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# D2.1 Overview of ITS initiatives in the EU and US

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## Abbreviations

| | |
|---|---|
| AHP: | Analytic Hierarchic Process |
| AHS: | Automated Highway System |
| APTS: | Advanced Public Transport System |
| ATIS: | Advanced Traveller Information System |
| ATMS: | Advanced Traffic Management System |
| ATPS: | Advanced Transport Pricing System |
| BHLS: | Buses with a High Level of Service |
| BRT: | Bus Rapid Transit |
| CCTV: | Close Circuit Television |
| CEN: | European Committee for Standardization |
| C-ITS: | Cooperative Intelligent Transport Systems |
| CR: | Consistency Ratio |
| CVS: | Cooperative Vehicle System |
| D2.1: | Deliverable 2.1 of NEWBITS |
| DoW: | Description of Work |
| EC: | European Commission |
| ERTICO: | Organisation for ITS in Europe |
| ETSI: | European Telecommunications Standards Institute |
| EU: | European Union |
| FCD: | Floating Car Data |
| FP7: | Framework Program 7 of the European Commission |
| FRAME: | EU ITS Framework Architecture |
| GA: | Grant Agreement |
| GLOSA: | Green Light Optimal Speed |
| GPS: | Global Positioning System |
| GSM: | Global System for Mobile Communication |

| | |
|---|---|
| H2020: | Horizon 2020 Program of the European Commission |
| IaaS: | Infrastructure-as-a-Service |
| ICT: | Information and Communication Technologies |
| ISTEA: | Intermodal Surface Transportation Efficiency Act |
| ITS: | Intelligent Transport Systems |
| I2V: | Infrastructure to Vehicle |
| KAREN: | Keystone Architecture Required for European Networks |
| KoM: | Kick-off Meeting |
| KPI: | Key Performance Indicator |
| LIDAR: | Laser Imaging Detection and Ranging |
| LVM: | Finnish Ministry of Transport and Communications |
| MaaS: | Mobility-as-a-Service |
| MS: | Microsoft |
| NASA: | National Aeronautics and Space Administration (US) |
| NFC: | Near Field Communication |
| OEM: | Original Equipment Manufacturer |
| OT: | Objectives Tree |
| PCM: | Pairwise Comparison Matrix |
| PDA: | Personal Digital Assistant |
| PPP: | Public-Private Partnership |
| RITA: | Research and Innovative Technology Administration (US DoT) |
| RFID: | Radio Frequency Identification |
| SD: | Service Dominant (logic) |
| SME: | Small and Medium Enterprise |
| SOM: | Self-Organizing Map |
| TNO: | Netherlands Organisation for Applied Scientific Research |
| TTRANS: | FP7 Project “Enhancing the transfer of ITS innovations to the market” |
| TRL: | Technology Readiness Level |
| UTMS: | Universal Mobile Telecommunications System |

| | |
|---|---|
| US: | United States |
| USDoT: | Unites States Department of Transportation |
| V2I: | Vehicle to Infrastructure |
| V2V: | Vehicle to Vehicle |
| V2X: | Vehicle to Other transport participants |
| WP: | Work Package |

# Abstract

In order to provide NEWBITS with a framework for approaching ITS and define relevant ITS categories for the project deployment, a mapping and assessment of ITS initiatives in the EU and US is carried out: Deliverable 2.1.

The interrelations of WP2 with the other work packages are discussed. There are numerous definitions of the term Intelligent Transport Systems (ITS) and Cooperative Transport Systems (C-ITS), but after literature research, a definition is proposed that describes the term in the NEWBITS context best. Furthermore, the different concepts of NEWBITS at macro and meso levels are described to further enhance the comprehension of those and the project scope.

The methodology used to categorize and map relevant ITS initiatives is developed to operate in a two-tier level at initiative (macro) and service (meso) levels. It follows a 3-stage categorization process based in iterative data gathering, conceptualization and codification of the data. After several literature research and assessment of the results of the initial data gathering, a categorization framework and a number of criteria are proposed, guiding the data gathering at service level. An important tool is the fiche template: through the template all partners provide information of ITS services in a structured manner. The process of validation of the categorization method follows the Analytical Hierarchy Process. A decision hierarchy is constructed and partners are asked to score the criteria and categorization parameters. Finally, the process of codify and organize data will deploy an identification of subcategories for service differentiation, presenting diverse mapping outcomes and extended visualization of the categorization.

# 0. Executive summary

Deliverable 2.1. *Overview of ITS initiatives in the EU and US* is the first deliverable for work package two (WP2), and the basis for the other work packages (WPs). There are interrelations with the other WPs and these are described in *Chapter 1 Introduction*. The main point is that there has been and will be contact with the other WP leaders to ensure efficient and effective use of each other's work to create synergy.

Since the terms 'Intelligent Transport Systems' and 'Cooperative Intelligent Transport Systems' will be used throughout the NEWBITS project following a dual scope, it is crucial to have a common understanding of both terms. Following research, a definition specific for NEWBITS was formulated:

> *We will consider ITS main function as the increased efficiency in the transport system, with special focus on the service and information provision for the full spectrum of users (drivers, passengers, vehicle owners, network operators…) which involves a diversity of stakeholders (network operators, public authorities, OEMs, service providers, technology developers…).*
>
> *C-ITS are considered a subset of the overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone system*

These definitions are specified in Chapter 2 *Definitions and Methodological Approach* together with the different concepts of NEWBITS at macro (initiative) and meso levels (case study, services), to further enhance the comprehension of those and offer a clearer focus of the project scope. Chapter 2 provides with an explanation of the methodological approach followed to produce the deliverable, inspired in the three stages of the knowledge management theory and backed-up by the Analytical Hierarchy Process (AHP) is also stated in this chapter, resulting in a 5-step process to be deployed in the following chapters.

Chapter 3 *Data identification and definition of the categorization framework* develops the first three steps of the proposed methodology: in *step 1* '*Data identification #1*', an initial data identification and gathering process is deployed. ITS initiatives are identified following the proposed scope as defined in the Description of Work. Basic information on those has been gathered and upon transversal analysis, has lead towards a first categorization and a "rough" inventory. In '*step 2 defining the categorization framework (conceptualization #1)*', NEWBITS partners discussed about the categorization approach to be followed, acknowledging the need to consider a market oriented framework, as well as identified a long list of criteria to consider the categorization. In step 3 'Data identification (#2)', NEWBITS partners identified a number of ITS applications or services, generating an ITS service inventory.

The chapter 4 *Codification and Mapping of ITS and C-ITS services* has a twofold focus: on the one hand, to propose a systematic methodology based on the Analytical Hierarchy Process (AHP) to determine: (1) a suitable categorisation that fits the purpose of NEWBITS, and at the same time, (b) provide a priority ranking of the long criteria list defined in Chapter 4 following pairwise comparison assessments by partners. On the other hand, to perform the mapping of the identified ITS/C-ITS services to the selected categorisation, and provide a visual mapping with respect to the short list of criteria resulting from the ranking in (1).

Thus, Chapter 4 deploys step 4 by validating the conceptualization process and organizing and mapping the identified ITS services. The mapping methodology will be the base to support further design inputs in Task 2.2 and Task 2.3.

# 1. Introduction

## 1.1 NEWBITS project

NEWBITS (New Business Models for Intelligent Transport Systems) is a Coordinated and Support Action project funded under the EC Programme Horizon 2020.

NEWBITS aims at providing further understanding of the changing conditions and dynamics that affect and influence the deployment of ITS innovations. This improved understanding must contribute to minimizing the failures inherent to ITS innovation diffusion, evolve present business models, and identify effective (policy) incentives to accelerate ITS deployment.

Although the significant added value that ITS applications can provide to the European transport system has been constantly highlighted in the past years, their deployment is considered to be slow and fragmented (C-ITS Platform, 2016; Ricardo, 2016). Robust and innovative business models that would support a truly responsive approach to accelerating commoditisation and price-competition in the market for ITS services are often missing, inter alia due to the public oriented nature of ITS users (Agelidou et al., 2015). Confidence of the core stakeholders on the (long-term) profitability of their investments in ITS services and technologies is necessary and requires sound and convincing business cases.

In consideration of this global context, the project has set the following specific objectives:

1. Applying a business ecosystem's concept for ITS and C-ITS, introducing a higher conceptual level than that of individual organizations.
2. Improve the understanding of ITS and C-ITS enablers and barriers, implementing a holistic intelligence process
3. Effectively implement a network based business modelling method for C-ITS
4. Validation of new business models, translation and capitalization of results.

NEWBITS project is articulated in three phases that correspond to certain Work Packages and activities, as depicted in the following figure:

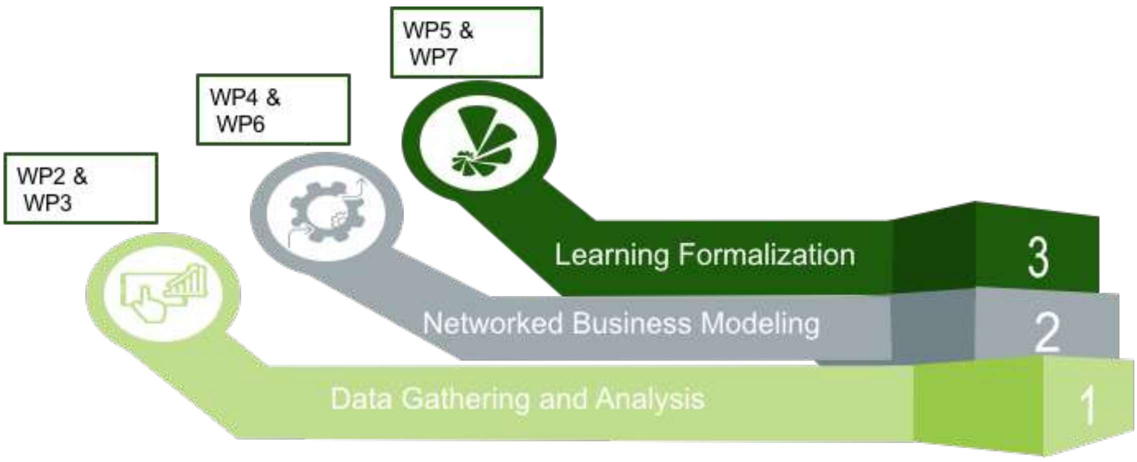


Figure 1 Overview of NEWBITS project key phases

The two first project phases will be devoted to Data gathering and analysis (Phase1) and Network Business modelling (Phase 2), with WP6 running in parallel and acting as a key element of the NEWBITS network oriented approach. Both phases will feed the third phase

(Phase 3), the implementation of which requires the execution of the biggest part of the work effort of the tasks of the previous phases.

## 1.2 Description of WP2

Work Package 2 “Mapping (C)-ITS context” is the first support Work Package of the project, having a relevant role in NEWBITS as an enabler of the understanding of the challenge underlying the NEWBITS project. WP2 aims at providing a good framework for the assessments to be carried out in the next WPs (in WP3, WP4 and WP5), being key outcomes: the assessment of ITS relevant initiatives and applications, and the validation of the project case studies.

The analysis performed by WP2 is based on three highly interlinked activities or tasks: mapping and categorizing relevant ITS initiatives and applications (services) at EU and US levels (Task 2.1); assessing Key Performance Indicators (KPIs) and barriers for implementing ITS following the categorization (Task 2.2); and define and validate valid case studies to deploy the business modelling method while generating an accurate taxonomy (Task 2.3).

Work Package 2 is configured considering the need to deploy an assessment at both the macro level (ITS initiatives) and the meso-level (ITS business ecosystems and services), in order to achieve its objectives. It is not intended to provide an accurate picture of the ITS environment, being this out of the project reach and scope, but to categorize such a diverse and evolving domain in order to assess the representativeness of NEWBITS case studies towards ITS.

Taking into consideration the relevance of WP2 as the work package in which NEWBITS framework is categorized and case studies are validated, there are interrelations within WP2, but also with other WPs, tasks and activities. These interrelations, highlighted in the Risk Management of the project, have been taken into consideration throughout the execution of the WP2. The most important foreseen and existing interrelations are described, as well as the steps that are to be taken - or already have been taken - in order to ensure efficient and effective interaction.

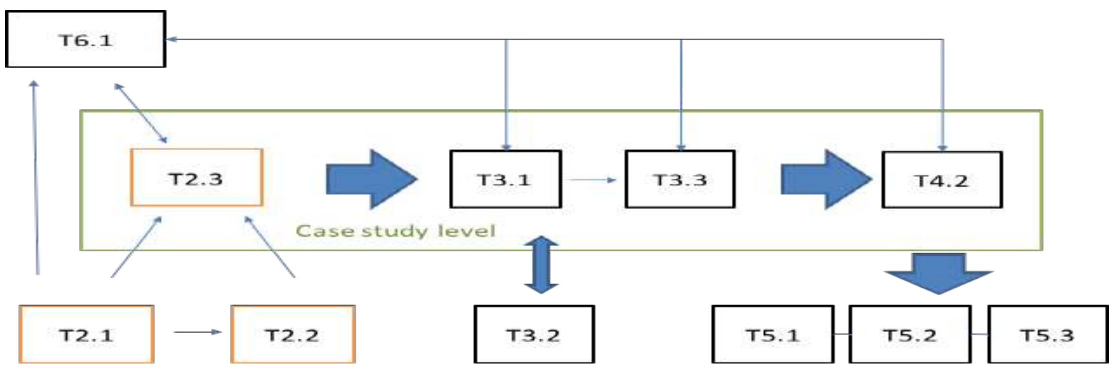


Figure 2 Diagram for key interrelations in NEWBITS

The key interrelations of WP2 are summarized as follows:

- ***Interrelation within WP2***

  The three WP2 deliverables and the work to be done to implement them are strongly interrelated. D2.1 (*Overview of ITS initiatives in the EU and US*) sets the operative ground for D2.2 (*Assessment of existing KPIs and barriers for implementation of C-ITS*) by identifying relevant initiatives and services (covering both macro and meso level), validating key criteria to implement a systematization of the ITS universe towards the objectives of NEWBITS project, and ultimately mapping most relevant ITS services using a qualitative analysis. The study of barriers for implementation is a key of NEWBITS project. D2.3 (Case study taxonomy), will build up on the results of both previous outcomes, further defining and validating case studies suitable for deploying the project method, and generating a taxonomy of those based on the prior systematization and categorization defined in D2.1.

  NEWBITS partners involved in the direction of each of WP2 tasks (CED and UAB), supported by Project Coordinator, have been collaborating and discussing the design of the most appropriate methodology since the inception of Task 2.1 in order to ensure that the outcomes are highly relevant to facilitate the processes in WP2.

- ***WP2 & WP3***

  The interrelation of WP2 activities with WP3 “Holistic Intelligence process” is considered. The key outcome of WP2 will be a validation of the case studies for NEWBITS project, based on a three-step approach represented by the three abovementioned WP2 tasks. The case studies are the critical enabler of the envisaged project methodology, further articulating the processes designed to fulfil the project objectives. WP3 focuses the multi-layered market analysis on the case studies: *Task 3.1 Market research analysis and Task 3.2 Perform conjoint analysis to analyze user preferences on the case studies,* will deeply rely on the output of WP2 and D2.3 particularly. Thus, WP3 builds upon the outcome of WP2, being strongly conditioned by the criteria utilized to validate the NEWBITS case studies.

  The consideration of the impact of WP2 outputs in WP3, has been acknowledged in the process of definition of Task 2.1 as first critical step to frame NEWBITS overall approach, guiding the actions of the consortium to deploy this deliverable. Since the implementation of WP2 follows an inter-linked rationale, it has also been considered for defining Task 2.2 (launched in M5, during the time of finalization of this document) and will be considered in Task 2.3. WP2 Leader (CED) and WP3 Leader (ATOS) have been in constant communication, supported by PC (ORT), in order to ensure a comprehensive approach in WP2 that considers the needs of WP3, and vice versa.

- ***WP2 & WP4***

  WP4 “Developing Innovative Business Models” focuses on the economic and commercial aspects of ITS, and will research for new business models for the selected NEWBITS case studies. Thus, the scope of WP4 is entirely devoted to the meso-level (case studies) and will draw on the results from both WP2 and WP3.

WP4 leader (ORT) has been involved in the definition of the relevant parameters to be considered by WP2 and Task 2.1 methodology regarding the deployment of WP4. Since the project does not foresee any further iteration past Task 2.3 on the case study validation, this outcome is of critical relevance. The process for selecting the most relevant criteria in the categorization process has considered WP4 needs. Moreover, and following the duality in the DoW with respect to the focus of T2.1 in initiatives, but also in services-applications, the final methodological approach has considered the service level as a priority in view of the inputs of both WP3 and WP4 leaders.

- ***WP2 & WP5***

  The interrelations of WP2 with WP5 “NEWBITS Business case validation, guidelines and training” are also considered. WP5 embeds the process of learning formalization and generalization from the case studies towards ITS environment. The assessment of the criteria of relevance for categorizing and ultimately validating the case studies has also considered WP5 approach. This has been ensured with the active participation of WP5 leader (CUE) in Task 2.1 deployment, though it was not initially established in DoW, and the specific communication between CED partner (WP2 and D2.1 Leader) and CUE on the matter.

