέχει πληροφορίες σχετικά με αλλαγές στις λωρίδες κυκλοφορίας στο οδικό δίκτυο
- / Σχετικές πληροφορίες μπορεί να αφορούν σε ανεστραμμένες λωρίδες κυκλοφορίας, σε κλειστές λωρίδες κυκλοφορίας και σε ειδικές λωρίδες κυκλοφορίας για την κίνηση συγκεκριμένων οχημάτων



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Εφαρμογή (App) χρηστών/οδηγών στη Θεσσαλονίκη

- / Μια κοινή εφαρμογή για έξυπνες φορητές συσκευές (smartphone ή tablet), η οποία παρέχει όλες τις υπηρεσίες C-ITS για τη Θεσσαλονίκη
- / Υπηρεσίες C-ITS: Road Works Warning, Road Hazard Warning, GLOSA, In-Vehicle Signage, Flexible Infrastructure, Mode and Trip Time Advice, Probe Vehicle Data
- / Μελλοντικές εκδόσεις θα περιλαμβάνουν επιπλέον υπηρεσίες C-ITS: Warning System for Pedestrians, Emergency Vehicle Warning, Signal Violation Warning, Green Priority, Cooperative Traffic Light for Pedestrian



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Εισαγωγή στη Διαχείριση της Κυκλοφορίας

Ρόλος των Διαχειριστών ΚΕΚ

- / Οι ενέργειες των Διαχειριστών ΚΕΚ στοχεύουν:
 - στην ασφαλή χρήση της υποδομής από τους χρήστες του οδικού δικτύου
 - στην εξασφάλιση ομαλών κυκλοφοριακών ροών στο οδικό δίκτυο
 - στην επιβολή κανόνων-μέτρων και στην παροχή πληροφοριών-οδηγιών για τους χρήστες του οδικού δικτύου



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ΚΕΚ και Συστήματα C-ITS

Προϋποθέσεις για την ενσωμάτωση συστημάτων C-ITS

- / Διαθεσιμότητα δυναμικών δεδομένων πραγματικού χρόνου
- / Ενσωμάτωση νέων πρακτικών
- / Συνεργασία με πολλαπλούς φορείς
- / Κατανόηση των ωφελειών των συστημάτων C-ITS στη λειτουργία των ΚΕΚ και στη βελτιστοποίηση της διαχείρισης της κυκλοφορίας

Χαρακτηριστικά ΚΕΚ με ενσωματωμένα συστήματα C-ITS

- / Νέοι ρόλοι για το προσωπικό των ΚΕΚ
- / Αυξημένο επίπεδο ενημέρωσης για την κατάσταση του οδικού δικτύου
- / Πρόσβαση σε νέες πληροφορίες/ δεδομένα
- / Αυτοματοποιημένη και εξατομικευμένη παροχή πληροφοριών στους χρήστες του οδικού δικτύου
- / «Ενσωμάτωση» των μετακινούμενων/οδηγών στις διαδικασίες διαχείρισης κυκλοφορίας

18 06/04/2020 C-Mobile, «Εκπαιδευτικό σεμινάριο Συστήματα C-ITS για Δημόσιους Φορείς», Webinar



ΚΕΚ και Συστήματα C-ITS

Νέες πληροφορίες-δεδομένα και αλλαγές στις λειτουργικές διαδικασίες

Είδος πληροφορίας	Διαθέσιμες πληροφορίες χωρίς C-ITS	Επιπλέον διαθέσιμες πληροφορίες με C-ITS	Πιθανές αλλαγές στις λειτουργικές διαδικασίες των ΚΕΚ
<p>Συμβάντα</p> 	<ul style="list-style-type: none"> • Τοποθεσία • Χρόνος έναρξης/ λήξης • Διάρκεια • Σοβαρότητα 	<ul style="list-style-type: none"> • Δυνατότητα γεωεντοπισμού για ακριβή προσδιορισμό τοποθεσίας • Επιπτώσεις σε πραγματικό χρόνο στο οδικό δίκτυο • Περιορισμοί στις λωρίδες κυκλοφορίας • Τύποι εμπλεκόμενων οχημάτων • Κατάσταση εναλλακτικών διαδρομών 	<ul style="list-style-type: none"> • Έγκαιρη-καλύτερη απόκριση με χρήση των κατάλληλων συστημάτων • Διαχείριση της κυκλοφορίας με έμφαση στον περιορισμό των επιπτώσεων στο οδικό δίκτυο • Παροχή δυναμικής πληροφόρησης • Βελτιωμένες πληροφορίες προς τους χρήστες του οδικού δικτύου • Εντοπισμός παραγόντων για τη δημιουργία συμβάντων και ανάλυση βελτιωτικών μέτρων • Δυνατότητα και βελτίωση μοντέλων πρόβλεψης

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ΚΕΚ και Συστήματα C-ITS

Νέες πληροφορίες-δεδομένα και αλλαγές στις λειτουργικές διαδικασίες

Είδος πληροφορίας	Διαθέσιμες πληροφορίες χωρίς C-ITS	Επιπλέον διαθέσιμες πληροφορίες με C-ITS	Πιθανές αλλαγές στις λειτουργικές διαδικασίες των ΚΕΚ
<p>Καιρός</p> 	<ul style="list-style-type: none"> • Συνθήκες οδοστρώματος • Ατμοσφαιρικές συνθήκες • Προβλέψεις • Προειδοποιήσεις • Βροχόπτωση 	<ul style="list-style-type: none"> • Ακριβέστερες συνθήκες οδοστρώματος • Ακριβέστερες πληροφορίες για τις οδικές συνθήκες • Επιπτώσεις στο οδικό δίκτυο • Επιπτώσεις στην οδική ασφάλεια • Αριθμός οχημάτων που επηρεάζονται • Έκταση των επιπτώσεων • Μετρήσεις οχημάτων 	<ul style="list-style-type: none"> • Έγκαιρες προειδοποιήσεις σχετικά με τις καιρικές συνθήκες και πιθανούς κινδύνους • Ακριβέστερες προειδοποιήσεις βασισμένες σε μοντέλα πρόβλεψης • Καλύτερος συντονισμός και απόκριση συνεργειών και ομάδων δράσεως