- ***WP2 & WP6***

  The results of WP2 are a key conditioner of WP6 “NEWBTIS Network”. The concept of Communities of Interest (CoIs) is to be articulated initially around the NEWBITS case studies. The key assumption of NEWBITS project is that business models are understood as a network, thus the process of engaging stakeholders towards a networked oriented value proposition generation is strongly linked to the nature of the validated case studies.

  Similarly to the abovementioned Work Package leaders, WP6 Leader (INTELS) has provided input to WP2 and D2.1 Leader (CED) so that WP6 constrains and focus is considered in Task 2.1 and WP2 deployment, and vice versa since both WPs are running in parallel till M10.

## 1.3 Deliverable 2.1 Objectives and methodology in a nutshell

Task 2.1 sets the frame within which most analyses and processes that will follow in the NEWBITS project will be carried out. The activity deployed in this task has been collated into this Deliverable 2.1, which aims to fulfil 2 major objectives:

1. Provide NEWBITS with a framework at ITS macro-level.

This objective will be fulfilled by identifying ITS and C-ITS initiatives at EU and US levels, and generating a rough inventory collating the information gathered. This macro-framework intends to provide with an overview of the complex and evolving ITS domain, not to be an accurate delimitation of it, and will contain basic information about the initiatives identified (description), stakeholders involved on those (if relevant), transport mode covered and geographic context.

2. Define relevant ITS categories for the project deployment

NEWBITS categorization exercise proposed and deployed in this deliverable intends to fulfil three transversal objectives: to frame the context of ITS into useful and valid parameters for the project purposes; to support the process of validation of the case studies (deployed in Task 2.3); to facilitate the process of result generalization from the case studies to a more ITS generic level (to be performed in WP5).

Taking in consideration those expected impacts for the resulting categorization, this objective requires to fulfil a higher level of systematization than at global initiative level. Thus, the categorization at initiative level will be consolidated towards the identification of ITS services. Further information will be collated and assessed in order to assess the relevant key criteria at service level, which will also consider the above mentioned transversal impacts expected.

In order to achieve the two core objectives, considering the relevance of the task and the need to pivot in both macro and meso levels, a 3-stage methodological approach has been designed and implemented inspired in Knowledge Management theory: Data Identification; Conceptualization; and Codification.

The 3 stages rely on 5 implementation steps which ensure the required iteration at data identification and the need to cover both levels of the project (macro and meso levels). Those steps are: Step 1 Data Identification; Step 2 Defining the categorization framework; Step 3 Data identification; Step 4 Validation of the categorization method; Step 5 Data codification.

Further detail on the methodological approach is provided in Chapter 2, sections 2.4 and 2.5.

## 1.4 Structure of the report

The structure of this document follows the methodology proposed in the NEWBITS description of work.

**Chapter 1: Introduction**

Within an introduction to the NEWBITS project, the work package 2 and the task 2.1, the special background and requirements of this task are explained.

**Chapter 2: Definitions and methodological approach**

The results of a thorough literature review are presented by giving definitions of key terms and summarizing the existing classifications at both EU and US levels for ITS. A short explanation of the NEWBITS macro and meso levels is introduced, linked with relevance of both concepts at methodological level.

The methodological approach of the deliverable is introduced. The method designed operates in a two-tier level, at initiative (macro) and application/service (meso) levels. A 3-stage categorization process is deployed, which embeds both tiers towards a feasible mapping at service level and is effectively deployed in a 5-step iterative process (Table 1 Overview of steps, processes and tools).

**Chapter 3: Data Identification and definition of the categorization framework**

In a first step, ITS initiatives are identified following the proposed scope as defined in the Description of Work. Basic information on those has been gathered and upon transversal analysis, has lead towards a first categorization and a “rough” inventory

In step 2, NEWBITS partners discussed about the categorization approach to be followed, as well as identified a long list of criteria to consider the categorization.

In step 3, NEWBITS partners identified a number of ITS applications or services, generating an ITS service inventory.

**Chapter 4: Codification and Mapping of ITS and C-ITS services**

Also in this chapter, two steps are combined:

In step 4, the process of conceptualization is finalized, validating the categorization proposed for NEWBITS using an Analytical Hierarchy Process based approach.

In step 5, the data is finally organized and codified, using a mapping method as base to support further design inputs in Task 2.2 and Task 2.3.

**Chapter 5: Conclusion**

In the last chapter, all previous are summarized and their findings and outcomes are stated again at a glance.

**Chapter 6: Annexes**

All figures, graphics, tables and other data gathering and collection tools (fiches, questionnaires) that are useful to understand project-related issues and outputs, but exceed the normal size of 1 page and therefor would impede the flow of reading are attached in the Annex section. There is also a glossary that collects all abbreviations used in this report and explains those of them, that haven’t a self-explanatory name when it is written out.

# 2. Definitions and Methodological approach

The dual **ITS** and **C-ITS** scope of NEWBITS is embedded into the project's approach since its inception. NEWBITS responds to the Topic MG-6.3-2016 "Roadmap, new business models, awareness raising, support and incentives for the roll-out of ITS". Though the topic intended to address ITS holistically, there was also a special focus on the "need to develop tools and guidance to support public and private stakeholders in the development of efficient policies for Collaborative ITS (C-ITS) deployment based on consolidated knowledge across the EU".

In consequence, NEWBITS proposes an approach to ITS as a domain, with specific emphasis throughout the project implementation, and in specific stages, to C-ITS.

In what regards to the methodology followed in this report, NEWBITS project as a whole is aligned with the Service Dominant Logic, considering services at the core of the methodological approach, and setting the ground for a Value Network based analysis. In order to fulfil the objectives of Task 2.1 Mapping and assessing relevant ITS and C-ITS initiatives at EU and US levels, a 3-stage approach based on classical knowledge management theory and practice has been proposed, further implemented in a 5-step process which determines the structure of this report.

The following sections in this chapter will further elaborate on the definitions adopted by NEWBITS, and provide with a concise yet robust explanation to the methodological approach. The results of this approach will be assessed in Chapters 3 and 4.

## 2.1 Definition of Intelligent Transport Systems

In the past few years, Intelligent Transport Systems (ITS) research and practice has developed an ever-growing body of knowledge while the application of ITS technologies has already had a significant impact on the current transport environment. With few doubts existing nowadays about the wide reaching and cross-cutting benefits of ITS, it is important to state that ITS is still a relatively young discipline.

Some references set the origins in late 1960s in the United States (US), with the deployment of the first dynamic messaging signs, and the later-on deployment of first generation bus automatic vehicle location mapping technologies. As a matter of fact, the first-time appearance of the term ITS as such occurs during the 1980s, when a new discipline, Telematics, appeared on the market as a synergy of two existing disciplines: Telecommunications and Informatics.

The embryonic ITS domain grow in relevance during the 1990's decade, especially after the "Intermodal Surface Transportation Efficiency Act" (ISTEA) was passed by US Congress, and the first federal ITS research program was established.

It has been though in the past 15 years when ITS have risen as a key technology and application spectrum, envisaged to provide an effective answer to the increase in transport demand under tight constrains, and to the need of dimension efficiently the limited capacity of transport infrastructures while releasing pressure on the environment and energy resources and providing a higher comfort and security for both passenger and goods transport.

This recent commonly granted holistic perception of ITS (or the role of ITS) based on a broad scope of ITS, coexists with a more narrow-focused one. As stated in the Report on Australia's future in Intelligent Transport Systems, "*for non-ITS experts and popular broadcasters, automated vehicles and ITS are often synonymous…even if they represent one part of a much richer menu of computerised intelligence supporting travel by vehicles*" (ITS Australia, 2017).

The lack of a commonly accepted and holistic definition of the ITS term is linked to its fast exponential development and highly cross-cutting and interdisciplinary nature, together with the original preponderance of ITS in the US context and its, still predominant, deployment in the road mode.

In this sense, the first step towards a NEWBITS definition of ITS is to acknowledge the two possible expressions of ITS:

- Intelligent transport systems
- Intelligent transportation systems

In this project, we will not further distinguish between both versions as there is no real difference between those terms rather than at a language use level.

In what regards to ITS meaning, the lack of a homogenised definition is still prevailing nowadays. A brief overview for the most extended definitions in the three macro-regions which are the primary object of study of NEWBITS project (United States, European Union and Australia), reveals this disparity.

**United States** has played an indisputable role in the global definition of ITS as key enabler for enhanced transport system performance. Though the US role worldwide has been overpassed by other players, namely Japan, Singapore and South Korea (ITIF, 2010), US has recently re-assessed the relevance of ITS at strategic level. Moreover, the commonly shared transport research issues, challenges and goals with the European Union (EU), has pushed towards a progressively more intertwined agenda in both regions.

The US Department of Transportation defines ITS as:

> "Intelligent transportation systems (ITS) provide a proven set of strategies for advancing transportation safety, mobility, and environmental sustainability by integrating communication and information technology applications into the management and operation of the transportation system across all modes." (US DoT, 2014)

Similarly, the definition of ITS in the Strategic Plan 2015-2019 states:

> "ITS is a set of tools that facilitates a connected, integrated, and automated transportation system that is information-intensive to better serve the interests of users and be responsive to the needs of travellers and system operators". (US DoT, 2015)

At **EU** level, the high cross cutting nature of ITS and their importance and potential have determined their consideration of an integral part of the Common Transport Policy. European Commission (EC) has highlighted the ITS potential to support major EU priorities as regard of economic growth by 2020 (EC, 2010a).

According to the EC:

> "ITS are 'advanced applications which –without embodying intelligence as such – aim to provide innovative services relating to different modes of transport and transport management and enables various users to be better informed and make safer, more coordinated and 'smarter' use of transport networks" (European Commission, 2010b).

EC uses also refers to ITS in a very holistic description:

> "Intelligent Transport Systems (ITS) apply information and communication technologies to transport." (European Commission, 2012)

The European Telecommunications Standard Institute (ETSI) provides the following definition:

> "Intelligent Transport Systems (ITS) use information and communications technologies (ICT) to improve safety, reliability, efficiency and quality of transport. The technologies are therefore added to infrastructures and are integrated at the corresponding transport vehicles." (ETSI, 2012)

**Australia** has a long history of ITS deployment, with the first systems introduced in the early 1970s and a context in which public authorities, transport industry and users have come to rely more heavily on the efficient operation of ITS. In this sense, the existing strong linkages amongst NEWBITS and Australian based ITS players has favoured the consideration of Australia as secondary object of study to be included in NEWBITS project. Thus, the definitions provided for ITS from an Australian perspective have also been considered at this stage of project implementation.

In this sense, ITS-Australia defined Intelligent Transport Systems (ITS) as:

> "ITS are the application of modern computer and communication technologies to transport systems, to increase efficiency, reduce pollution and other environmental effects of transport and to increase the safety of the travelling public." (ITS Australia, 2002)

More recently, the Australian Department of Infrastructure and Transport provided the following definition:

> "ITS encompass the application of information and communications technologies to transport. ITS include stand-alone infrastructure applications such as traffic management systems, as well as cooperative ITS (C-ITS) applications involving

> telematics, vehicle-infrastructure and vehicle-vehicle communications. These technologies cover private and public transport by road, rail, water and air, as well as cycling and walking, together with applications for cross modal transport and transport hubs." (Australian Department of Infrastructure and Transport, 2012)

An updated definition, also by ITS Australia:

> "The term 'Intelligent Transport Systems' (ITS) covers the development and deployment of advanced information and communications technologies to deliver safer, more efficient and environmentally sustainable transport across all public and private modes – air, sea, road and rail." (ITS Australia, 2017b)

Finally, the PIARC World Association ITS Handbook, defined ITS as:

> "ITS - Intelligent Transport Systems - is a generic term for the integrated application of communications, control and information processing technologies to the transportation system." (ITS Handbook, 2011)

Thus, we can resume that ITS in its more simplistic definition (Taylor, 2001; EC 2012) refers to the application of information and communication technologies (ICT) to the transport sector.

ITS covers all modes of transport and considers all elements – the vehicles, the infrastructure, the drivers and users – all interacting together dynamically (ITS Handbook, 2011). ITS can have applications in a broad range of fields, including infrastructure, vehicles and users, traffic and mobility management, and interfaces with other modes of transport. More specifically, ITS cover travel information services, transport management systems, a broad range of mobility services (e.g. smart travel cards, integrated ticketing services), vehicle control and safety systems (e.g. anti-collision warning and control systems) and transportation pricing systems (e.g. electronic toll collection, variable parking fees) (CE Delft et al., 2011).

As for the NEWBITS project, the definition of ITS is basically aligned with that provided by the ITS Handbook, which anchors ITS in the implementation of ICT in transport. We will consider ITS main function as the increased efficiency in the transport system, with special focus on the service and information provision for the full spectrum of users (drivers, passengers, vehicle owners, network operators…) which involves a diversity of stakeholders (network operators, public authorities, OEMs, service providers, technology developers…).

The impact of ITS in NEWBITS will be considered in a transversal manner, considering ITS as enablers of improved traffic flow, enhanced safety, de-creased environmental impacts, generating a wide array of advantageous services for users and establishing convenient multimodal mobility service use (LVM, 2014) which reverts into a higher capillarity and efficiency of the whole system.

## 2.2 Definition of Cooperative Intelligent Transport Systems

Having provided with several references for ITS in the previous section, and established a commonly agreed valid definition for NEWBITS, this section will briefly introduce the C-ITS concept as part of the ITS broader domain.

Cooperative ITS (C-ITS) is a subset of ITS that has been defined by the European Committee for Standardization (CEN) TC278 WG16/ISO TC204 WG18 and European Telecommunications Standards Institute (ETSI) EC ITS together as: *'A subset of the overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems*". (EC, 2016)

What C-ITS distinguishes from other ITS is the communication between different systems (i.e. personal ITS stations (e.g. mobile phones), vehicles, transport infrastructure or traffic management centres), which increases the ability for applications to collect and deliver information, and hence increases the overall quality of ITS services.

C-ITS typically involves communication between vehicles (vehicle to vehicle, V2V), between vehicles and infrastructure (vehicle to infrastructure, V2I; infrastructure to vehicle, I2V) and/or between vehicles and other transport participants (V2X), such as pedestrians and cyclists:

- *V2V* applications provide the opportunity to transmit messages about the vehicle's speed, location, direction, brake status and other information to other vehicles, and receive the same type of information from other vehicles. In this way information can be shared that cannot be provided by sensors, cameras, radar or the human eye, such that travellers receive the same information sooner or receive higher quality / more reliable information. Based on this information the transport users can act accordingly or, one step further, the vehicle can act autonomously, e.g. to prevent dangerous situations.

- In *V2I / I2V* applications, the infrastructure plays a coordinating role, e.g. by collecting information of road conditions and suggesting or imposing certain behaviours on a group of vehicles.

- V2X applications provide the opportunity for communication between vehicles and other travel participants (e.g. pedestrians). For example, vehicles communicate with mobile devices, e.g. smart phones) carried by pedestrians so that both the user of the vehicle and the pedestrian can be warned in case of any possible conflict.

As for the NEWBITS project, the definition of C-ITS is aligned with that provided jointly by CEN and ETSI.

## 2.3 Macro and Meso levels definition

NEWBITS proposed in WP2 a “Mapping of the C-ITS context” in which an analysis of barriers and Key Performance Indicators (KPIs) will be deployed at two levels: Macro level and Meso Level. These two tiers are also mentioned in diverse stages of the project. The original definitions were introduced at proposal level:

- **Macro Level**: Analysing ITS supporting initiatives and applications with focus on the C-ITS subarea (at both initiatives and applications levels)

- **Meso Level**: Case studies for specific sub-areas, covering concrete C-ITS related projects/programs.

Though the meaning of terms initiatives, applications, case studies, projects and programs can be in general and broadly accepted, could be at the same time questioned and challenged, since they are rather wide in terms of their concept covering many overlapped and interrelated aspects, thus they can be interpreted subjectively by different persons and viewpoints.

In this sense, the interdependency in the original definition between initiatives and applications, positioned at the same level of analysis (Macro level) requires of further assessment. NEWBITS provided with a description of what were considered **initiatives**, when describing Task 2.1: “FP7-H2020 projects, scientific papers, policy reports, research reports, other strategic reports and communications”. Besides offering a heterogeneous base for the definition, which was the intention of the data gathering process in D2.1, this definition has the impediment of including elements referred also in the Meso level as defined in the proposal (projects).

Furthermore, the original definition did not provide with sufficient background guideline regarding the key enabling tool in which NEWBITS project pivots: the case studies (i.e. the Meso level).

Thus, both Macro and Meso levels need to be defined at this initial stage of project implementation, and the terms of Initiative, Application and Case Study defined as key parts of the categorization and mapping (D2.1), the KPIs and barrier assessment (D2.2) and the taxonomy (D2.3).

The following lines are devoted to provide an operative description of all key elements in NEWBITS approach.

1. **Initiative**: As stated in NEWBITS DoW, initiatives are considered in its original scope and width in order to enable a generic approximation to the ITS domain. Thus, Initiatives are defined as FP7-H2020 projects, scientific papers, policy reports, research reports, other strategic reports and communications.