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ΚΕΚ και Συστήματα C-ITS

Νέες πληροφορίες-δεδομένα και αλλαγές στις λειτουργικές διαδικασίες

Είδος πληροφορίας	Διαθέσιμες πληροφορίες χωρίς C-ITS	Επιπλέον διαθέσιμες πληροφορίες με C-ITS	Πιθανές αλλαγές στις λειτουργικές διαδικασίες των ΚΕΚ
<p>Ταχύτητα</p> 	<ul style="list-style-type: none"> • Φόρτος/ κατάληψη/ ταχύτητα στο οδικό δίκτυο • Κυκλοφοριακά δεδομένα οχημάτων • Ιστορικά δεδομένα • Συνθήκες κυκλοφοριακής συμφόρησης 	<ul style="list-style-type: none"> • Ακρίβεια δεδομένων • Μετρήσεις οχημάτων • Προβλέψεις 	<ul style="list-style-type: none"> • Δυναμική παρακολούθηση και καταγραφή κυκλοφοριακών συνθηκών • Προειδοποιήσεις σχετικές με την κυκλοφοριακή συμφόρηση • Δυναμική προσαρμογή στρατηγικών ελέγχου κυκλοφορίας • Επέκταση του εύρους του οδικού δικτύου προς παρακολούθηση και επέμβαση

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ΚΕΚ και Συστήματα C-ITS

Νέες πληροφορίες-δεδομένα και αλλαγές στις λειτουργικές διαδικασίες

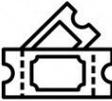
Είδος πληροφορίας	Διαθέσιμες πληροφορίες χωρίς C-ITS	Επιπλέον διαθέσιμες πληροφορίες με C-ITS	Πιθανές αλλαγές στις λειτουργικές διαδικασίες των ΚΕΚ
Οδικά έργα 	<ul style="list-style-type: none"> • Επιτήρηση • Περιορισμοί σε λωρίδες κυκλοφορίας 	<ul style="list-style-type: none"> • Τήρηση περιορισμών ταχύτητας • Παρακολούθηση των ελιγμών των οχημάτων • Δυναμικοί περιορισμοί σε λωρίδες κυκλοφορίας • Έλεγχος παραβιάσεων 	<ul style="list-style-type: none"> • Έγκαιρες πληροφορίες σε οδηγούς κινούμενους κοντά στις ζώνες οδικών έργων • Βελτιωμένες προειδοποιήσεις για την ασφάλεια των οδηγών • Δυναμικές πληροφορίες για περιορισμούς στην ταχύτητα και στις λωρίδες κυκλοφορίας

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ΚΕΚ και Συστήματα C-ITS

Νέες πληροφορίες-δεδομένα και αλλαγές στις λειτουργικές διαδικασίες

Είδος πληροφορίας	Διαθέσιμες πληροφορίες χωρίς C-ITS	Επιπλέον διαθέσιμες πληροφορίες με C-ITS	Πιθανές αλλαγές στις λειτουργικές διαδικασίες των ΚΕΚ
Εκδηλώσεις 	<ul style="list-style-type: none"> • Ημέρα, ώρα, διάρκεια • Τοπικές επιπτώσεις στο οδικό δίκτυο • Περιορισμοί σε λωρίδες κυκλοφορίας 	<ul style="list-style-type: none"> • Ενημερότητα για τις εκδηλώσεις σε μεγαλύτερο εύρος του οδικού δικτύου • Επιπτώσεις σε μεγαλύτερο εύρος του οδικού δικτύου • Πληροφορίες για πολλαπλά μεταφορικά μέσα 	<ul style="list-style-type: none"> • Βελτιωμένα συστήματα ενημέρωσης μετακινούμενων για πρόσβαση σε διάφορες περιοχές κατά τη διάρκεια των εκδηλώσεων • Δυναμική διαχείριση της κυκλοφορίας κατά τη διάρκεια των εκδηλώσεων • Άμεση απόκριση σε αλλαγές στην κυκλοφορία • Δυναμική διαχείριση πολλαπλών μέσων μεταφοράς • Μείωση ανθρώπινου δυναμικού στο πεδίο για τη διαχείριση των κυκλοφοριακών συνθηκών

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ΚΕΚ και Συστήματα C-ITS

Νέες πληροφορίες-δεδομένα και αλλαγές στις λειτουργικές διαδικασίες

Είδος πληροφορίας	Διαθέσιμες πληροφορίες χωρίς C-ITS	Επιπλέον διαθέσιμες πληροφορίες με C-ITS	Πιθανές αλλαγές στις λειτουργικές διαδικασίες των ΚΕΚ
Εξοπλισμός πεδίου 	<ul style="list-style-type: none"> • Κατάσταση • Έλεγχος • Τοποθεσία 	<ul style="list-style-type: none"> • Νέα συστήματα • Νέοι τύποι δεδομένων • Μετρήσεις απόδοσης 	<ul style="list-style-type: none"> • Παρακολούθηση της απόδοσης του εξοπλισμού πεδίου • Αυτοματοποίηση ενημερώσεων και επίλυσης προβλημάτων • Καλύτερη απόσβεση του εξοπλισμού πεδίου

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ΚΕΚ και Συστήματα C-ITS

Νέες απαραίτητες δεξιότητες για την αξιοποίηση των τεχνολογιών C-ITS

Τεχνικός Τομέας	Δεξιότητες
Τεχνολογίες Πληροφοριών και Διαχείρισης Δεδομένων	<ul style="list-style-type: none">Τεχνική υποστήριξη υλισμικού και λογισμικού για διαχείριση Μεγάλων Δεδομένων (Big Data) και ενσωμάτωση νέων τύπων δεδομένων στις λειτουργικές διαδικασίες των ΚΕΚΓνώσεις σε αποθήκευση, αναζήτηση, πρόσβαση και αναδιανομή δεδομένωνΓνώσεις σε ενσωμάτωση νέου υλισμικού και ενημέρωση αυτούΣυντονισμός και συνεργασία με ειδικούς από τον τομέα της Τεχνολογίας Πληροφορικής και Τηλεπικοινωνιών (ICT)
Ανάλυση συστημάτων	<ul style="list-style-type: none">Προσδιορισμός μεθόδων για την αναβάθμιση (νέες αυξημένες δυνατότητες) των λειτουργικών διαδικασιών των ΚΕΚΣυντονισμός και συνεργασία με άλλα ΚΕΚ ή τεχνικά τμήματα για την καλύτερη αξιοποίηση των νέων δεδομένωνΣυλλογή και επεξεργασία δεδομένων για την εξαγωγή αποτελεσμάτων σχετικά με τη λειτουργία και την απόδοση των συστημάτωνΠροσδιορισμός μεθόδων για τη βελτιστοποίηση της λειτουργίας και της απόδοσης των συστημάτων