2. **Case Study:** NEWBITS follows a case study based approach as a qualitative research method to bring understanding of the complexities of ITS and strengthen the existing know-how. Case studies are envisaged to emphasize contextual analysis of a limited number of conditions and their relationships. In this sense, NEWBITS is aligned with the classic definition of case study research as an empirical inquiry that investigates a

contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context and not clearly evident and in which multiple sources of evidence are used (Yin, 1984). The process of selection and validation the case studies is due to be performed in a later stage of WP2 (during Task 2.3), having gained information on the background of ITS and existing barriers and enablers. Thus, it will be in D2.3 when an accurate description of NEWBITS case studies will be offered.

Key elements underlying the definition of case study already at proposal stage that are taken into consideration in the selection and validation process, and thus are embedded into the NEWBITS consideration of the case studies, are summarized in the following bullet points:

- The case studies have a market vision, and intend to cover different ITS application areas (or key business areas) as resulting from the categorization exercise in this task.
- Case studies are service based, since NEWBITS moves from the supplier value chain to the value network of the involved stakeholders ("balanced centricity"), considering service as the output.
- Case studies need to be context appropriate, pivoting on existing capabilities and knowledge of the actors involved, and linked to prior or on-going (but accessible) research.
- Case studies have to enable the definition of a network of stakeholders, facilitating knowledge sharing and fulfilling the premise of a value network.

3. **Application:** In Information and Communication Technologies, an application is the use of a technology, system or product. In this sense, NEWBITS considers applications as the use given to ITS in order to achieve a purpose. In line with T-TRANS project (2013), applications refer to the combination and use of several technologies in order to fulfil user requirements related to a transport mode (or the integration of more than one transport mode) on a certain market. This term is to be distinguished from **Application area**, which relates to ITS areas, and thus, to the Macro-level.

   In this sense, applications are aligned with the concept of **Service,** being sometimes indistinctively used in the project, and having a key relevance in the definition of the case studies and the meso level configuration. Examples of ITS services are traffic jam ahead warning, green light optimal speed advisory, cooperative forward collision warning, V2V merging assistance, platooning.

   ITS technologies are components of the ITS services. They are defined as the use of materials, tools, techniques, infrastructures and sources of power to make communication between ITS stations (e.g. vehicles, infrastructure, mobile phones) possible. They do not have a relation to any certain market and are not dedicated to a certain transport mode. But by combining them, they can be used to satisfy certain user needs as ITS services.

## 2.4 Methodological approach

In order to carry out the activities envisaged in Task 2.1, it is highly relevant to have a clear understanding of the objectives of the Task, and its relevance in the following tasks in WP2. Figure 4 summarizes Task 2.1 objectives using a basic Objectives Tree (OT) or objectives hierarchy, which shows how higher order objectives are linked to sub-objectives and eventually to implementation measures or attributes.

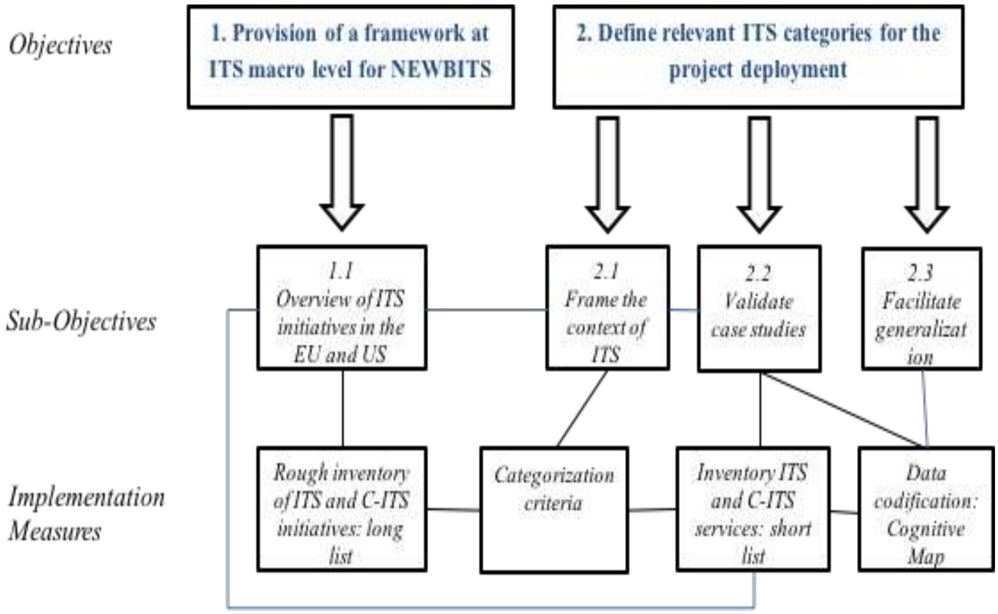


Figure 3 Deliverable 2.1 Objective Tree

Following WP2 rationale, it has been considered by this consortium to proceed to a **2-tier** based approach. Tier 1 being a set of processes leading to a categorization of the ITS and C-ITS macro-level (at initiative level), and thus fulfilling the objective 1 of Framing the complex context of ITS.

Tier 2 has been considered at Application or Service levels (both used indistinctively in NEWBITS). Based on a categorization and systematization of the higher initiative level, a set of processes have followed also to ensure a categorization and mapping at service-application levels, therefore fulfilling the objectives 2.2 and 2.3 of the Task, and furthermore, paving the way for the development of Task 2.2 ("Assessment of existing KPIs and barriers for implementation of C-ITS") and robustly supporting the fulfilment of Task 2.3 ("Taxonomy of the case studies") critical objectives: validate the NEWBITS case studies, and develop an accurate taxonomy of those, both requiring a solid data codification at the meso level (service-application).

The following assumptions, discussed at consortium internal level during the implementation of this deliverable, have motivated this approach:

a) The assessment of barriers and enablers to be performed in Task 2.2 is feasible and brings high added value to the project at an ITS Service/application level, not at the higher initiative level due to the high disparity of the pre-established initiative categories (projects, reports, scientific papers, strategic papers…);

b) The core objective of case study validation to be implemented in the second stage of Task 2.3, is strongly anchored in tier 2. Thus, it is only possible if the categorization of the ITS and C-ITS domain has been implemented, even though considering tier 1, at a service based level (tier 2).

## 2.5 Stages and steps in NEWBITS approach

The proposed methodological approach of D2.1 contains 3 stages. The approach is based on the initial phase of the knowledge management cycle, in which emphasis is given to elicit tacit knowledge, trigger the creation of new knowledge, and to subsequently, organize this content in a systematic manner (Dalkir, 2005) under a knowledge or data categorization. NEWBITS has considered these three stages in an iterative approach, in order to consider the 2 tiers explained above.

The following diagram outlines the process implemented in Deliverable 2.1:

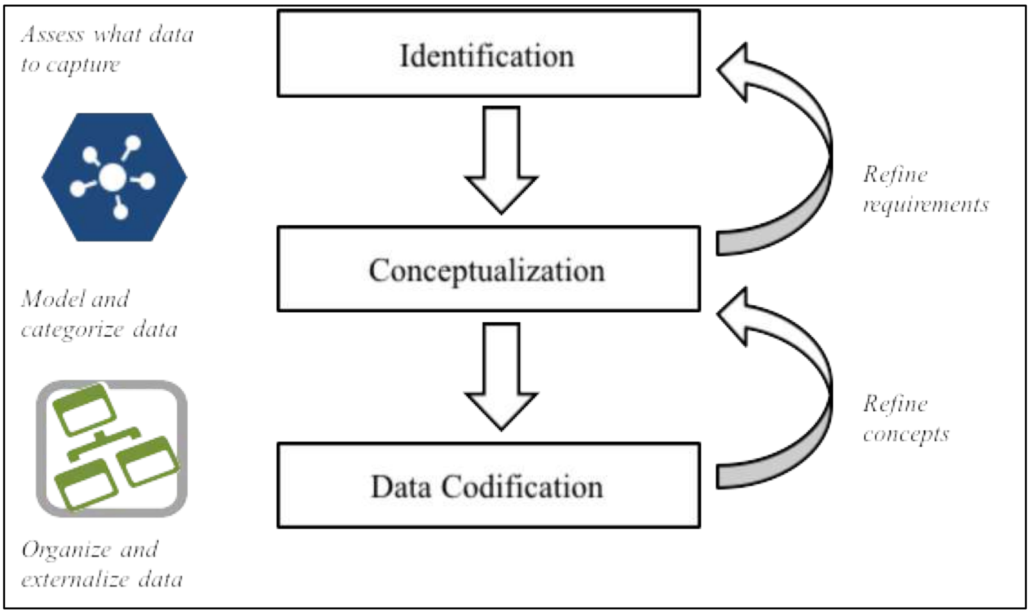


Figure 4 D2.1 key methodological phases

The key stages of the adopted process can be summarized as follows:

1. **Data identification**: We scanned and gathered a long list of ITS and C-ITS initiatives. The data identification considered both explicit data (by desktop analysis) and tacit data (at individual Level, by interviewing experts using semi-structured interviews). Following NEWBITS DoW, a number of major differentiation attributes were established as initiatives (national and EU projects, research papers, policy reports, research reports, other strategic reports). Those have been addressed in this stage, resulting in a “rough” inventory of ITS and C-ITS initiatives. The data identification will be iterated at service level.

2. **Conceptualization and categorization**: In order to propose a categorization model, NEWBITS consortium reviewed relevant literature related to system configuration, categorization of ITS and design thinking. As a result, a number of major differentiation concepts were introduced to organize the inventory. A first key outcome of this process has been the confirmation of the inefficiency of developing a categorization at initiative level, due the disparity of elements to categorize. Thus, NEWBITS consortium framed the categorization according to ITS parameters, resulting in the introduction of a **market-oriented categorization**. Upon this generic focus of the categorization, a second literature review was performed in order to detect relevant **criteria** to guide the categorization process.

   This outcome has led to the first iteration in the process ("refine requirements"), in order to identify "entities" at the meso level to fulfil the categorization: ITS and C-ITS services. Thus, the conceptualization at initiative level has developed a second identification stage, and the elaboration of a ITS and C-ITS inventory based on a number of key criteria. This process has been backed up following an **Analytic Hierarchy Process** (AHP) in order to determine the most suitable categorization method and the criteria required.

3. **Codification of the data**: In this stage, NEWBITS consortium has reviewed and organized the data, following an explicit knowledge codification process. In order to ensure the utility of the categorization for the NEWBITS objectives and in view of the data acquired, the consortium has developed a priority ranking sub process based on Analytical Hierarchy Process devoted to assess and select key relevant criteria. As a result, stage 3 has implemented a mapping of ITS services to category according to selected criteria, allowing further assessment on the categorization (second iteration in the process: refine concepts).

Despite the difficulties encountered and the need to tailor a simple yet effective methodological approach to enable the implementation of Task 2.1, the relevance and substantial importance of Deliverable 2.1 lies in the fact that organizes comprehensively the huge available information in the ITS and C-ITS domains. It forms a framework for understanding the challenge underlying the NEWBITS project and, moreover, sets the backbone of the assessments to be carried out in next work packages and activities.

The following document sub-sections provide a basic outline regarding each stage. Considering the iterations introduced at Data identification and Data conceptualization stages, a sequential process based on **5 key steps** has been introduced. For a complete overview of the process, including the objectives and tools, see Table 1 at the end of this section.

### 2.5.1 Step 1. Data identification (#1)

This step is about the identification and collection of data at ITS initiative level, by means of internal discussion, reviewing of reports and literature. The process of explicit data gathering has been complemented by interviews to ITS experts following a semi-structured approach.
In summary, the processes implemented in this step have been:

i. *Internal discussion amongst partners about the approach to the C-ITS and ITS data*
ii. *Desk research: acquiring basic information about ITS initiatives*
iii. *Defining interviews and implementing*

The main outcome of this step is a global inventory of ITS and C-ITS initiatives. The tool used by partners to gather the data is been a MS Excel, annexed in this document (Annex 1 Long List of Initiatives). Interview template in MS word has been also used by partners upon design and distribution by CED (Annex 2 Interview Template).

### 2.5.2 Step 2. Defining the categorization framework (conceptualization #1)

The key assumption guiding this step has been the need to assess the nature of the diverse possible categorization methods, and the ways in which those are applied, in order to determine what methodological approach is more useful for NEWBITS purposes. NEWBITS consortium engaged a **literature review and assessment** of categorization and systematization methods which could be translated for the purpose of modelling the existing inventory.

At this stage of the conceptualization process, NEWBITS partners reached the conclusion that the categorisation to be considered should support a user-driven approach, rather than a theoretical-driven technological solution. Thus, the conceptualization process was decided to be scaled down from an initiative level (macro level) towards a service level (meso level).

This process was followed by a literature review and assessment in order to identify a long list of criteria to consider in the categorization.

In summary, the processes implemented in this stage have been:

i. *Literature review of categorization approach and assessment*
ii. *Systematic approach for categorization in NEWBITS*
iii. *Literature review and establishment of long list criteria*

The outcomes of this step are twofold: at global methodological level, it is decided to include the service-application level in order to assess the categorization framework proposed; at operative level, a long list of criteria is introduced.

### 2.5.3 Step 3. Data identification (#2: Iteration to capture data at service level)

The objective of this step is to acquire relevant information about the C-ITS and ITS services, derived from the long list of Initiatives identified in Step 1 and focusing on a typology of initiative: Project (as enabler of service generation).

The processes implemented in this step have been:

i. *Desk research: acquiring of basic information about services*

The main outcome of this step is an inventory of ITS and C-ITS services. The tools used by partners to gather the data is been: a MS Word template fiche, and a MS Excel sheet collating all the data at service level (Annex 3 Long List of Services).

### 2.5.4 Step 4. Validating the categorization method (conceptualization #2)

In order to assist the decision-making process, we adopt the analytic hierarchy process (AHP) after a series of brainstorming sessions with the partners. Partners were asked to set up internal groups of experts and hold internal consultation sessions on the possible answers to the AHP. Once the process was finalised, partners were asked to report to the official AHP template/questionnaire with one single answer per institution which represented the consensus of the opinions of the internal experts who participated in the process. The aim is to achieve two objectives in one process; the ranking of relevant criteria, and the priority ranking of the market segment categorisations.

The processes implemented in this step have been:

*i.* *Construct decision hierarchy*
*ii.* *Develop pairwise comparison matrix*
*iii.* *Internal voting process for the collective of subjective judgements*
*iv.* *Synthetize judgements: set of weights*
*v.* *Develop priority ranking and selection of categorisation.*

The main outcome of this step is a validated categorisation and criteria for NEWBITS project.

### 2.5.5 Step 5. Codification of the data

The key activity to be deployed in this step is to review and organize the data. Basically, step 5 will proceed to codify the explicit knowledge (in the form of data) generated by NEWBITS by applying a mapping method.

*i.* *Identification of subcategories for service differentiation*
*ii.* *Tabular one-to-one mapping*
*iii.* *Three-dimensional mapping*
*iv.* *Extended mapping visualization*

The main outcome of this step is a visual mapping of NEWBITS services.

### 2.5.6 Overview of steps, processes and tools

The following table depicts the key steps, processes and tools deployed in this deliverable:

| Step | Process | Tools |
|---|---|---|
| **Step 1. Data identification #1** | *i. Internal discussion amongst partners about the approach to the C-ITS and ITS data* | ▪ Long list of ITS initiatives (MS Excel) |

| | | |
|---|---|---|
| Obj1: Acquire first rough inventory | *ii. Desk research: acquiring basic information about ITS initiatives*<br><br>*iii. Defining interviews and implementing* | ▪ Template for interviews |
| **Step 2. Defining the categorization framework**<br><br>Obj2: Define systematization<br><br>Obj3: Identify criteria | *i. Literature review of categorization approaches and assessment of results*<br><br>*ii. Systematic approach for a categorization framework in NEWBITS*<br><br>*iii. Literature review and establishment of long list criteria* | ▪ Long list of criteria (MS Word) |
| **Step 3. Data identification # 2**<br><br>Obj4: Acquire systematized inventory | *i. Desk research: collection of data at ITS service level* | ▪ Long List of ITS services (MS Excel)<br><br>▪ Template for data gathering (MS Word) |
| **Step 4. Validating the categorization method**<br><br>Obj5: Validate categorization method<br><br>Obj6: Validate relevance criteria | *i. Construct Decision Hierarchy*<br><br>*ii. Develop pairwise comparison matrix*<br><br>*iii. Internal voting process*<br><br>*iv. Synthetized judgements: weights*<br><br>*v. Develop priority ranking and categorization selection* | ▪ Ranked categorization and criteria via AHP<br><br>▪ MS Excel list of Services |
| **Step 5. Codification**<br><br>Obj7: Codify and organize data | *i. Identification of subcategories for service differentiation*<br><br>*ii. Tabular one-to-one mapping*<br><br>*iii. Three-dimensional mapping*<br><br>*iv. Extended visualization* | ▪ Diverse mapping outcomes |

Table 1 Overview of steps, processes and tools

## 2.6 Boundaries of D2.1 approach

The field of ITS applications and services is complex, highly dynamic and interdisciplinary. Though it would have been very interesting to deploy a holistic approach to the domain, it is not the intention of this deliverable to do so but to establish a valid categorization that facilitates the sub-objectives as stated in figure 3 of this section.

This means reversely that some still interesting issues and applications cannot be considered at this stage of the project. In this subsection, we have highlighted two higher level concepts under current development in the ITS domain that besides being extremely relevant, are not directly approached in D2.1 though they are transversally taken into account and will be considered in future work deployed by the NEWBITS project. Those are the "**Multiple Servicizing Concept**" and the "**Connected and Automated Transport**".

**Multiple Servicizing concept**

The transport sector has witnessed a paradigm shift in the recent years, shifting the focus from movement to creation of access (Litman, 2013). The impossibility to exponentially increase the infrastructure capacity (at least in urban areas), and the irruption of new technologies facilitating a more efficient and affordable transport organization, have pushed towards an increased multimodal approach.

The increased deployment of a combination of ITS is enabling a more efficient utilization of resources, including infrastructure and fleets, improved fluidity of traffic and enhanced provision of mobility services. This trend has favoured the inclusion of new actors in the provision of mobility and transport services (telecom operators, online mobility booking agencies, payment engine platforms, technology solution providers and mobility integrators). Transport sector is not isolated from the global changes that are pushing from the supplier value chain to the value network of all stakeholders ("balanced centricity") and services, as a new paradigm towards a Service Economy.

As a matter of fact, recent development in the transport domain are showing an increased focus in the design of service systems for business and societal purposes, generating a new context and culture in which the focus is on mobility demand (not only offer), and in which ITS have a key role in the mobility management. This shift towards customer/user satisfaction needs is commonly referred as "servicizing". Plainly speaking, servicizing refers to a phenomenon in which the organizing and selection action is bought and performed by someone else, and customers receive merely the outcome of the actions (Heikkilä, 2014).

Servicizing concept is aligned with the Service Dominant (S-D) Logic defined by Lusch and Vargo, in which the concept of service is given a new meaning, going from an undefined input to the value of the output and value-in-use or in a more generalized way to value-in-context. Service is the fundamental basis of exchange and goods are merely distribution mechanisms of service. A service provider can only offer a value proposition to the market; the beneficiaries are always co-creators of value. The network aspect is implicit through the statement that all social and economic actors are co-creators and resource integrators, implying that value creation takes place through interaction in complex networks and systems (Vargo and Lusch, 2004).

NEWBITS project is aligned with this logic, considering services at the core of the methodological approach, and setting the ground for a Value Network based analysis.

In what regards to the ITS domain, the servicizing evolution has generated diverse frameworks in which a combination of ITS are deployed to enable higher level concepts or systems, deriving into a **multiple servicizing**. Examples of this are: Mobility as a Service (MaaS), a system in which a comprehensive range of mobility services are provided; Fleet as a Service (FaaS), a system in which fleets of vehicles are provided; Infrastructure as a Service (IaaS), a system in which infrastructure owners sell the right use it. Similar approach can be extracted from concepts like Bus Rapid Transit (DRT) and Buses with a High Level of Service (BHLS).

In order to ensure a valid categorization approach that served the purposes of the NEWBITS project, in this study we have attempted to consider ITS services "per se", and not mobility services that make use of (several) ITS services such as MaaS or BHLS. These higher or multiple service level concepts (as an example, see text below a short description of MaaS) make extensive use of ITS and C-ITS services, and are stimulators of those, providing them a potential business case. We will consider them as enablers for ITS services. Thus, they will be discussed in NEWBITS Deliverable 2.2.

**MaaS: Mobility as a Service**

Mobility-as-a-Service (MaaS), being a new transport paradigm, has many definitions. One of those defines MaaS as "an innovative operating model generating user-centric mobility and freight services based on a seamless, co-operative and sustainable transport system. The system builds upon fully utilizing digitalization and data, as well as strong cooperation with the public sector, business and users" (Huktalla et al, 2015)

MaaS describes the shift from personally owned modes of transport (vehicle, train ticket, taxi fare) towards mobility services that are consumed as a service. New mobility services fit into this framework very well.

Vehicle sharing, pop-up transport and self-driving vehicles are steps that reduce the need to own your own vehicle. Ultimately this would combine public and private transport and allow this to be payed using a single account. This requires cooperation between different transport providers.

The development towards services has happened in other areas, for example Netflix for TV series and Spotify for music. Mobility would start with a travel advice that combines different modes of transport to give an advice based on your preferences. The customer could decide based on costs, time or comfort. The bookings and payment would then be done by the service provider. Payment could be in the form of a monthly subscription or pay-as-you-go.

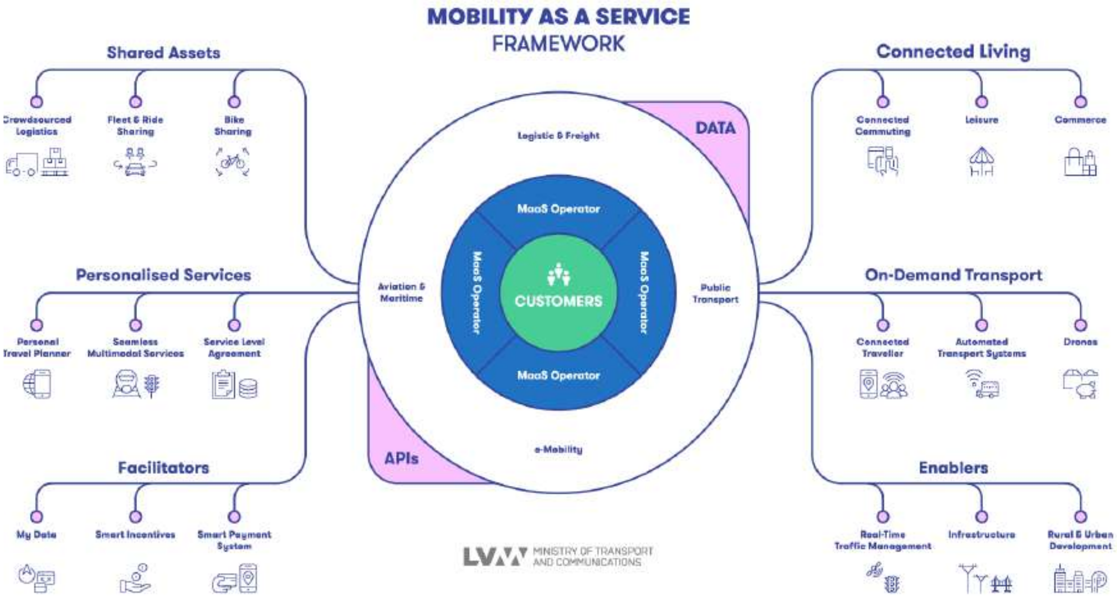


Figure 5 Mobility as a Service Framework

Source: LVM (2016)

**Connected, cooperative and automated transport**

Cooperative ITS are closely related to connected and automated transport, as is illustrated by Figure 6. Connected and cooperative transport are often used interchangeably, although they refer to different concepts (see also Figure 7). Connected vehicles/drivers are connected to the internet by a service provider (via a cloud), either directly or by smartphone integration (Scholliers, 2016). The vehicle/driver is always connected to a single operator, i.e. the OEM cloud or the service provider cloud (in case of smartphone integration) by cellular communication technologies.

Cooperative vehicles/drivers, on the other hand, are directly connected to the infrastructure or to other vehicles (by using direct wireless communication technologies), providing them the opportunity to exchange information directly. These differences between cooperative and connected transport is also reflected by the related ITS services, as is shown in Figure 6.

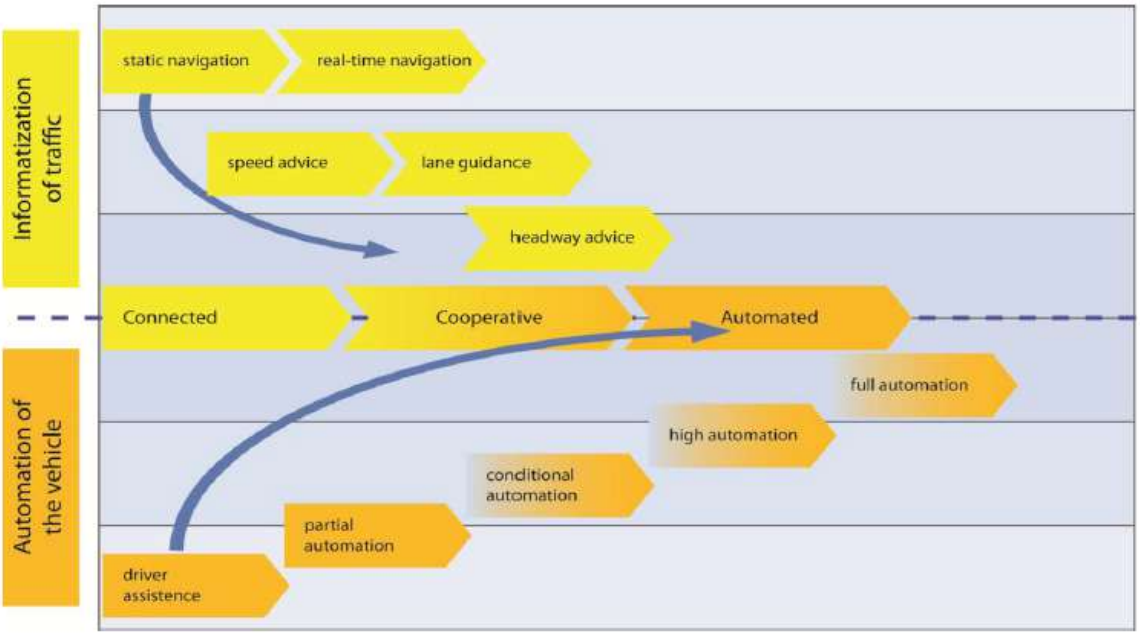


Figure 6 Relation between connected, cooperative and automated services

Source: Amsterdam Group (2016)

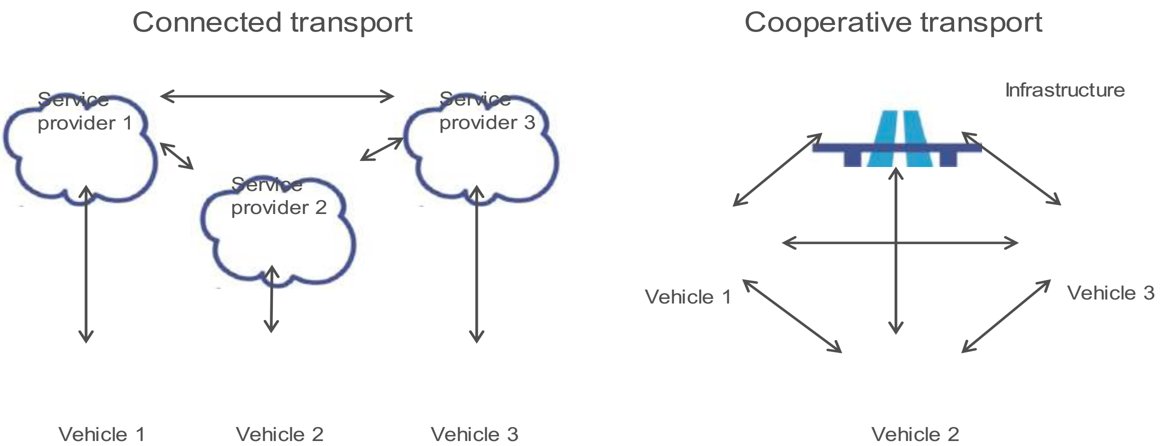


**Figure 7 Difference between connected and cooperative transport**

Source: Based on Scholliers (2016)

Highly cooperative systems may provide the opportunity to automate specific functions of the vehicle, leading to semi-automated vehicles. By making vehicles and infrastructure more and more cooperative, they will become able to drive automatically in the end. Cooperative services may, therefore, be a first step to automated transport.

However, as discussed by Rathenau Instituut (2015), this is just one possible pathway to automated transport. Another pathway, based on highly intelligent autonomous vehicles (robot vehicles), is possible as well (see the textbox below).

**Robotic vehicles**
Increasing levels of cooperative transport may be one pathway to the development of fully automated vehicles. However, there is another pathway to this destination, based on the intelligence of the vehicles themselves (Rathenau Instituut, 2015). By using sensor technology, cameras, GPS, radar and support programmes, vehicles can autonomously 'read' their environment and on that basis, take over the tasks of the driver. As these vehicles do not depend on cooperative communication systems, they are often referred to as autonomous or robotic vehicles. Google car and Tesla's autopilot are examples of this type of vehicles. In contrast to cooperative vehicles, which will gradually evolve towards automated vehicles, robotic vehicles are a more disruptive innovation, aiming to switch to automated vehicles at once.

Connected and Automated Vehicles can be considered as a systemic integration of diverse technology blocks, emerged from diverse Automotive Electronics and Communications communities (Underwood, 2015). Figure 7 summarizes the complexity behind the connected autonomy in terms of the communities involved in the design of the automated and connected vehicle:

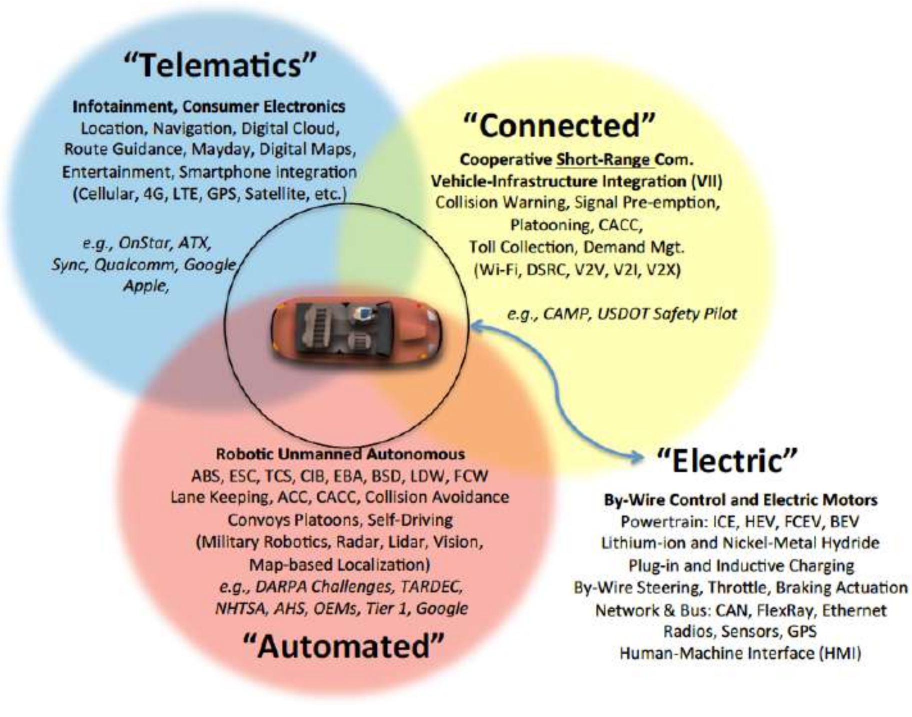


Figure 8 Four Automotive Electronics and Communications technology communities
Source: Underwood (2015)

This study aims at providing an overall framework for ITS, with special focus on Cooperative ITS services. However, it should be noticed that within the range of C-ITS services, some are closely related to connected services while others supply a lot of automated functions. In other words, C-ITS services may differ in the level of cooperation they require between vehicles or between vehicles and infrastructure.

NEWBITS will consider Connected Autonomy as a systemic enabler of C-ITS services: when the vehicles systems are connected with the environment, an additional layer of benefits enhancing network management and relieving congestion can be achieved. Thus, they will be assessed and discussed in NEWBITS Deliverable 2.2.

# 3. Data Identification and definition of the categorization framework

As stated in Chapter 2 of this document, the proposed methodology for Deliverable 2.1 is based on an iterative 3 stage process, which relies on 5 implementation steps. This chapter englobes the 3 first steps of the Deliverable 2.1 method, namely: data identification at initiative level (step 1), definition of the categorization method (step 2), and data identification at service level (step 3).

In essence, this chapter engages with a first approach to the ITS and C-ITS domain and an initial data gathering of a number of highly heterogeneous initiatives (Step 1). Upon the results of this initial search and collection of structured data, and the outcomes of semi-structured interviews to a number of experts, the consortium engaged in step 2 a thorough assessment of the categorization framework in order to establish a valid approach for NEWBITS project holistically. Thus, considering all the inter-relations existing in the diverse activities of the project. The main outcome of Step 2 has been the reinforced assumption, already considered in the very beginning of project launching at Kick off Meeting, of the need to focus the categorization at a market level, and thus, the need to deploy a second data identification this time focused at service level (meso level). Step 3 represents the first key iteration in the methodological process, deploying a data identification and collection at ITS and C-ITS level to allow a categorization which results valid for NEWBITS objectives, ultimate purpose of this deliverable.

The following sections in this chapter will further elaborate on the processes adopted and activities undertaken by NEWBITS partners during the abovementioned 3 steps, and provide with an assessment of the results and outputs generated.