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ΚΕΚ και Συστήματα C-ITS

Νέες απαραίτητες δεξιότητες για την αξιοποίηση των τεχνολογιών C-ITS

Τεχνικός Τομέας	Δεξιότητες
Συντήρηση δικτύου και εξοπλισμού	<ul style="list-style-type: none">Ειδικές γνώσεις για τη συντήρηση εξοπλισμού πεδίου απαραίτητου για τη λειτουργία και υποστήριξη των συστημάτων C-ITSΔιαδικασίες ελέγχου της λειτουργίας του εξοπλισμού πεδίουΣυνεργασία και συντονισμός με προμηθευτέςΣυνεργασία και συντονισμός με τεχνικά τμήματα για την εγκατάσταση και την ενσωμάτωση του νέου εξοπλισμού πεδίο στο δίκτυο
Διαχείριση Κυκλοφορίας	<ul style="list-style-type: none">Ειδικές γνώσεις για την ενσωμάτωση των συστημάτων C-ITS στη διαχείριση της κυκλοφορίαςΑνάπτυξη και τροποποίηση προγραμμάτων σηματοδότησης και στρατηγικών ελέγχου για βελτιστοποίηση των κυκλοφοριακών ροών λαμβάνοντας υπόψη και τα συστήματα C-ITSΑναβάθμιση και επέκταση στρατηγικών ελέγχου με νέα δεδομένα προερχόμενα από τα συστήματα C-ITSΔυναμική διαχείριση της κυκλοφορίας και παρακολούθηση της απόδοσης των εφαρμοζόμενων στρατηγικών ελέγχου αξιοποιώντας τις νέες δυνατότητες των τεχνολογιών C-ITS

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Ενσωμάτωση C-ITS στη Διαχείριση Κυκλοφορίας

Μεθοδολογία

/ Η μεθοδολογία ενσωμάτωσης των υπηρεσιών C-ITS στη δυναμική διαχείριση της κυκλοφορίας περιλαμβάνει τα ακόλουθα βήματα:

- Προσδιορισμός πολιτικών για τη διαχείριση της κυκλοφορίας:** καταγραφή κατηγορίας-ρόλου των τμημάτων του οδικού δικτύου και προσδιορισμός ορίων για τη λειτουργική τους απόδοση
- Διάκριση οδικού δικτύου:** κόμβοι (nodes), συνδέσεις (links), άξονες (segments), διαδρομές (routes)
- Προσδιορισμός στρατηγικών ελέγχου:** στρατηγικές για την επίτευξη στόχων
- Συχετισμός των υπηρεσιών C-ITS με τις στρατηγικές ελέγχου:** ενσωμάτωση των κατάλληλων υπηρεσιών C-ITS στις στρατηγικές για την επίτευξη συγκεκριμένων στόχων

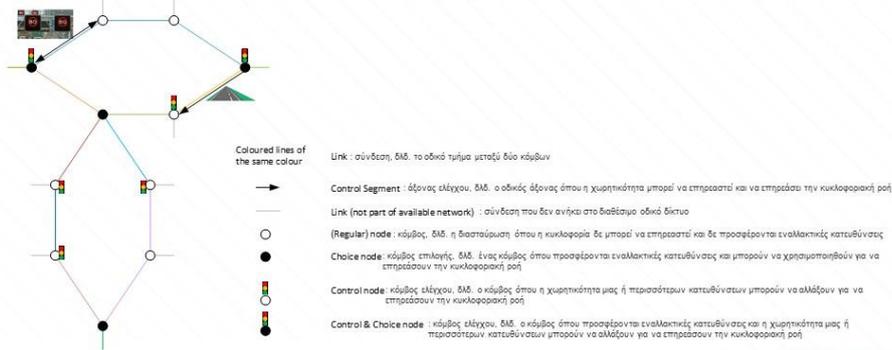


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Ενσωμάτωση C-ITS στη Διαχείριση Κυκλοφορίας

Κατηγοριοποίηση οδικού δικτύου



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Ενσωμάτωση C-ITS στη Διαχείριση Κυκλοφορίας

Στρατηγικές ελέγχου



Ενημέρωση της κυκλοφορίας
(Inform traffic)



Μείωση εισερχόμενων ροών
(Reduce inflow)



Αύξηση εξερχόμενων ροών
(Enlarge outflow)



Επαναδρομολόγηση της κυκλοφορίας
(Reroute traffic)

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Ενσωμάτωση C-ITS στη Διαχείριση Κυκλοφορίας

Συσχετισμός υπηρεσιών C-ITS με στρατηγικές ελέγχου

Υπηρεσία C-ITS	Στόχος	Ενημέρωση της κυκλοφορίας	Αύξηση εξερχόμενων ροών	Μείωση εισερχόμενων ροών	Αναδρομολόγηση της κυκλοφορίας
GLOSA	Οδήγηση φιλική προς το περιβάλλον	Πληροφόρηση σχετικά με βέλτιστη ταχύτητα, ενδείξεις φωτεινών σηματοδοτών	-	-	-
Road Hazard Warning	Ενημέρωση σχετικά με κινδύνους στο οδικό δίκτυο	Πληροφόρηση για επικίνδυνες τοποθεσίες	-	-	-
Road Works Warning	Ενημέρωση σχετικά με οδικά έργα	Πληροφόρηση για τοποθεσίες οδικών έργων	-	-	-
Flexible Infrastructure	Έλεγχος διαθέσιμης χωρητικότητας	-	Αύξηση χωρητικότητας	Μείωση χωρητικότητας	-
In-vehicle Signage	Ενημέρωση μέσω στατιών και δυναμικών πινακίδων	Πληροφόρηση για τη σήμανση στο οδικό δίκτυο	Μεταβαλλόμενα όρια ταχυτήτων	Μεταβαλλόμενα όρια ταχυτήτων	-
Mode & Trip Time Advice	Πληροφόρηση σχετικά με το δρομολόγιο	Πληροφόρηση για χρόνους ταξιδιού	-	-	Πληροφόρηση για εναλλακτικές διαδρομές
Probe Vehicle Data	Παροχή δεδομένων κινούμενων οχημάτων	(έμμεση επίδραση)	(έμμεση επίδραση)	(έμμεση επίδραση)	(έμμεση επίδραση)