## 3.1 Step 1. Data identification (#1)

The approach used to capture, describe, and subsequently categorize the data depends on the type of knowledge and data. Deliverable 2.1 defined a number of higher level attributes or sources to guide the data identification already at proposal stage. Those are considered as **Initiatives**: *FP7/H2020 projects, scientific papers, research reports, policy and other strategic reports* (reference: NEWBITS GA).

According to the nature of the data sources, considered mostly as explicit knowledge (public and accessible), the consortium defined a process of data identification and collection based essentially in **internal discussion** and **reviewing of reports and literature.** Nevertheless, due to the complexity of ITS domain, NEWBITS partners also designed a sub-process to include tacit knowledge capture at individual level, by defining and carrying out **semi-structured interviews** with experts.

Therefore, the data identification in Step 1 has been implemented following three interconnected processes:

i. *Internal discussion amongst partners about the approach to the C-ITS and ITS data*

ii. *Desk research: acquiring basic information about ITS initiatives*
iii. *Defining interviews and implementing*

The description of the activities and outcomes derived from the three abovementioned processes are explained in the following lines.

### 3.1.1 Internal discussion amongst partners about the approach to the data

In order to facilitate the gathering of data NEWBITS partners have decided on the approach to be taken. The internal discussion on the approach to be followed was focused on two elements: the scope of the research, and the process of gathering data.

Data gathering in this stage is concentrated at **initiative level (macro level)** as described in DoW. No distinction amongst types of modes is made, thus including passenger and freight transport as well as urban and interurban transport. Supportive actions and policies will be discussed in later stages of the NEWBITS project such as the analysis of enablers and barriers in task 2.2 ("Assessment of existing KPIs and barriers for implementation of C-ITS") and during task 3.3 ("Benchmarking ITS innovation diffusion and ITS production processes EU vs. US"), therefore they are not fully considered in this stage rather than at the framework level in which they are defined. FP7/H2020 projects, national projects, scientific papers and research reports, and other types of literature and reports where therefore considered as main sources for the data capturing and description.

The method deployed to capture the existing knowledge is adapted to the nature of the data (initiatives). In this sense, it was agreed that initiatives were clearly explicit knowledge, being the data available and well described, though might require to abstract or summarize the content in order to fit the task purposes. Thus, a **desk research approach** to collect data from existing sources was approved to be the most appropriate method.

In parallel, NEWBITS partners considered the need to include tacit knowledge capture at individual level (knowledge acquisition from individuals) as a valuable expertise transfer from a knowledge source (experts) towards a knowledge repository (long list of initiatives). Following classic theory about the approaches to deploy knowledge acquisition from individuals and groups (Parsaye, 1988), the integration of tacit knowledge was decided to be at an individual level, defining **semi-structured interviews** to a number of selected experts from a long list generated by NEWBITS consortium. Interviews would primarily support the process of data gathering of relevant initiatives and furthermore, gather data relevant for Task 2.2 by including questions on barriers and enablers of ITS. In this way, the added value of interviews would extend beyond Task 2.1.

The outcome of the discussion was an agreement among the partners involved about the initial data gathering of initiatives. All partners would search for references to generate a long list of relevant interviewees and a long list of relevant reports and literature (initiatives).

Moreover, further discussion was held in order to define the most appropriate level of data gathering to be conducted in the next process, as well as the most effective tools. After several rounds of communication, and initial un-structured approximation to the knowledge base object of study, partners agreed on the need to group the defined initiatives into two blocks: Projects and Other (reports-studies), and elaborate simple, yet specific data gathering tools for each, in order to be able to provide with basic information for each of those.

In this sense, two fiches were developed in MS Word in order to facilitate the data identification in the next process, as summarized in the following tables:

| | Initiative: Relevant studies | | | |
|---|---|---|---|---|
| **Basic Information** | Authors | Title | Dates | Link |
| | | | | |
| **Brief summary** | | | | |
| **Type of study** | Grey literature | Scientific study/paper | Policy document | |
| | | | | |

Table 2 Basic data parameters for Initiatives-Other

| | Initiative: H2020 and FP7 projects | | |
|---|---|---|---|
| **Basic Information** | Acronym | Title | Dates |
| | | | |
| **Description** | | | |
| **Contact info** | Person | Organization | Project web |
| | | | |

Table 3 Basic data parameters for Initiatives-Project

In consideration of the main output expected for this step, a long list of initiatives configuring a rough inventory, partners agreed on the use of a MS Excel sheet to collate the future data, considering the basic information parameters as established in the above tables.

### 3.1.2 Desk research: acquiring of basic information of initiatives

The process of desk research was engaged after the validation of the approach was confirmed in the prior process, and aimed at generating a long list of ITS and C-ITS initiatives. Partners devoted their efforts in approaching the knowledge base by means of:

- Consulting internal know-how
- Internet research, including data-base access and information gathering
- Review of literature
- Contact with external ITS experts active at each organisation's network' level

As agreed in the prior phase, the **Other-Initiatives** data stream was intended to include the following types:

- Policy documents: Officially released documents and directives from National and EU or International policy makers
- Academic literature: Academic studies and scientific articles
- Grey literature (IGLWG, 1995): Literature that is not realised via the traditional commercial or academic distribution channels. Included are reports, roadmaps, and white papers from industry representatives, research institutes, and consultants among other institutes.

In what regards to the **Project-Initiatives** data stream, NEWBITS partners focalized the search and data gathering by utilizing databases that focus on FP7 and H2020 projects. In this sense, NEWBITS has made use of both **TIPS** (2013) and Transport Research & Innovation Portal (**TRIP**[1]) databases in order to track and acquire basic information about a number of FP7 and Horizon 2020 with relation to the field of ITS.

A short analysis of the TRIP database, by selecting Intelligent Transport Systems in the search tool, showed that there is a vast amount of FP7 and H2020 projects in the field of ITS, being focused in very diverse areas of ITS. In order not to predetermine any parameter of relevance, the search was focalized in combining both ITS and C-ITS words.

Thus, the information collected for FP7 and H2020 projects, as established in the fiches template (Table 3) includes basic information such as the project acronym and full title to retrace the project. Dates provide information on the duration of the projects. Main contact persons and organization are included to indicate possible interview candidates or primary sources of more information about the initiative. A brief description is provided to back-up further investigation in latter stages of the NEWBITS project.

The desk research resulted in two differentiated streams of initiatives: **76** FP7/H2020 projects and **62** initiatives from other types (policy documents, academic/scientific documents and grey literature). The total initiatives are collated into Annex 1: ***Long list of initiatives***. In the following tables, we provide with an overview and basic assessment of all initiatives collected at this stage, following the two abovementioned streams.

**Grey literature**

The table below illustrates the **grey literature** indicated by NEWBITS partners during the process of data gathering:

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1 TRIP is a single portal for information on all transport research and innovation conducted at European and national levels. Their website is: http://www.transport-research.info/

| Title | Authors | Year |
|---|---|---|
| Automated, Connected and Electric Vehicle Systems. Expert forecast and roadmap for sustainable transportation | Institute for Advanced Vehicle Systems, University of Michigan (USA) | 2015 |
| C-ITS final Report | C-ITS platform | 2016 |
| C-ITS in the USA: A Status Update on 5.9 GHz DSRC | John B. Kenney Toyota Info Technology Centre, USA | 2016 |
| Communication Technologies for future C-ITS service scenarios | ERTICO | 2015 |
| Connected Car in Europe | Pac | 2015 |
| Converging Roads - Linking self-driving cars to public goals | Rathenau Institute | 2015 |
| Guide about technologies for future C-ITS service scenarios | ERTICO | 2015 |
| Status of ITS Communication Standards | EU-US ITS Task Force | 2012 |
| Intelligent Transportation Systems, Explaining international IT application leadership | ITIF | 2010 |
| Intelligent Transportation Systems. Benefits, Costs and Lessons Learnt 2014 Report | US DoT, ITS Joint Programme Office | 2014 |
| ITS Strategic Plan 2013-2018 "Delivering Safer, more efficient, more sustainable mobility solutions | ITS Australia | 2012 |
| Planning for the future of transportation: connected vehicles and ITS | US DoT | 2015 |
| Quality on traffic information | TISA | 2016 |
| Research Theme Analysis Report - Cooperative Intelligent Transport Systems | Transport Research & Innovation Portal (TRIP) | 2016 |
| Roadmap between automotive industry and infrastructure organisations on initial deployment of Cooperative ITS in Europe | Amsterdam Group | 2013 |
| Roadmap for promoting ITS – 20 global actions – 2014/2020 | UNECE (United Nations Economic Commission for Europe) | 2014 |
| Safety Applications of ITS in EU and Japan, International Technology Scanning Program | US DoT, Federal Highway administration | 2006 |
| Smart Transport for Australia, Enhancing liveable cities and communities | ITS Australia | 2016 |
| TISA position concerning a public consultation of the European Commission on the Provision of EU-wide Real-time Traffic Information Services | TISA | 2014 |
| TISA Provision of EU-wide multimodal travel information services | TISA | 2015 |
| Towards an architecture for CITS applications in the Netherlands | BETA | 2015 |
| Trip C-ITS | Trip | 2016 |
| Website report on state-of-the-art strategy for C-ITS deployment | Onno Tool, Rijkswaterstaat; Fred Verweij, Rijkswaterstaat | 2015 |
| Whitepaper on truck platooning | TNO | 2015 |

Table 4 Summary of Initiatives: Grey literature

All the initiatives have been published in a recent time span, and are considered to provide with a valid sample and overview of the state-of-the-art. Cooperative, connected and automated driving are topics that appear and are explained in several studies, especially in the form of roadmaps and future guides. Literature also differs in the type and modes of transport. Certain studies focus at passenger transport while other focus on freight. Simultaneously, certain studies have a special focus on urban solutions following the intersection of Smart Cities and ITS. The topics of the literature in recent year is dominated by connected, cooperative and automated driving.

The selected reports have been elaborated or commissioned by different organisations, including well known research institutes like TNO, BETA and the Rathenau Institute. European-level initiatives and platforms relevant in the ITS field, such as ERTICO, TRIP, Amsterdam group and the C-ITS platform, are another type of authors that has been considered in the data gathering as key source of grey literature. Furthermore, global coverage is provided by initiatives from the US Department of Transportation, the United Nations Economics Commission and ITS Australia.

**Policy documents**

The table below illustrates the policy documents indicated by the NEWBITS consortium.

| Title | Authors | Year |
|---|---|---|
| Cooperative ITS Regulatory Policy Issues Discussion Paper | Marcus Burke and James Williams, NTA Australia | 2012 |
| ITS Action Plan | Algoé Consultants SA, Rapp Trans, Alain Bensoussan Avocats, Liberty Incentives & Congresses | 2012 |
| Guidelines for policy makers: policy challenges on the way to the development of CVIS | F Verweij, N Hoose, S Sondeijker, M Kuiken, J Pommer and W Savenije | 2010 |
| A Master Plan for the deployment of Interoperable Cooperative Intelligent Transport Systems in the EU | European Commission Communication | 2016 |
| Key Performance Indicators (KPIs) for road transport Intelligent Transport Systems (ITS), | AECOM for DG MOVE | 2015 |
| ITS Action Plan Action B - EU-wide real-time traffic information services | Tom van de Ven, Mark Wedlock (RAPPTRANS) for DG MOVE | 2014 |
| All Ways Travelling: To develop and validate a European passenger transport information and booking system across transport modes | Zeppelin University, Amadeus, Thales, UNIFE, IATA | 2014 |
| ITS Action Plan Study regarding Reservation Services for Safe and Secure Parking Places for Trucks and Commercial Vehicles | Hugo Chauvin, Cornelie van Driel, Karl-Gerhard Freyer, Philippe Gaches, Peter Rapp, Ian Wilkinson | 2013 |
| Mid-term evaluation of the implementation of the ITS Action Plan | Ramboll | 2013 |
| ITS Action Plan Action C - Free Road Safety Traffic Information | Tom van de Ven, Mark Wedlock (RAPPTRANS) for DG MOVE | 2013 |
| Cooperative Intelligent Transport Systems and Services | Stefan Klug, Bernd Beckert (Fraunhofer ISI/D) | 2013 |
| USDoT ITS Strategic Plan 2015- 2019 | US DOT | 2014 |
| ITS initiative in Japan | Ministry of land, infrastructures, transport and Tourism | 2014 |
| Cooperative Intelligent Transport Systems and Services (C-ITS) | Smart Cities Stakeholder Platform | 2013 |

Table 5 Summary of Initiatives: Policy documents

In EU, the ITS Action Plan and directive have a predominant role, and have resulted in a variety of documents. Similarly, in the United States the Department of Transportation has issued the ITS Strategic Plan which can be considered the critical framework document for ITS. Due to the timing of the strategic plans most policy documents are published in 2013 and 2014. Authors are policy makers or research institutes and industry experts commissioned by those. The policy papers are either focused in specific areas or tackle ITS broadly.

## Scientific reports

| Title | Authors | Year |
|---|---|---|
| Traffic management 2.0 - The Win-Win | Karl Rehrl et al. | 2016 |
| Traffic management of the future and road automation | Evangelia Portouli et al. | 2016 |
| Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; | European Telecommunications Standards Institute | 2011 |
| A co-operative methodology to estimate car fuel consumption by using smartphone sensors; Ecosmart and TutorDrive: tools for fuel consumption reduction | Vittorio Astarita, Giuseppe Guido, Domenico Mongelli & Vincenzo Pasquale Giofrè | 2015 |
| Coordinating dangerous goods vehicles: C-ITS applications for safe road tunnels | Lei Chen et al. | 2015 |
| Performance study of a Green Light Optimized Speed Advisory (GLOSA) application using an integrated cooperative ITS simulation platform | Konstantinos Katsaros, Ralf Kernchen, Mehrdad Dianati, David Rieck | 2011 |
| The Grand Cooperative Driving Challenge 2016: boosting the introduction of cooperative automated vehicles | Cristofer Englund et. al | 2016 |
| Cooperative ITS — EU standards to accelerate cooperative mobility | Lei Chen and Cristofer Englund | 2014 |
| Impact analysis of the ecoApproach advice application | Robbin Blokpoel, Md. Faqhrul Islam, Jaap Vreeswijk | 2014 |
| SoCar: A Social Car2Car Framework to Refine Routes Information Based on Road Events and GPS | Walter Balzano, Maria Rosaria Del Sorbo, Domenico Del Prete | 2015 |
| Deployment Path Analysis for Cooperative ITS Systems | Steven E. Shladover | 2008 |
| Towards an Architecture for Cooperative-Intelligent Transport System (C-ITS) Applications in the Netherlands | Marcel van Sambeek et. Al | 2015 |
| iTETRIS: A modular simulation platform for the large-scale evaluation of cooperative ITS applications | Michele Rondinone et al. | 2013 |
| C-ITS and Services | Karl Oskar Proskawetz | 2013 |
| Towards a Reference Architecture for a Collaborative Intelligent Transport System Infrastructure | A. Luis Osorio et al | 2014 |
| Cooperative ITS standards in Europe (IEEE Com. Mag) | Andreas Festag TU Dresden | 2014 |
| Deployment Path Analysis for Cooperative ITS Systems | Steven E. Shladover, UC Berkeley | 2009 |
| A Survey of Intelligent Transportation Systems | Sheng-Hai An, University of South Korea | 2011 |

| | | |
|---|---|---|
| Informed consent in Internet of Things: The case study of cooperative intelligent transport systems | EC JRC Ispra | 2016 |
| Evaluation framework in Cooperative Intelligent Transport Systems (C-ITS) for freight transport: the case of the CO-GISTICS speed advice service | Salanova Grau et al. | 2013 |
| Security of Cooperative Intelligent Transport Systems: Standards, Threats Analysis and Cryptographic Countermeasures | Elyes Ben Hamida; Hassan Noura; Wassim Znaidi | 2012 |
| Cooperative intelligent transport systems standards in Europe | Festag, Andreas | 2015 |

Table 6 Summary of Initiatives: Scientific documents

The table above lists the scientific studies indicated by the NEWBITS consortium. Several of these articles are related to FP7 and H2020 projects, such as EcoSmart, EcoApproach, iTETRIS and CO-GISTICS projects. Not surprisingly, the authors of these scientific articles have contributed to these respective FP7/H2020 projects. Authors are aligned with traditional academic institutes.

The collected articles are published recently and can be considered representative of the state-of-the-art. Grey literature and policy documents mostly discussed ITS at a macro level, which is not necessarily the case for scientific documents. Several scientific studies operate on the meso level, discussing applications and case studies. Examples are Green Light Optimal Speed (GLOSA), applications for safe road tunnels and an application that measures fuel consumption.

## FP7/H2020 projects

The initial desk research has looked at Trip database in order to generate a long list of FP7/H2020 projects related to ITS. In order to assess the results in the basic level performed in this section of the deliverable, three type of FP7/H2020 projects can be indicated:

- Overview projects: These projects provide an overview of a variety of services.
- Application projects: These studies have applied applications and analysed those in detail. Especially helpful to support analysis on NEWBITS Meso level.
- Platforms: These projects have set a platform to bring together different stakeholders in the field of ITS

Information for several initiatives-projects was insufficient to perform an analysis on. This was due to diverse causes, such as the website has gone offline or no public deliverables are available. From the 76 initiatives, 11 turned out to have too little or no data available for enabling any future consideration. Those projects, though included in the overall repository, have not been considered in this basic assessment.

### Overview projects

| Name | Short description | Start | End |
|---|---|---|---|
| Amitran | Assessment methodologies for ICT in multi-modal | 2011 | 2014 |

| | | | |
|---|---|---|---|
| | transport from user behavior to C02 reduction | | |
| Cimec | Cooperative ITS for mobility in European cities | 2015 | 2017 |
| Co-cities | Cooperative cities extend and validate mobility services | 2011 | 2013 |
| Comesafety2 | Communications for e-safety | 2011 | 2014 |
| Cover | Coordination of vehicle and road safety initiatives | 2009 | 2013 |
| Ecomove | Cooperative mobility systems and energy services | 2010 | 2014 |
| Efuture | Efficient mobility | 2010 | 2013 |
| Icar support | Intelligent car support | 2009 | 2012 |
| Optimism | Optimizing passenger transport information | 2011 | 2015 |
| Race2050 | Future outlook to mobility | | |
| Scout | Safe and connected automation in road transport | 2016 | 2018 |
| Tips | Transport R&D for innovation | 2012 | Ongoing |
| Ttrans | ITS products and services to market | 2012 | 2014 |
| Ttrim | Tomorrow's road infrastructure monitoring and management | 2011 | 2014 |
| Usemobility | Analysis of European mobility behavior | 2011 | 2015 |

Table 7 Summary of projects: Overview

The projects indicated above touch up on topics like vehicle communication, transport innovation, automated driving and other developments at a macro level. The gathered projects are state-of-the-art that have just finished or are still deployed.

**Application projects**

| Name | Short description | Start | End |
|---|---|---|---|
| 79ghz | 79GHZ communication test | 2012 | 2014 |
| Adaptive | Automated driving demonstration | 2014 | Ongoing |
| Assess | Assessment of Integrated vehicle safety systems | 2009 | 2013 |
| Carnet | Rapid data communication network for connected cars | 2015 | 2017 |
| Cogistics | Cooperative logistics | 2014 | 2016 |
| Colombo | Cooperative self organizing system for low carbon mobility at low penetration rates | 2012 | 2015 |
| Companion | Cooperative mobility solution for supervised platooning | 2013 | 2016 |
| Compass4d | Cooperative driving solutions | 2012 | 2015 |
| Drive c2x | Accelerate cooperative mobility | 2010 | 2014 |
| Ecogem | Cooperative Advanced Driver Assistance System for Green Cars | 2010 | 2013 |
| Eurofot | European Field operational test on active safety systems | 2008 | 2012 |
| Fotsis | European Field operational test on safe, intelligent and sustainable road operation | 2011 | 2015 |
| Hights | Precise location | 2015 | 2018 |
| Inroads | Intelligent Renewable Optical advisory System | 2011 | 2015 |
| Intersafe | Cooperative intersection safety | 2008 | 2011 |
| Local 4 global | System-of-systems that act locally for optimizing globally | 2013 | 2016 |
| Mobility 2.0 | Toolset for urban electro-mobility | 2012 | 2015 |
| Mobincity | Smart Mobility in Smart City | 2014 | 2015 |
| Preserve | Secure v2x communication | 2011 | 2015 |
| Roadart | Research on alternative diversity aspects for trucks | 2015 | 2018 |

| | | | |
|---|---|---|---|
| Satre | Safe road trains for the environment | 2009 | 2012 |
| Straightsol | Strategies for smarter urban freight solutions | 2011 | 2014 |
| Timon | Enhanced real time services | 2015 | 2018 |

Table 8 Summary of Projects: Application

The table above indicates projects that research deployment of specific applications. Tested services include platooning, advanced driver assistance systems, cooperative intersection safety among others. These projects have the possibility to discuss case studies that are relevant for the NEWBITS project. Start and end dates exemplify that the selected studies are among the state-of-the-art.

**Platform Projects**

| Name | Short description | Start | End |
|---|---|---|---|
| Codecs | Cooperative its deployment coordination support | 2015 | 2018 |
| ITS observatory | ITS observatory | 2014 | Ongoing |
| Nearctis | Excellence in co-operative traffic management | 2011 | 2013 |
| Fot-net | Field Operational Test Networking and Data Sharing Support | 2014 | 2016 |
| Vra | Vehicle and Road Automation | 2013 | 2016 |
| Civitas | Cleaner and better transport in cites | 2002 | 2016 |
| Eranet | European research network area | | Ongoing |
| Etna 2020 | European transport network alliance | 2016 | 2019 |
| Euridice | European inter-disciplinary research on intelligent cargo for efficient, safe and environmental-friendly logistics | 2008 | 2012 |
| Centrico | Central European region transport telematics implementation project | 2001 | 2006 |

Table 9 Summary of Projects: Platform

As stated previously, platform based projects bring different stakeholders within the field of ITS together. The above table shows the list of those identified in this step of NEWBITS.

In essence, the process of data gathering at initiative level has shown a large variety of sources. Policy documents, Scientific articles, diverse types of grey literature and many FP7/H2020 projects have been indicated by our initial data gathering in the inventory. The wide spectrum of ITS has resulted in diverse topics for studies.

### 3.1.3 Defining interviews and implementing

In order to complemented the data gathered via desk research, interviews with experts in the field of ITS have been conducted. The goal of these interviews was to include tacit knowledge of experts during the data gathering. Furthermore, the output of the interviews helped to determine the approach of the categorization. NEWBITS partners carried out a desk research that resulted in a long list of interview candidates, which has been used as repository to select a short list of candidates to implement the interviews. This section will elaborate how the interview candidates have been selected, the approach followed and the general results of the interviews.

In order to detect and gather information on possible relevant interviewees, two complementary guiding criteria were agreed:

- Partners should focus on possible experts related to the already identified initiatives (long list of initiatives).
- Relevant interviewees should be representative of the NEWBITS target groups, precisely: ITS developers and providers, Academia and Research, Public Actors (infrastructure managers, transport authorities, operators) and Policy Makers.

Information for possible candidates is collected via a MS Excel sheet (*Long List of Candidates*) which included the name of candidate, organization of the candidate, nationality of the candidate, expertise of the candidate and contact information. The long list included **108** possible interviewees from a variety of organizations from SMEs to large multinational firms and from local to European level including: national ITS organizations and associations, Service providers, Universities and Research Centers, Transport and ICT specialized consultancies, Transport Authorities and Policy makers. The experts were representative Experts from the US and Australia have been also considered to provide coverage in the two relevant regions of NEWBITS besides the European Union.

In order to generate a short list which resulted representative, 3 criteria have been determined by the NEWBITS consortium:

- Single-Organization representation. Several candidates on the long list were affiliated to the same organization. Based on an internet search and LinkedIn® scan, it was investigated which candidate had more “visible” expertise in the field of ITS. This process resulted in One primary candidate per organization was established in the short list, while others would function as in reserve-list mode.
- Variety of regions. Special attention was paid in order to include experts from different regional areas inside and outside Europe.
- Variety of organizations, covering as much as possible the range of NEWBITS target groups as indicated for the long list, while ensuring a balance amongst those.
- Involvement in projects. Based on an internet search and LinkedIn® scan, it has been assessed whether the listed candidate has participated in projects and events.

The resulting short list included **17 experts** in the field of ITS which were considered to fulfill the above-mentioned criteria.

Having the repository of experts streamlined, partners proceeded to design the template for the interviews. The expected inputs from the interviews where two-fold. Primarily the goal was to complement and support the data gathering process of initiatives. However, there was also a qualitative element considered extract the knowledge of the experts towards ensuring cohesion on the data gathered. Due to the diverse expertise of the candidates the interview format is used as a general guideline rather than a strict questionnaire. Interviewers had the freedom to go beyond format to make the best use of the knowledge of the interviewed experts. The format of the interview is shown in the Appendix 2: ***Interview Format*** *of* this document. In essence, experts have been asked in 4 blocks of questions covering:

- General Information about the role of their organization in the ITS domain
- Vision for C-ITS applications (main applications, future trends, primary benefit of ITS)
- KPIs, barriers and enablers
- Open questions

NEWBITS partners have finally interviewed in total **12 experts**, which are listed in the table below.

| Interviewee | Country | Organisation |
|---|---|---|
| Alessandro Lue | Italy | Poliedra |
| Andre Perpey | France | Geoloc Systems |
| Avery Ash | United States | INRIX |
| Claus Doll | Germany | Fraunhofer |
| Eric Koenders | Netherlands | Dynniq |
| Evangelos Mitsakis | Greece | Hellenic Institute of Transport |
| Fabio Nussio | Italy | Rome Mobility Agency |
| Jose Martinez | Spain | CTAG |
| Kerry Malone | Netherlands | TNO |
| Lluís Alegre | Spain | Metropolitan Transport Authority |
| Martin Bohm | Austria | Austriatech |
| Mohamad Talas | United States | NY Department of Transportation |
| Vladislav Maraš | Serbia | University of Belgrade |

Table 10 List of Interviewees

The interviewed experts work for a variety of organizations including universities, public authorities, research institutes and service providers. Two interviews with candidates from the United States have been conducted to ensure NEWBITS supra-regional coverage.

During the interviews a large variety of initiatives have been mentioned. Some of these initiatives resulted as input for process ii. Simultaneously, most the initiatives discussed by the experts operated on the service level, resulting in meaningful discussions with the experts. For example, the added value of ITS applications was discussed by providing examples like road works warning systems and advanced traffic signal control. One of the key takeaways from the interviews is that projects are directly linked with the services that they offer. Furthermore, services determine the benefits of Intelligent Transport Systems as well as the image for end users.
Due to the interest of NEWBITS in focalizing the interviews within a C-ITS framework (whenever possible), the developments in automated, connected and cooperative driving have been introduced. The interviews helped NEWBITS consortium to further understand the

relation between these areas. One of the key findings was that developments in these three areas not necessarily complement each other. Different future paths of development are possible, depending on (international) cooperation between all stakeholders.

## 3.2 Step 2. Defining the categorization method (conceptualization #1)

After concluding step 1 with a rough inventory of data at initiative level, a first attempt to provide a valid framework for the data modelling and categorization was implemented in step 2.

The results from step 1 at initiative (macro) level showed a high conceptual and contextual disparity, based on the own heterogeneous and unparalleled character of the elements involved in the data identification: *FP7/H2020 projects, scientific papers, research reports, policy and other strategic reports.*

This highly heterogeneous level of analysis based on the macro level was already highlighted at the start of project implementation, with most partners showing their concern about the feasibility to perform a valid categorization exercise at the initiative framework. In order to formalize a valid approach for knowledge conceptualization, consortium partners engaged in step 2 a process to assess the categorization framework and context more appropriate for NEWBITS overall objectives, and WP2 and Task 2.1 specific objectives.

This initial conceptualization stage has been implemented by deploying the following processes:

i. *Literature review of categorization approach and assessment*
ii. *Systematic approach for categorization in NEWBITS*
iii. *Literature review and establishment of long list criteria*

The description of the activities and outcomes derived from the three abovementioned processes are explained in the following lines.

### 3.2.1 Literature review of categorization approach and assessment

The key assumption guiding this step has been the need to assess the nature of the diverse possible categorization and systematization methods and frameworks, and the ways in which those are applied, in order to determine what methodological approach is more useful for NEWBITS purposes.

To come up with a well-defined categorisation of ITS fitting the objectives of Task 2.1 (and the interlinks existing with the diverse tasks throughout the project), it was first important to identify the relevant concepts in NEWBITS context.

From the DoW, the relevant requirements are focused on market analysis, stakeholder analysis, users and their preferences (need and demand), and the value network analysis. Thus, the first conclusion reached by partners was that the level of categorisation for NEWBITS should be at a level that would allow "making categories" based on those project requirements.

NEWBITS consortium followed the premise of considering classification and categorization systems in a broad sense, as having an important role in business decision-making tasks by classifying the available information on some criteria (Kiang, 2003).

The vast literature existing on categorization methods, concept and approach, and the highly interdisciplinary character of categorization approaches applied from Cognitive Science to Machine Learning, advised NEWBITS to concentrate the literature search in categorization models at ITS level. Thus, the second conclusion was to concentrate the efforts in the different ways proposed in the literature to categorize ITS.

From the scientific literature reviewed, some systematizations are based on single dimensional categorisation based on technological perspective (Figueredo et al, 2001; Perallos et al, 2015), market areas (McQueen et al, 1999) or a multidimensional approach based on application areas (Kanminen, 1995; Samper et al, 2006; RITA, 2009; Toral et al, 2010).

**Technology based categorisation**

Technology based categorisations tend to split ITS into different technology functions or technological architectures such as communication, navigation, hardware, in-vehicle etc. Those are composed by a combination of technologies. As stated in T-TRANS project *Deliverable 3.1 ITS State of the art assessment* (available online at: http://www.ttransnetwork.eu/ttrans/its-state-of-the-art-assessment/), "at technological point of view, there are similar approaches that classify technologies by their functions". The following figure summarizes this statement:

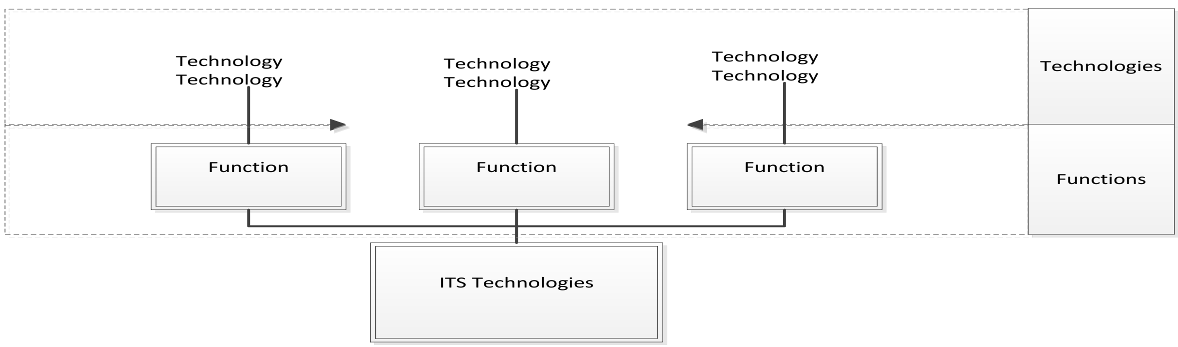



Figure 9: ITS technologies and technology functions. Source: T-TRANS project

Technology based systematizations approach ITS as multisystem structures that combine tasks of management, information collection and actuation systems, and which have to be synchronized to meet the objectives of the whole system. The focus of this approach tends to rely on the architecture of the system as key operative framework containing the set of common assumptions for the system itself (Perallos et al, 2015). At the broader level, ITS architectures integrate 3 main elements:

- The functions that are required for the systems (ITS)
- The system partitioning into functional entities (Subsystems or modules)
- The information and data flows that connect the functions and subsystems together

In this sense, there are several architectures of reference in EU and US that share the aim to help ITS providers and designers to define and plan effective operational systems that contribute to improve the mobility experience. Thus, they are often referenced in technology based systematizations.

At EU level, the key reference is the European ITS Framework Architecture (FRAME), developed under the EU funded project KAREN (Keystone Architecture Required for European Networks). At US level, the reference is the National ITS Architecture.

As a matter of fact, technology based categorizations based or derived from the broader system architectures, are quite helpful from the designer perspective and no doubt, a great enabler for an ITS initiative. However, they provide no real focus on the requirements of ITS users such as the needs, at least directly, since their goal is to frame the technological components in a given system, and/or map their interdependencies.

**Multidimensional approach based on ITS areas and application areas**

A multiplicity of strategic documents and scientific papers propose a diversity of approaches to ITS based-on areas and/or application areas, which tend to be then subdivided in sub-areas. Some of these studies are limited either in scope or focused in specific ITS subsystems. For instance, Kanninen provided back in 1995 a ITS structure based on three basic subsections:

- Advanced Traveller Information Systems (ATIS)
- Automated Highway Systems (AHS)
- Intelligent Transit Systems (ITS)

Samper et. al. (2006) for example give an insight into Traveller Information Systems, without considering the interconnections amongst other areas, sectors and subareas of ITS.