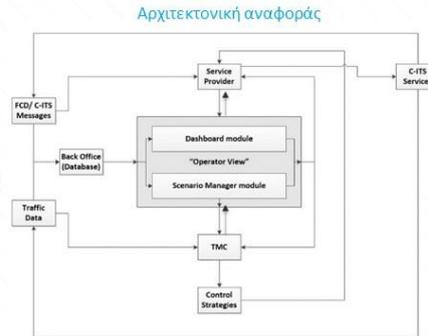
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Ενσωμάτωση C-ITS στη Διαχείριση Κυκλοφορίας

Εργαλείο Bundling για Διαχειριστές Κυκλοφορίας

- ✓ Ενδιάμεσο σύστημα ανάμεσα στους παρόχους υπηρεσιών C-ITS και στα ΚΕΚ
- ✓ Λειτουργικότητες
 - > Διεπαφές με τα ΚΕΚ
 - > Πρότυπα πρωτόκολλα επικοινωνίας
 - > Ολιστική διαχείριση της κυκλοφορίας
 - > Επιλογή και εφαρμογή στρατηγικών ελέγχου
 - > Ενεργοποίηση/ απενεργοποίηση υπηρεσιών C-ITS
 - > Δυναμική παρακολούθηση της κατάστασης του οδικού δικτύου



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Ενσωμάτωση C-ITS στη Διαχείριση Κυκλοφορίας

Εργαλείο Bundling για Διαχειριστές Κυκλοφορίας

- ✓ Συστήματα
 - 1. Dashboard**
 - Παρακολούθηση κυκλοφοριακών συνθηκών και απόδοσης του συστήματος
 - Καίριοι Δείκτες Απόδοσης (Key Performance Indicators), ψηφιακοί χάρτες, διαγράμματα, ιστορικά δεδομένα
 - 2. Scenario Manager**
 - Όρια απόδοσης-αποτελεσματικότητας για τις στρατηγικές ελέγχου Threshold values related to each control strategy
 - Πρόβλεψη κυκλοφοριακών συνθηκών
 - Επιλογή - Ενεργοποίηση - Απενεργοποίηση στρατηγικών ελέγχου και υπηρεσιών C-ITS

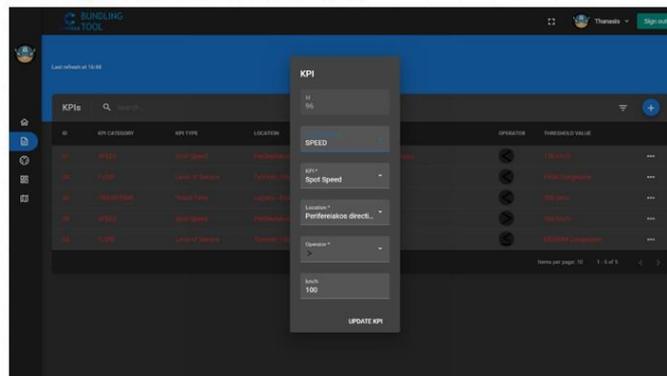
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Ενσωμάτωση C-ITS στη Διαχείριση Κυκλοφορίας

Dashboard - Παραδείγματα οπτικοποίησης



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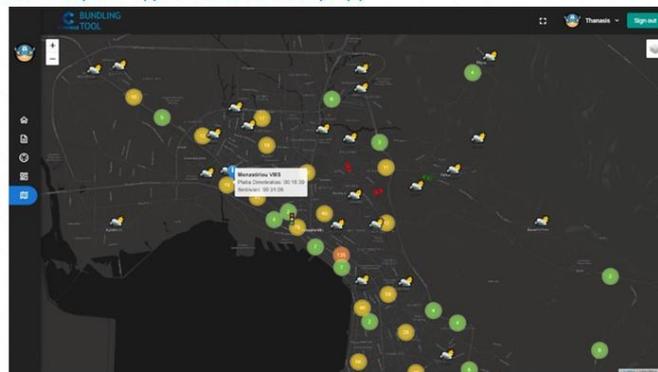


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Ευχαριστούμε για την προσοχή σας!

Δρ. Ευάγγελος Μητσάκης, emit@certh.gr

Αρετή Κώστη, akotsi@certh.gr

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AGENDA DEL EVENTO/

09:00 – 09:05	<ul style="list-style-type: none">• Bienvenida• Irene Saco, CTAG
09:05 – 09:15	<ul style="list-style-type: none">• Presentación Proyecto C-MOBILE• Irene Saco, CTAG
09:15 – 10:00	<ul style="list-style-type: none">• Arquitectura y servicios C-ITS desplegados en Vigo• Jose Antonio Fernández, CTAG
10:00 – 10:10	<ul style="list-style-type: none">• Presentación App C-MOBILE• David Rubio, CTAG
10:10 – 10:40	<ul style="list-style-type: none">• Sesión preguntas. Mesa Redonda• Tod@s

2



INTRODUCCIÓN/

/ Ponentes

- | | |
|--------------------------|--|
| / Irene Saco | Project Manager at CTAG |
| / Jose Antonio Fernández | Manager for C2X & Mobility Services at CTAG |
| / David Rubio | HMI, Human Factor and Consfort Systems at CTAG |





PROYECTO C-MOBILE

Irene Saco
CTAG

Co-funded by
the European Union 

ACCELERATING C-ITS MOBILITY INNOVATION AND DEPLOYMENT IN EUROPE /



5

C-Mobile, meeting/eventtitle, Venue

OBJETIVOS /



MEJORAR EL TRANSPORTE EN CARRETERA

Mejorar el transporte en carretera, hacerlo más seguro, eficiente y más sostenible



TECNOLOGÍAS

Demostrar la integración plena de las tecnologías de C-ITS en condiciones reales



SEGURIDAD Y PROTECCIÓN

Calcular y evaluar los impactos en la aceptación, la seguridad y la protección de los usuarios.