T-TRANS (2013) project performed an analysis of the main ITS areas and subareas following a number of references which identified 5 main areas:

- Information Services
- Security, Safety and Control
- Freight and logistics
- Booking, Payment and Pricing
- Traffic Management

The figure extracted summarizes the areas and subareas in relation to the sources found in diverse systematization studies:

| ITS AREAS | Sources | Kanninen (1995) | Diebold (1995) | Wootton and García-Ortiz (1995) | Weiland (1999) | Institute of transportation engineers (2000) | NVF Road Transport Informatics (2002) | Samper et al. (2006) | ITS Japan (2007) | RITA US DOT (2009) | EC Transport (2012) | Aparicio (2012) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ITS area** | **ITS subarea** | | | | | | | | | | | |
| Information Services | | x | x | x | x | x | x | x | x | x | x | x |
| | Public Transport Information | x | | x | x | x | x | | | x | | x |
| | Individual Traveller Information | x | x | x | x | x | x | x | x | x | x | x |
| | | | | | | | | | | | | |
| Security, Safety and Control | | x | x | x | x | x | x | | x | x | x | x |
| | Drivers Assistance | x | | | | x | x | | x | x | | |
| | Emergency Management | | | x | | x | | | | x | | |
| | Collision Management | x | | x | | | | | x | x | | |
| | Safety & Security | | | | x | | | | x | x | x | x |
| | Control | x | x | x | x | x | x | | x | x | | |
| | Smart Grid | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Freight and Logistics | | | | x | | x | x | | | x | x | x |
| | Transshipment | | | | | | | | | x | | |
| | Storage | | | | | | | | | x | | |
| | Transport | | | x | | x | | | | x | | x |
| | | | | | | | | | | | | |
| Booking, Payment and Pricing | | | | x | | x | x | | x | x | x | x |
| | Electronic Payment | | | x | | x | x | | x | x | x | x |
| | Pricing | | | | | | | | | x | x | |
| | Booking | | | | | | x | | | | | |
| | | | | | | | | | | | | |
| Traffic Management | | x | x | x | x | x | x | | x | x | x | x |
| | Fleet Management | | | x | | x | x | | | x | | |
| | Operations & Maintenance | | | x | | | | | | x | | |
| | Demand Management | | | x | | x | | | | x | | |

Figure 10: Overview of ITS (sub) areas in the literature. Source: T-TRANS project

The ITS area oriented categorizations, despite providing a framework that tends to be aligned with ITS applications, offers a limited view on ITS and disregards many other possible application sectors being often relevant for the specificities of the studies in which they are deployed, but not considering a truly holistic approach to ITS. Still, the consideration of ITS areas tends to be relevant in order to define the ever-changing ITS domain.

### Market areas based categorisation

Following the roots of the above mentioned ITS area systematization, the market areas approach focuses on identifying ITS users and group them according to their needs and demands. ITS market areas have been defined as the groupings of ITS users, operators and procurers with similar needs and buying characteristics (McQueen, 1999).

There are several examples in the literature providing with a diversity of market segments or areas. Generally, these studies have great potential; however, they are based on theoretical research and limited data captured from a few sources.

Toral et al (2010) identify nine market areas:

- Traffic management
- Emergency management
- Transportation planning
- Traveller information
- Commercial vehicles
- Transit management
- Intelligent vehicles
- Incident management
- Payment systems

From the industry research point of view, a wide variety of data sources are usually considered ranging from independent studies, government and regulatory published materials, technical journals, to trade magazines.

Two of such recent studies (ITS Market Analysis, 2016; ITS Market Insight, 2016) segment ITS market by component, type, and application. The first component segment relates to market characterised by technology, comprising surveillance camera, interface board, monitoring & detecting system, telecommunication network, software and others.

The second classification by type segments the market into:

- Advanced Traveller Information System (ATIS)
- Advanced Traffic Management System (ATMS)
- Advanced transportation pricing system (ATPS)
- Advanced public transportation system (APTS)
- Cooperative vehicle system (CVS).

The third segment by application is divided into eight categories namely.

- Traffic management
- Road safety and security
- Freight management
- Public transport
- Environment protection
- Automotive telematics
- Parking management
- Road user charging

These results emanated from exhaustive research employing well-founded statistical and mathematical analysis tools like weighted average analysis, correlation, regression and time-series analysis, which have been verified by key industry participants.

Other business research reports (Markets and Markets 2014) have also expanded the market categorisation to the geographical level namely North America, Europe, APAC, and Rest of the World. Since the geographical coverage of NEWBITS has a limited scope out of Europe, covering only some initiatives from the US and Australia, the latter categorisation has little impact towards achieving NEWBITS objectives.

### 3.2.2 Systematic approach for categorisation in NEWBITS

In view of the results generated by the literature review on categorisation for ITS, NEWBITS partners internally discussed about how to approach the categorization method to be adopted to fulfil NEWBITS objectives.

For the particular case of the systematic categorisation of the rather extensive and heterogeneous list of initiatives, it was decided that it was not possible to define a valid categorisation method. Thus, the first conclusion derived from the data gathering process (step 1) and the initial process of step 2 has been the need to iterate a second data identification step towards a more suited component of ITS. Keeping the reference in the macro level, NEWBITS consortium determined to focus the data gathering process at the specific type of initiative: Projects.

This decision was determined also by the following two key elements:

1. Projects provide with a more homogeny base to apply a categorisation method.
2. Projects embed outcomes in the form of services, being a catalyser between the macro and meso levels as defined in NEWBITS.

Moreover, based on the existing information in the initial inventory, and the outcomes of this step, NEWBITS considered that amongst all three possible categorization frameworks tracked, the market oriented definition, fit the adopted **business ecosystem** conceptualization for ITS and C-ITS which determines the operational level of NEWBITS as: the *structure and behaviour of a number of organizations sharing a key platform and the set of relationships (symbiosis) between those actors* (Moore, 1993).

For NEWBITS purposes, it was decided to consider a categorisation that could support a user-driven approach rather than a theoretical-driven technological or generic solution. Yet, considering the variety of methods available to categorise ITS from a market perspective (component, type, application), it becomes rather difficult at this stage to select an appropriate segmentation that would fulfil NEWBITS project's objectives.

The resulting conclusions from this step being:

1. The categorisation could not be deployed at initiative level due the high disparity of the elements. The next steps required to focus on one typology of initiatives: **projects**
2. The framework to develop a categorisation for NEWBITS required a **Market driven approach** in order to be aligned with WP2 and overall project objectives.
3. The market oriented framework and the need to build a well-organised and comprehensive inventory required to **iterate** the data identification moving from the initial initiative level (macro) towards a **service-application level** (meso).

### 3.2.3 Literature review and establishment of long list criteria

Following the conclusions of the prior process, NEWBITS consortium engaged in a process to support the future data gathering at a service-application level by identifying criteria that would guide the second phase of data gathering on a service-application level in Step 3.

The long list of criteria is constructed using a review of the literature indicated in Step 1. Criteria used by state-of-the-art initiatives in similar mapping exercises are analysed by the NEWBITS consortium. In addition to the criteria indicated by the literature review, multiple criteria of relevance are added by the NEWBITS consortium. These criteria are proposed by individual NEWBITS partners for their relevance to the project objectives and relation with upcoming Work Packages.

Many recent studies that perform a mapping exercise focus on ITS and in the specific area of C-ITS. C-ITS Platform (2016), Ricardo (2016) and Trip (2016) are three important studies in the field of (C-)ITS that have performed a mapping exercise. The following sources have been used to detect criteria for NEWBITS:

- The C-ITS platform (2016) aims to boost development of C-ITS deployment and have grouped services into 'Day 1 services' and 'Day 1.5 services' based on societal benefits and maturity of technology. These two groups have been further bundled based on the type of C-ITS communication (V2V, V2I, V2X) and primary purpose of the service. A latter stage distinguished between urban and non-urban services. The goal of these three-dimensional bundling was to generate different levels of deployment for bundles of services. Some bundles would be close to market deployment, whereas others are not, which is closely related to the objectives of the C-ITS platform.

- TRIP (2016) operates on a project level and distinguishes between modes and types of transport to map FP7 and H2020 projects.

- Ricardo (2016) describes a variety of C-ITS bundles. Based on technological maturity, type of communication/technology, application areas, type of transport and type of ITS service. Furthermore, the benefits of services for the grouping of bundles.

- The ITS Roadmap (2007) mapped applications per the primary benefit they offer, distinguishing efficiency, safety, environmental and economic benefits, while considering also the type and mode of transport.

- AECOM (2015) has performed a multi-level mapping exercise based on the categories defined by the 2DECIDE project. Criteria include geographical coverage, area of transport, primary problem ITS service tackles, primary objective, and several types of ITS measures.

The criteria used by the different literature sources have been documented and cross-matched to provide a long list of criteria used to categorise ITS services. Moreover, the NEWBITS partners have added **three criteria** to the long list configured, which are included because of the envisaged relevance to the NEWBITS objectives:

- Information on the institutional framework of the service,
- the stakeholders involved, and
- the possibility to scale and transfer the service have been included

Table 11 provides with an overview of the criteria identified and used by different literature to map ITS services, as well as certain parameters used to quantify the criteria.

| Criteria | Parameters | Sources |
|---|---|---|
| Technology maturity | Innovation phase | Ricardo (2016), Amsterdam Group (2013), C-ITS Platform (2016) |
| ITS enabling technology | | Ricardo (2016), TRIP (2016), Spaanderman and Broeders (2016), T-TRANS (2013), ERTICO (2015) AECOM (2015) |
| Targeted geographic deployment area | Urban, interurban, all | Ricardo (2016), TRIP (2016), Adaptive (2015) ITS Roadmap Outline (2007) C-ITS Platform (2016) 2DECIDE (2011) |
| Transport mode | Scheduled, Unscheduled | TRIP (2016), ITS Roadmap Outline (2007), 2DECIDE (2011) |
| Type of transport | Freight, passenger | Ricardo (2016), ITS Roadmap Outline (2007), 2DECIDE (2011) |
| Primary benefits | Safety, Efficiency, Comfort, Environmental benefits | TRIP (2016), Ricardo (2016), Spaanderman and Broeders (2016) Harding et al. (2014) ITS Roadmap Outline (2007), 2DECIDE (2011) |
| Institutional framework | Private, public, PPP | Added because of potential relevance for NEWBITS assessments |
| Stakeholders | Users, vehicle suppliers / OEMs, infrastructure authorities, governments, ITS companies, service providers, universities/research institutes, others | Added because of potential relevance for NEWBITS assessments |

| Criteria | Parameters | Sources |
|---|---|---|
| Transferability | | Added because of potential relevance for NEWBITS assessments |

Table 11 Long list of criteria for ITS services

A brief description on each criterion configuring the long list is provided in the following lines:

- **Innovation level**
The innovation level refers to the extent by which the service or application is still in the development phase or ready for market introduction. It is applied by several studies to categorise (C-) ITS services (Amsterdam Group, 2013; C-ITS Platform, 2016; Ricardo, 2016). Often a distinction is made between Day 1 and Day 1.5 services (e.g. by Ricardo, 2016; C-ITS Platform). Day 1 services are expected to be available on the market in the short term, while Day 1.5 services are technology wise mature, but all required specifications or standards are not completely ready yet.

- **Type of technologies**
Technologies, and Communication Technologies are often applied by recent studies (Ricardo, 2016; Spaanderman and Broeders, 2016; TRIP, 2016) to categorise C-ITS services. A common distinction is between Vehicle to Vehicle (V2V) and Vehicle to infrastructure (V2I). Beyond communication technologies other categories are needed for ITS services, like hardware (ITS stations) and sensing devices (e.g. cameras, sensors). ITS enabling technologies have been used by several studies (TTRANS, 2013; AECOM, 2015).

- **Geographic deployment area**
The geographic deployment area refers to the type of areas where the C-ITS service is mainly applied (in urban areas, on motorways, etc.). This criterion is used by several studies to categorise (C-)ITS services (Adaptive, 2015; ITS Roadmap Outline, 2007; Ricardo, 2016; TRIP, 2016). Often a distinction is made between urban applications in city environments and interurban applications.

- **Transport mode**
ITS and C-ITS services may also be categorised based on the transport mode (e.g. road, rail, aviation, inland shipping), as was done by TRIP (2016) and ITS Roadmap Outline (2007). ITS services significantly differ between different transport modes as different levels of coordination between vehicles are required.

- **Type of transport**
The type of transport can be used as criteria for the categorisation of (C-)ITS services, as has be done by Ricardo (2016) and ITS Roadmap Outline (2007). Parameters used by the literature include freight and passenger transport. Where further breakdowns to public, road are possible. A breakdown to transport motive (e.g. commuting, business, leisure) is less relevant, as the ITS services targeted on passenger transport can be applied for all transport motives.

- **Primary benefit**
  ITS services may contribute to more safety, efficiency, comfort or environmental benefits. These benefits of (C-)ITS services are often used as criterion for the categorisation of (C-)ITS services (e.g. by TRIP, 2016; Ricardo, 2016; Spaanderman and Broeders, 2016; Harding et al., 2014; ITS Roadmap Outline, 2007).

- **Institutional framework**
  Although not used by other studies for categorising ITS services, NEWBITS has considered to add the institutional framework to the longlist of criteria as it may be a relevant criterion with respect to the NEWBITS objectives. It could provide information on the financing of the identified service. This could indicate if the service has reached market maturity or whether different it is still in development

- **Stakeholders**
  As institutional framework, (type of) stakeholders is not used by other studies as criteria to categorise C-ITS services. However, the key assessments that will be carried out in NEWBITS pivot on a network based approach which requires a thorough identification of stakeholders and the consideration of the value fluxes existing in the network in which those interoperate (e.g. stakeholder analysis, Value Network Analysis, Communities of Interest).

- **Transferability**
  Transferability is added because this of relevance to the NEWBITS project. In later stages information on case studies will be aggregated to a higher level. Transferable and scalability of services is an important prerequisite to aggregate results.

## 3.3 Step 3. Data identification (#2: Iteration to capture data at service level)

In Step 3 the necessary data will be collected at a service level. The documentation of the services has been done in line with the criteria identified, and considering the conclusions of the categorization assessment.

Based on the criteria and parameters identified by the NEWBITS partners, a fiche has been constructed to facilitate the data gathering at a service level. Step 1 has indicated relevant FP7 and H2020 deployment projects. In this step, those have been analysed into greater detail in order to document ITS services. This desk research process has been complemented by a further investigation from the NEWBITS partners involved to find operational applications and services in national projects.

In this sense, fiches are constructed based on the deployment projects. Multiple services can be deployed via a single project, in this case multiple fiches are provided. Data gathering via the fiches was performed by the NEWBITS partners involved, with CED being responsible for the gathering of the different services, which have been analysed and documented in a long list in Microsoft Excel format that forms the basis for the categorisation in Step 4 and 5.

Taking into consideration Step 3 as an iteration in the data gathering activity, essentially linked to the prior steps conclusions, this step has been basically implemented in one core process:

i. Desk Research: identification of services and collection of data

### 3.3.1 Desk research: Identification of services and collection of data.

At this stage, NEWBITS partners have followed a very similar desk research approach to the one performed in Step 1, but without involving further interviews.

The goal of the data gathering in step 3 is to collect state-of-the-art ITS services deployed or piloted in projects in Europe and outside Europe. A first preparatory activity was to engage the identification of services in the projects already described in the Long list of Initiatives, and complemented by other possible relevant projects at national level. Thus, two main sort of initiatives were considered in the initial approach as embedding or deploying services:

- Projects and applications at a national level
- FP7 and H2020 projects

NEWBITS consortium has investigated initiatives at a national level to identify relevant services. Research on a national level is done in the country of origin of the NEWBITS partners. The following countries are covered by the research on a national level: Austria, Belgium, Germany, France, Ireland, Italy, the Netherlands, Spain, and the UK. Furthermore, projects in Australia and the United States are researched to provide a comparison as was stated in NEWBITS DoW.

The result was an initial, not structured list of services linked to the projects.

In order to avoid the generation of an extensive list of services without any added value for the categorization framework and the criteria identified in step 2, the next point of step 3 has been the definition of an appropriate **scope** and **tool** for data gathering considering the nature of the targeted data and the conclusions of previous steps. In this sense, a MS Word doc was defined and distributed amongst partners labelled as “Fiche Template”.

Thus, NEWBITS consortium was involved in designing a fiche which contained two blocks of information to be filled by the partners in the process of data gathering for each identified service:

- General information
- Criteria parameters

Both information blocks are further explained in the following lines:

1. **General Information:** To structure the data, general information has been collected for the identified services.

The following table summarizes the level of description required for the general information block.

| Input | Explanation |
|---|---|
| Name | Name of the project |
| Status | Ongoing, Planned, Finished and duration of the service |
| Country or region of deployment | Country, Region of piloted service or area of application |
| Brief description | A brief description of the project and the service or organisation that offers the service is provided. |

Table 12 General information in Service Fiche Template

The general information for each service is used to provide a better understanding of the collected services, though is not considered at this step relevant for the mapping exercise in step 5. In this sense, for each identified service the status of the service has been collected. Active services without an end date have been labelled ongoing. Services deployed during a pilot project have been labelled: planned, active or finished in combination with the duration of the pilot. This provided information on the status the specific service was based on

The country in which the services is applied or piloted has been documented. In case the service has been deployed in multiple countries, for example in FP7/H2020 projects, the region has been documented, which would be Europe in this case. Services which are applied globally are documented as global. Furthermore, the status and regional information provide relevant information on whether the collected services represent state-of-the-art services offered globally.

A brief description of the service, including the type of ITS following a market oriented framework, is provided which explains the main information of the service and the project in which it has been deployed.

2. **Criteria parameters:** following the long list of criteria indicated in Step 2, NEWBITS partners has determined those to be embedded into the data gathering process at service level. These parameters are the key input for these fiches constructed to collect relevant ITS services.