RENTABILIDAD

Demostrar el valor añadido y la viabilidad económica de los servicios de C-ITS para los usuarios

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ÁMBITO DE C-MOBILE /



CONECTIVIDAD

Habilitar los servicios de C-ITS para dar soporte a las aplicaciones en vehículos y a las comunicaciones bidireccionales de infraestructura, basadas en el acceso y el intercambio de datos



INTEROPERABILIDAD

Permitir la interoperabilidad entre sistemas gracias a los estándares de pruebas y validación



DESPLIEGUE

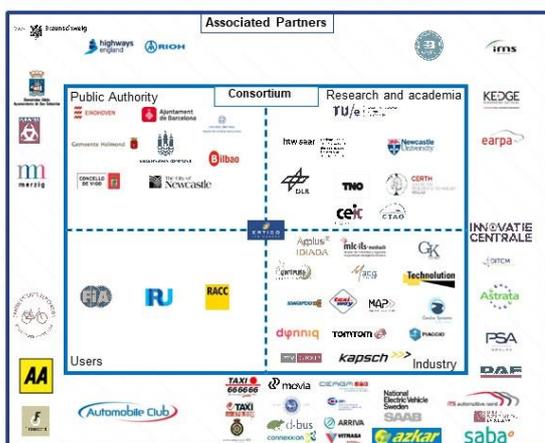
Calcular, demostrar y evaluar los beneficios de la integración de C-ITS

7



SOCIOS /

- / **Coordinador del proyecto**
 - > Alex Vallejo, Applus+ IDIADA
- / **37 socios de 9 países de la UE**
- / **Junio 2017 – Noviembre 2020**
- / **Presupuesto total**
 - > 15,059,453.42 €
- / **Presupuesto financiado por la UE**
 - > 12,575,000.05 €



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DEPLOYMENT SITES

- / Barcelona
- / Copenhagen
- / Thessaloniki
- / Bilbao
- / Vigo
- / Newcastle
- / Bordeaux
- / North Brabant



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SUMARIO

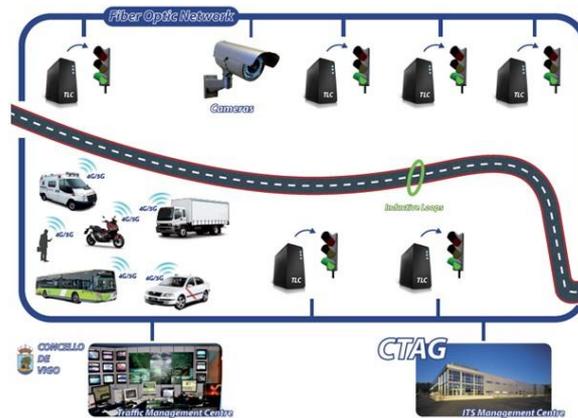
- Qué es C-ITS
- Arquitectura C-ITS (Vigo, C-MOBILE)
- Clasificación Servicios C-ITS
- Despliegue servicios C-ITS(Vigo,CMOBILE)

QUÉ ES C-ITS

- C-ITS (Cooperative Intelligent Transportation Systems) se puede definir como el conjunto de procesos y tecnologías que permite la comunicación y compartición de información entre los integrantes de un sistema de transporte (vehículos, infraestructura, peatones,...) con el fin de mejorar la seguridad y reducir las emisiones, contribuyendo por tanto, a una operativa más segura y eficiente del tráfico.



ARQUITECTURA C-ITS



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SERVICIOS C-ITS

List of Day 1 services

Hazardous location notifications

- Slow or stationary vehicle(s) & Traffic ahead warning
- Road works warning
- Weather conditions
- Emergency brake light
- Emergency vehicle approaching
- Other hazardous notifications

Signage applications

- In-vehicle signage
- In-vehicle speed limits
- Signal violation / Intersection Safety
- Traffic signal priority request by designated vehicles
- GLOSA (Green Light Optimal Speed Advisory) / TTR-TTG (Time To Red-Time To Green)
- Probe vehicle data



C-MOBILE

SERVICIOS C-ITS

List of Day 1'5 services

- Information on fuelling & charging stations for alternative fuel vehicles
- Vulnerable Road user protection
- On street parking management & information
- Off street parking information
- Park & Ride information
- Connected & Cooperative navigation into and out of the city (1st and last mile, parking, route advice, coordinated traffic lights)
- Traffic information & Smart routing



C-MOBILE

SERVICIOS C-ITS C-MOBILE

C-Mobile Applications Bundling	
Bundle 1: Urban efficiency Rest time management Motorway parking availability Urban Parking availability	Bundle 2: Infrastructure-to-vehicle safety Road works warning Road hazard warning (incl. traffic jams) Emergency Vehicle Warning Signal Violation Warning Warning system for pedestrian (not limited to crossings)
Bundle 3: Traffic efficiency Green priority Green light optimal speed advisory (GLOSA) / *Dynamic eco-driving -> Time To red / Time To Green Cooperative traffic light for pedestrian Flexible infrastructure (HOV, peak-hour lanes) In-vehicle signage (e.g. Dynamic speed limit) Mode & trip time advice (e.g. by incentives) Probe Vehicle Data	Bundle 4: Vehicle-to-vehicle safety Emergency Brake Light Cooperative (Adaptive) cruise control (Urban ACC) Slow or Stationary Vehicle Warning Motorcycle approaching indication (including other VRUs) Blind spot detection / warning (VRUs)



ROAD WORKS WARNING

Antecedentes

Dado el elevado número de incidentes relacionados con usuarios accediendo a las zonas de obras o impactando contra los elementos de protección de las mismas causando víctimas (tanto usuarios como operarios), se entiende que el aviso con suficiente antelación de la existencia de este tipo de eventos prevendría o al menos reduciría significativamente el tipo de incidentes comentados.

Propósito

Proporcionar al usuario con antelación suficiente información sobre la existencia de obras (fijas o móviles) en la calzada y su posible incidencia en las condiciones de la misma (e.g. cierre parcial o total de uno o varios carriles).

Comportamiento deseado

- Aumento atención.
- Adaptación de la velocidad.
- Cambio de carril (si fuese necesario).

Beneficios esperados

- Reducir el riesgo y número de accidentes y situaciones peligrosas tanto para usuarios como operarios.
- Informar a los usuarios sobre el riesgo existente en la calzada.
- Mejorar la gestión de tráfico a través de la reducción de eventos relevantes como los señalados.



ROAD HAZARD WARNING

Antecedentes

Dado el elevado número de incidentes relacionados con usuarios encontrándose de forma repentina con eventos no esperados en la calzada, se entiende que el aviso con suficiente antelación de la existencia de este tipo de eventos prevendría o al menos reduciría significativamente el tipo de incidentes comentados.

Propósito

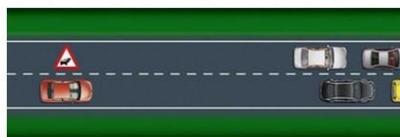
Proporcionar al usuario con antelación suficiente información sobre aquellos eventos que puedan suponer algún tipo de afectación sobre el normal desarrollo de las condiciones de circulación.

Comportamiento deseado

- Aumento atención.
- Adaptación de la velocidad.

Beneficios esperados

- Reducir el riesgo y número de accidentes y situaciones peligrosas para los usuarios de la calzada.
- Informar a los usuarios sobre el riesgo existente en la calzada.
- Mejorar la gestión de tráfico a través de la reducción de eventos relevantes como los señalados.



EMERGENCY VEHICLE WARNING

Antecedentes

Dada la limitada capacidad de reacción que muchas veces existe para los usuarios, especialmente en entornos urbanos, ante la aparición "repentina" de un vehículo circulando en condiciones de emergencia de cara a facilitar su paso, y las situaciones de estrés y nerviosismo que muchas veces comporta tal situación, se entiende que el aviso con suficiente antelación de la presencia de este tipo de vehículos prevendría o al menos reduciría significativamente el tipo de incidentes derivados de este tipo de situaciones, facilitando el paso con seguridad de dichos vehículos.

Propósito

Proporcionar al usuario con antelación suficiente información sobre la presencia en sus inmediaciones de un vehículo circulando en condiciones de emergencia (e.g. policía, bomberos, ambulancias,...)

Comportamiento deseado

- Aumento atención.
- Adaptación de la velocidad.

Beneficios esperados

- Reducir el riesgo y número de accidentes derivados de las condiciones de tráfico existentes.
- Formación más rápida y segura de corredores de emergencia permitiendo reducir los tiempos de tránsito de los vehículos circulando en condiciones de emergencia.



SIGNAL VIOLATION WARNING

Antecedentes

Dado que las intersecciones son entornos complejos donde por error u omisión los usuarios pueden ocasionalmente no respetar la regulación existente, el aviso de tal circunstancia supone mejorar las condiciones de seguridad en dicho entorno.

Propósito

Proporcionar al usuario aviso de una inminente violación (tanto propia como de otros usuarios) de la regulación existente en la intersección a la que se aproxima.

Comportamiento deseado

Reducción de la velocidad (hasta la detención total del vehículo) de cara a evitar la posible colisión.

Beneficios esperados

- Reducción de las violaciones de la regulación existente.
- Reducción del número y grado de incidentes generados.



WARNING SYSTEM FOR PEDESTRIAN

Antecedentes

Dado el elevado número de incidentes relacionados con usuarios encontrándose de forma repentina (por unos u otros motivos) con peatones en la zona de conducción, se entiende que el aviso con suficiente antelación de su presencia prevendría o al menos reduciría significativamente los incidentes anteriormente comentados.

Propósito

Proporcionar al usuario con antelación suficiente información sobre la presencia de peatones en su zona de conducción.

Comportamiento deseado

- Aumento atención.
- Adaptación de la velocidad.

Beneficios esperados

Reducir el riesgo y número de accidentes y situaciones peligrosas para los usuarios de la calzada.



TIME TO RED TIME TO GREEN

Antecedentes

Dado que las variaciones bruscas de velocidad que, por unas u otras razones, se producen en intersecciones afectan negativamente tanto a nivel medio ambiental como a las condiciones de seguridad de la conducción, se entiende que el proporcionar información sobre la regulación semafórica existente supondría una ayuda a mejorar los aspectos anteriormente mencionados.

Propósito

Proporcionar al usuario información sobre el tiempo restante para el cambio de fase del semáforo hacia el cual se está aproximando.

Comportamiento deseado

Adecuación de la velocidad de aproximación a la intersección acorde a la información proporcionada minimizando así las variaciones bruscas de velocidad.

Beneficios esperados

- Reducción de emisiones
- Mejora de los niveles seguridad.



IN VEHICLE SIGNAGE

Antecedentes

Debido al hecho de que, por unos u otros motivos, no siempre es posible visualizar de forma apropiada la señalización/información existente en la calzada, se entiende que el proporcionar esta información "dentro del vehículo", incluso de forma enriquecida y/o adaptada, supondría mejorar los niveles de seguridad existente al reducir los niveles de ansiedad que el hecho anterior supone.

Propósito

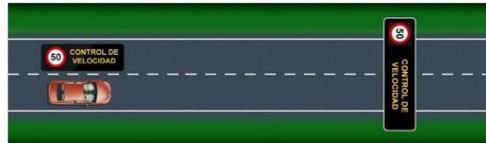
Proporcionar al usuario "dentro del vehículo" de forma enriquecida y/o adaptada la señalización/información existente en la calzada.

Comportamiento deseado

Adecuación de forma segura a la regulación/condiciones de tráfico existentes.

Beneficios esperados

- Mejora de la gestión de tráfico debido a la posibilidad tanto de proporcionar información de forma global (i.e. broadcast) y no sólo local (i.e. PMV) como a poder hacerlo de forma enriquecida.
- Mejora de los niveles de seguridad a través de la mejora de la comunicación con los usuarios.
- Posible reducción de los costes de equipación de infraestructura.



PROBE VEHICLE DATA

Antecedentes

La necesidad de tener conocimiento en tiempo real de las condiciones existentes en un entorno tan dinámico y cambiante como es el de la circulación, hace necesario encontrar nuevas fuentes de información más allá de las convencionales (i.e. inspección de operarios y agentes de seguridad, sensores en las calzadas, ...) que faciliten la obtención/actualización de dichas condiciones.

Propósito

Usar los vehículos como "sensores" móviles para que a través de su información (e.g. velocidad, estado luces, activación ESP, ...), permitan obtener/actualizar información sobre las condiciones de tráfico existentes.

Objetivo

Proporcionar a los centros de control y gestión de tráfico información mejorada y actualizada sobre las condiciones de tráfico existentes.

Beneficios esperados

- Mejora de la seguridad a través de una mayor y más actualizada información sobre las condiciones de tráfico.
- Posible reducción de los costes de equipación de infraestructura.



SLOW OR STATIONARY VEHICLE WARNING

Antecedentes

Dada la limitada capacidad de reacción que muchas veces existe para los usuarios, ante la aparición "repentina" de un vehículo circulando a velocidad anormalmente lenta o un vehículo averiado, se entiende que el aviso con suficiente antelación de la presencia de este tipo de vehículos prevendría o al menos reduciría significativamente el tipo de incidentes derivados de este tipo de situaciones, facilitando el adelantamiento en condiciones de seguridad de los mismos.

Propósito

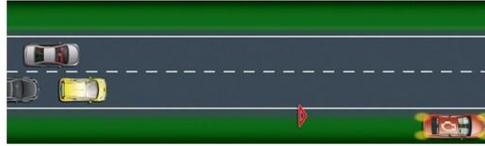
Proporcionar al usuario con antelación suficiente información sobre la presencia en sus inmediaciones de un vehículo circulando a velocidad anormalmente lenta o un vehículo averiado.

Comportamiento deseado

- Aumento atención.
- Adaptación de la velocidad.

Beneficios esperados

- Reducir el riesgo y número de accidentes derivados de las condiciones de tráfico existentes.
- Facilitar el adelantamiento en condiciones de seguridad de este tipo de vehículos.



MOTORCYCLE APPROACHING INDICATION

Antecedentes

Dada la limitada capacidad de reacción que muchas veces existe para los usuarios, ante la aparición "repentina" de una motocicleta, se entiende que el aviso con suficiente antelación de la presencia de este tipo de vehículos prevendría o al menos reduciría significativamente el tipo de incidentes derivados de este tipo de situaciones, facilitando el adelantamiento en condiciones de seguridad para ambos vehículos.

Propósito

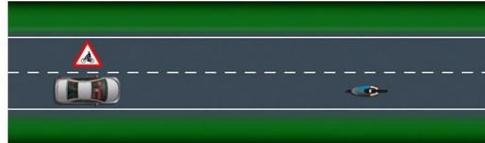
Proporcionar al usuario con antelación suficiente información sobre la presencia en sus inmediaciones de una motocicleta.

Comportamiento deseado

- Aumento atención.
- Adaptación de la velocidad.

Beneficios esperados

- Reducir el riesgo y número de accidentes derivados de las condiciones de tráfico existentes.
- Facilitar el adelantamiento en condiciones de seguridad de este tipo de vehículos.



APLICACIÓN C-MOBILE

David García Rubio

CTAG

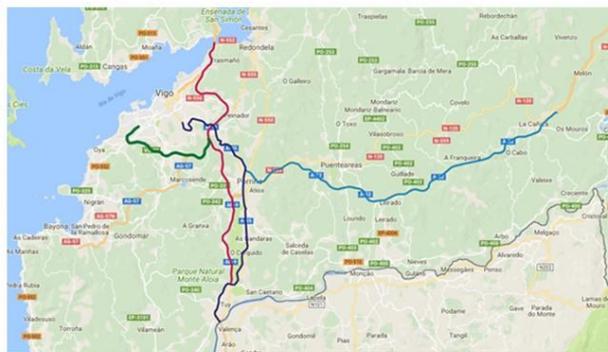
Co-funded by
the European Union



ARRANQUE DE LA APLICACIÓN



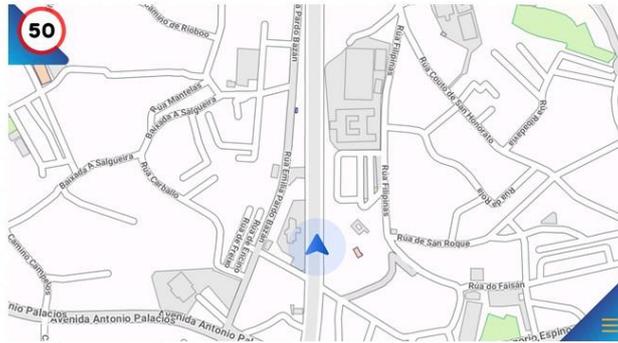
CORREDOR INTERURBANO



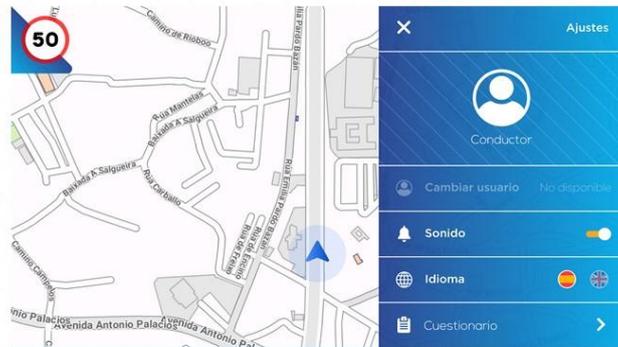
CORREDOR URBANO



PANTALLA DE INICIO



TIPO DE USUARIO



FUERA DEL CORREDOR



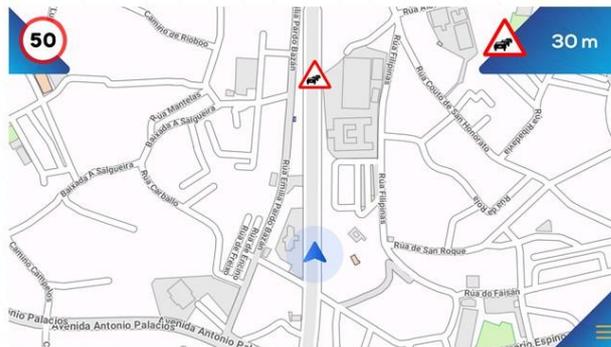
TIPOS DE ERRORES



ROAD WORKS WARNING



ROAD HAZARD WARNING



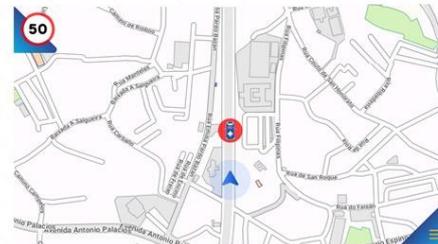
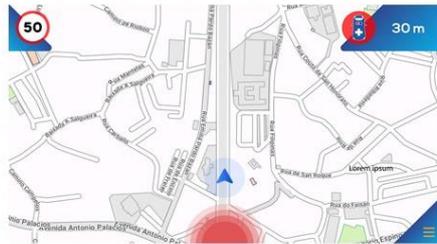
SLOW OR STATIONARY VEHICLE WARNING



VARIOS EVENTOS EN PANTALLA



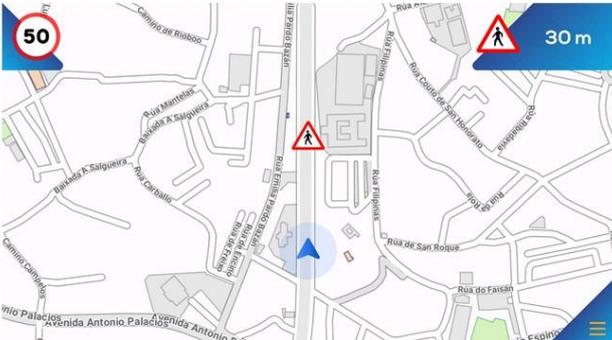
EMERGENCY VEHICLE WARNING



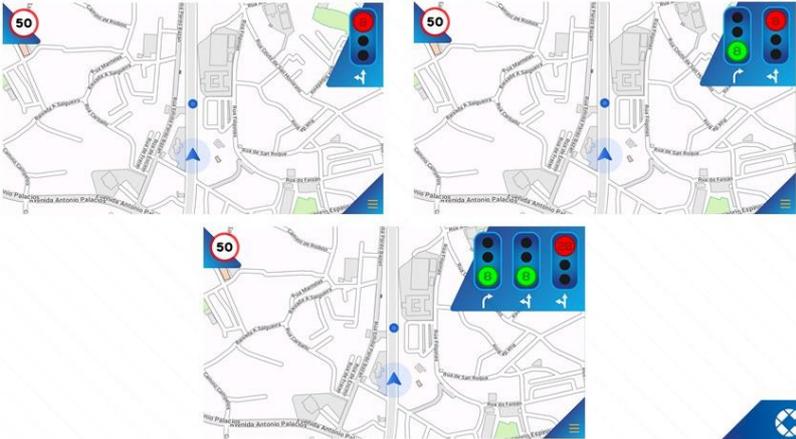
SIGNAL VIOLATION WARNING



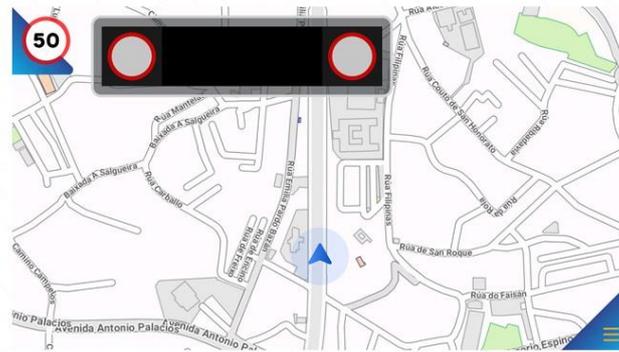
WARNING SYSTEM FOR PEDESTRIAN



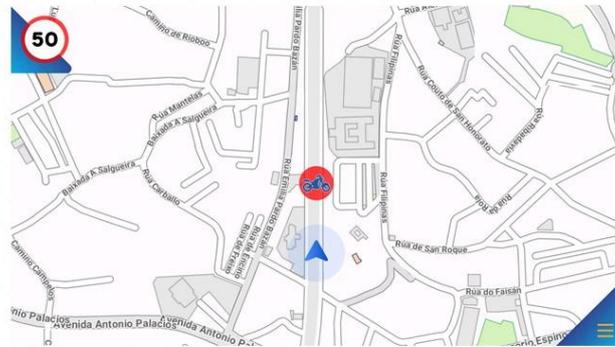
TIME TO RED TIME TO GREEN



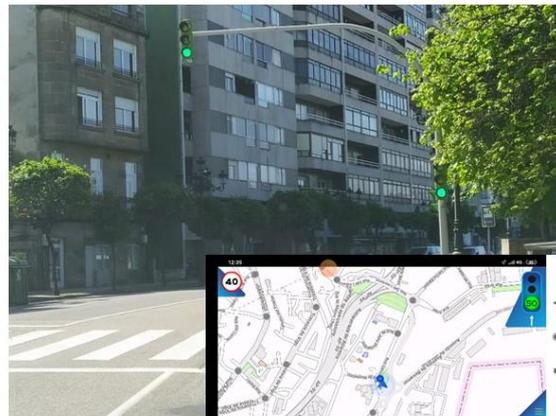
IN VEHICLE SIGNAGE



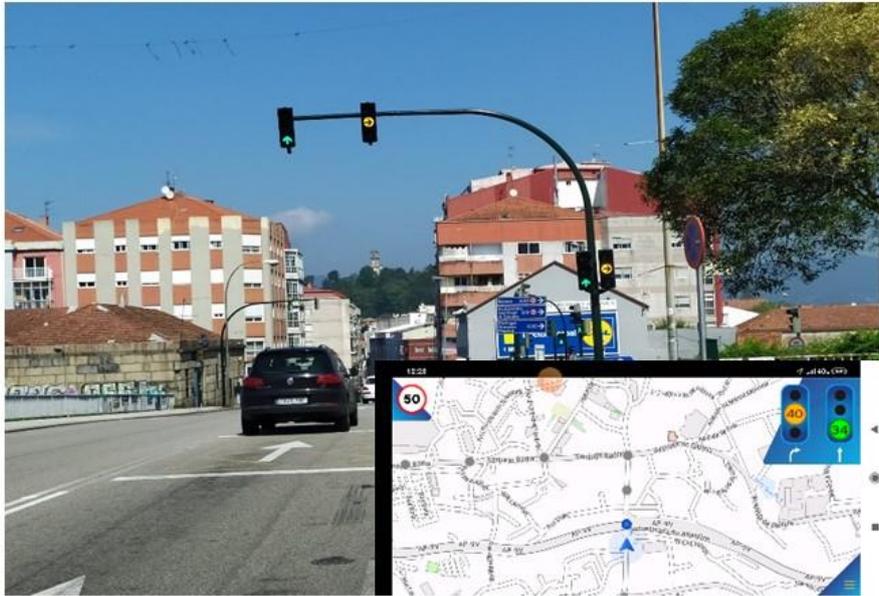
MOTORCYCLE APPROACHING INDICATION



GLOSA



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¡Muchas gracias!

Más información:
<http://c-mobile-project.eu>
https://youtu.be/qv44y_oa6yc

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