The following table summarizes the level of description required for the criteria block.

| Criteria | Parameters |
|---|---|
| Technology maturity | Innovation phase (TRL) |

| Criteria | Parameters |
|---|---|
| ITS key-enabling technology | Communication technologies, Hardware infrastructure, Software infrastructure, Algorithms, Positioning technologies, Sensors (monitoring and detection), Identification technologies |
| Targeted geographic deployment area | Urban, Interurban, All |
| Transport mode | Scheduled, Unscheduled, Both |
| Type of transport | Freight truck, Passenger car, Road vehicles, Rail, Air |
| Primary benefits | Safety, Efficiency, Comfort, Environmental benefits |
| Institutional framework | Private, Public, PPP |
| Stakeholders | Users, vehicle suppliers / OEMs, infrastructure authorities, governments, ITS companies, service providers, universities/research institutes, others |
| Transferability | Yes, No |

Table 13. Summary of criteria information in Service Fiche template

### a) Technology maturity

The first criteria to be developed in the data gathering was the innovation level of the service, or the technological maturity of the service. After an internal discussion, the NEWBITS consortium decided to measure innovation level by the Technology Readiness Level (TRL) of services. This is an often-used indicator to reflect the innovation. TRLs have originally been introduced by NASA in 1974 and have since been evolved into the current 9 levels of technology maturity. We follow the definition as proposed by the European Union in Work Programme 2014-2015 for Horizon 2020 (European Commission, 2014) as shown in

Table **14**.

| | **Definition of Technology Readiness Levels** |
|---|---|
| TRL 1 | Basic principles observed |
| TRL 2 | Technology concept formulated |
| TRL 3 | Experimental proof of concept |
| TRL 4 | Technology validated in lab |
| TRL 5 | Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies) |
| TRL 6 | Technology demonstrated in relevant environment (industrially relevant environment in the case |

| | Definition of Technology Readiness Levels |
|---|---|
| | of key enabling technologies) |
| TRL 7 | System prototype demonstration in operational environment |
| TRL 8 | System complete and qualified |
| TRL 9 | Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space) |

Table 14 Definition of Technology Readiness Levels

In this study, a pre-condition of the data gathering was to focus in ITS services that are close to implementation or are implemented in the market already. As the NEWBITS project aims to provide a better understanding of the deployment process of ITS services, a certain maturity of the innovative ITS service is required. Therefore, services identified will be considered if they are currently piloted or applied (TRL 7 or higher). However, several services with a TRL of 5 or 6 have been included as well as the boundaries between the different innovation levels are not always clearly defined.

**b) Key enabling technologies**

NEWBITS partners have reported the key enabling technologies supporting the different services. Key enabling technologies are introduced in the following lines, being the key reference the 8 technology blocks proposed by TTRANS project (2013): Communication technologies; Hardware Infrastructure; Software Infrastructure; Algorithms; Positioning technologies; Sensors (monitoring and detection); Identification technologies.

The following lines provide with a brief description of the major technologies considered in each of the technology blocks:

- **Communication technologies**
    - Cellular network: Cellular communication technologies have developed during the last decade and multiple techniques are possible. The earlier second generation (2G/GSM/GPRS/EDGE) is occasionally used for ITS applications. Most applications use the third generation (3G/UTMS/HSPA) or the fourth generation (4G/LTE) network. Currently the 5$^{th}$ generation (5G) of mobile network is under development. This 5$^{th}$ generation could facilitate direct communication between vehicles. The 5$^{th}$ generation mobile network is expected to become available gradually available from 2020 onwards. Vehicle-to-vehicle communication using 5G will therefore be something to be seen in the future. The currently available technologies are best suited for longer range communication and are for example used to provide real time navigation.
    - *Urban Wi-Fi and landline internet*: wired and wireless internet are very important for the functioning of C-ITS services. C-ITS services use a lot of data, especially when all sources come together at traffic management centres and other platforms. Due to the large amount of data landlines are used. Wireless networks are slower and less stable as landlines. However, they are mobile, and therefore are suitable when no wired network is possible.

    - *Other technologies.* Bluetooth, GSM-R and Zigbee are three technologies that facilitate communication for ITS. Bluetooth is commonly used for short range communication, GSM-R is the of the art communication standard for railways. Zigbee is an ad-hoc wireless network which is a de-facto standard for industrial wireless sensors.

- **Hardware infrastructure**
    - *Integrated Stations:* inside vehicles hardware is installed that allows the vehicle to set up communication using Wi-Fi-p. Vehicle manufacturers are technology wise ready to equip vehicles with Wi-Fi-p. Currently the customer demand is not large and therefore only a very limited number of vehicles has an integrated Wi-Fi-p module installed. It will take at least several years until Wi-Fi-P hardware is common in new cars.
    - *Mobile telephones:* another option for C-ITS applications is to rely on the cellular network. Information is sent towards the smartphone of the driver where the message will be displayed. Several services use this method and it is effective specifically for providing real time information.
    - *Stand-alone unit/ tablet / PDA*: almost no vehicle has hardware installed to support Wi-Fi-p yet. In pilot's vehicles are therefore equipped with stand-alone Wi-Fi-p units that allow communication using vehicular Wi-Fi. These stand-alone units behave similarly as a stand-alone navigation system. Stand-alone unit could be used for aftermarket installation of a Wi-Fi-p module inside a car.
    - *Sensors inside vehicle:* board computers inside vehicles are becoming more advanced and are able to collect more data on the driving behaviour. For example, driving speeds, braking intensity, and weather conditions are measured by vehicles. Examples are (advanced) board cameras, speed and distance measuring through radar (LIDAR). RFID systems to track and scan vehicles (for example. In parking garages). This information is relevant for C-ITS applications. For example, cars could automatically inform the road operator about the occurrence of slippery road conditions.

- **Software**
    - *Cloud services:* more and more data is been send and stored in the cloud. This means data is not stored on a central place but rather on a 'cloud' of computers online. Floating car data (FCD) is data that continuously transmits location, speed and direction of a car. This is used to generate real time traffic advice. Cloud computing is perfect for this type of data, as it is not necessary to save this data for a long period.
- **Algorithms:** traffic is often analysed using algorithms. Certain initiatives are improving these algorithms especially with an eye on C-ITS services. An example is personalized real time traffic advice that differs between users to disperse traffic. As data platforms become more advanced the effect and importance of algorithms increases.

- **Positioning**
    - Satellites: In order to determine the location of vehicles satellite based location is most commonly used. This would involve the Global Positioning

System (GPS) which is maintained by the US, or the European satellite system Galileo.
  - *Real time location systems*: Positioning data is often combined to generate a real-time location of vehicles. These exact and moving locations facilitate advanced ITS applications. An example is floating car data, which are car movement data generated from GPS and cellular connectivity.

- **Sensors**
  - *Road side beacons:* Roads could be equipped with beacons that broadcast using Wi-Fi-p technology. These Wi-Fi-p beacons allow traffic managers, road side infrastructure and other users to send and receive information using Wi-Fi-p. Currently these beacons are only installed for pilot projects. In the future, they have the potential to be common for (dense) roads.
  - *Dynamic road signs:* these signs installed above the road or on the side of the road. These inform road users about a variety of issues. Matrix signs do not communicate directly but are regulated via a traffic centre.
  - *Conditions sensors:* Sensors could measure weather conditions, acceleration, fuel level, and many other conditions in- and outside vehicles.
  - *Inductive loops:* integrated sensors or loops that for example sense whether a vehicle is occupying a parking spot or is approaching an intersection.
  - *Video cameras:* certain stretches of road are equipped with video cameras that operate on a closed circuit (CCTV).

- **Identification technologies**
  - *Smartcards.* Cards that incorporate a chip. These have become mainstream technology and are widely deployed.
  - *Charge cards*: Charge cards enable vehicles to tank fuel and charge it automatically using a separate account. This could be traditional fuel as well as electricity in the case of electric vehicles.
  - *NFC:* Near Field Communication (NFC) is used by smartcards for quick, simple and secure ticketing. Many new mobile telephones are equipped with NFC technology in order to facilitate payments with mobile telephones.
  - *RFID*: Radio-frequency identification allows wireless identification and tracking of objects. Common for track and trace processes.

Each of the reported services could use multiple types of technologies. Based on the available data specific technologies or standards are reported. However, one type of technology is key for the functioning of the service. For example, many C-ITS services depend on direct V2V communication, exemplifying that communication technologies are the key type of technology for this service. Identification technologies are key for electronic toll collection. Following this rationale, a key technology has been identified for the different services selected by the NEWBITS consortium.

### c) Geographical scale

The geographical deployment area of services is documented by the NEWBITS project. In line with existing literature services are classified under urban, interurban or both to reflect their geographical scale. For example, advanced traffic lights apply to urban solutions, whereas highway management systems are interurban solutions.

### d) Type of transport

The multiple types and modes of transport a service applies to have been documented. The NEWBITS project follows the parameters used in the literature. Firstly, it is indicated whether the service aims at passenger, freight or both types of transport. Secondly, the transport mode for which the service applies for scheduled, non-scheduled or multimodal transport.

### e) Type of stakeholders

The type of stakeholders involved in the service have been reported. Different stakeholders are research institutes, universities, industry, OEMs, public authorities and end users among many others. The types of stakeholders are identified via the project website, deliverables or other communication methods.

### f) Institutional arrangements

The type of financing for the service has been documented. Three options are chosen to measure institutional arrangements:  private, public or a public private partnership (PPP).

### g) Transferability

NEWBITS partners have assessed to what extent the service is transferable and scalable to other regions. The fiches provide an indication of NEWBITS partners on the transferability of the service. The long list of services contains two options; services are transferable or not transferable.

The performed desk research generated a number of fiches on a service level, containing the above referenced information at the two blocks level.

If multiple services are deployed in one project, multiple fiches were constructed to present the information correctly. This differentiation between services was not possible for all identified initiatives. For several projects, there was not enough information available to construct fiches at the service level.

Therefore, from the 160 identified initiatives **94 fiches** have been constructed on a service level. The fiches are shown in Annex 7 Service Fiches.

# 4. Codification and Mapping of ITS services

A number of categorisations in terms of market segmentation have been identified for ITS in Chapter 3. Also, a long list of relevant criteria has been proposed in the same chapter collected from a wide range of literature sources including those with potential relevance to NEWBITS assessments. Given these two inputs, the objectives of this chapter are:

1. To propose a systematic methodology based on the analytical hierarchy process (AHP) to determine: (a) A suitable categorisation that fits the purpose of NEWBITS, and at the same time, (b). Provide a priority ranking of the long criteria list defined in Chapter 4 following pairwise comparison assessments by partners.
2. To perform the mapping of the identified ITS/C-ITS services to the selected categorisation, and provide a visual mapping with respect to the short list of criteria resulting from the ranking in (1).

As stated in the introductory section of Chapter 3, we will not take into consideration categorisations proposed by theoretical research methods from the scientific literature. Our focus is on market segments emanating from industrial market research reports excluding the geographical scope.

## 4.1 Validation of ITS Market Categorisation

Owing to the different categorisation schemes available from market research reports and the several potential criteria that need to be considered, it becomes difficult to choose a suitable categorisation scheme that would satisfy all the criteria identified. This constitutes a multicriteria decision making problem for the consortium about the best categorisation that meets the requirements of NEWBITS objectives.

In order to assist with the decision-making process, we adopt the AHP (Saaty 1980) to find the right categorisation among several alternatives after a series of brainstorming sessions with the partners. For this purpose, the AHP framework is preferred to a more extensive method such as analytic network process (Jharkharia and Shankar 2007), because of its simplicity to assess collective judgements for effective decisions by expediting a natural decision-making process (Saaty 1980). As agreed by the consortium, AHP would allow us take the advantage of the individual strengths and expertise of partners' opinions including ITS experts and to deal with any disagreements by installing voting rules based on preference ratings. The aim is to achieve two objectives in one process; the ranking of relevant criteria, and the priority ranking of the market segment categorisations.

The AHP process has been useful for complex decision making in a variety of domains including in industry and in government. The main idea behind AHP is to select an alternative or a rank of alternatives (goal in level 1) from a set of different decision alternatives (level 2) given a set of criteria (level 3). Figure 11 shows the AHP structure. Several levels of sub-criteria can be added to the hierarchy, for the purpose of this task, we are only considering one criteria level. The process requires the decision maker (partners and experts) to provide judgments about the relative importance of each criterion and then specify a preference for each decision alternative on each criterion.

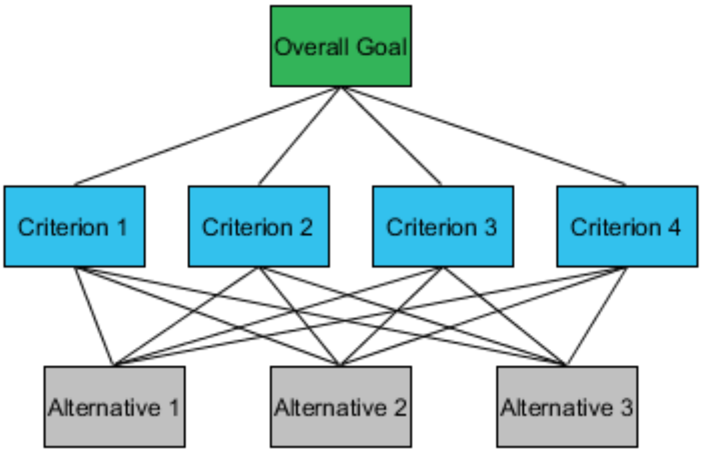



Figure 11: Overview Analytic Hierarchy Process, AHP (Saaty 1980)

To achieve these goals, clearly defined methodological processes have been defined, which includes establishing the relevant criteria for the assessment of categorisation schemes, through to synthesis and ranking of criteria and categorisation. The deployed AHP consists of five sub-processes in total:

*i.* *Process 1: Construct the decision hierarchy (decompose the decision-making problem into goal, criteria, and decision alternatives).*
*ii.* *Process 2: Construct the pairwise comparison matrix.*
*iii.* *Process 3: Internal voting process for the collection of partners' subjective judgements.*
*iv.* *Process 4: Synthesise judgements to obtain the set of overall weights for achieving the goal and evaluate the degree of consistency among the pairwise judgements.*
*v.* *Process 5: Develop priority ranking and determine the best categorisation.*

Each of these processes is further developed as subsections in this chapter. The outcome of this process is expected to set the baseline for Task 2.3 in selecting and validating case studies that are representative of the variety in types of the ITS/C-ITS services.

### 4.1.1 Construct decision hierarchy

The first process in the AHP involves the model of the problem in a hierarchic or network structure. This kind of representation involves defining the decision problem and the goal of the problem, specifying the criteria to be considered, and the decision alternatives. To apply the AHP, the hierarchic formulation for the problem then becomes: Choose or rank market categorisation(s) (goal) from the existing categorisation available for ITS market according to a given set of relevant criteria that would satisfy NEWBITS objectives. The three decision alternatives are the MARKET by component, by type and by application. A set of 10 relevant criteria are considered namely; innovation level (C1), ITS enabling technology (C2), targeted geographic deployment area (C3), transport mode (C4), transport type (C5), primary benefits (C6), institutional framework (C7), stakeholders (C8), transferability (C9), and deployment period (C10). The hierarchy is shown in Figure 12. For simplicity sake, not all the criteria are listed in the structure.

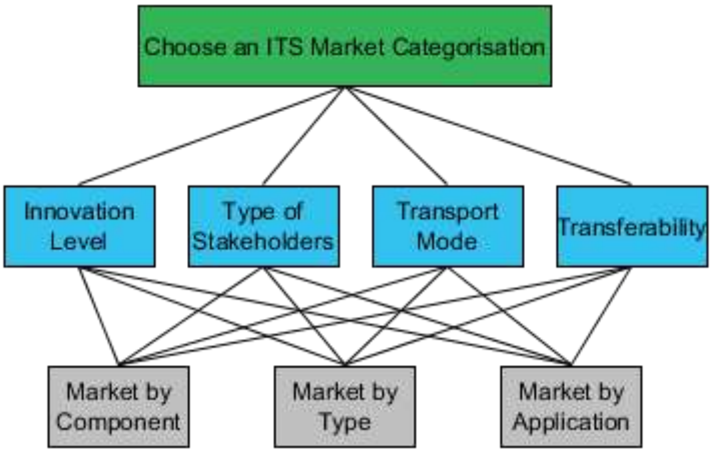



Figure 12: AHP schematic deployment for selection of categorisation

### 4.1.2 Construct the pairwise comparison matrix

The next process is to develop the pairwise comparison matrix (PCM). PCM is an essential tool in the AHP that serves to establish relations within the hierarchical structure. It allows the partners (decision makers in this process) to judge the preference of one criteria or decision alternative relative to the other. Each element in the adjacent upper level is used to compare the elements in the level immediately below it. For the three-level structure described in Figure 4.2, the relations are established at both the lower and upper level leading to the following PCMs:

i. Pairwise comparison of categorisations according to a given criterion - This indicates the preference or priority for each categorisation in terms of how it contributes to each criterion. To fill an entry in the matrix, the question asked to compare any two elements is:

   **Q**. On criterion C, how important is categorisation A relative to categorisation B?

ii. Pairwise comparison of criteria with respect to the goal of choosing a suitable categorisation – This is the relative importance of each criterion in terms of its contribution to the achievement of the overall goal. The question for this comparison is:

   **Q**. To select a categorisation suitable to achieve NEWBITS objectives, how important is the criterion Ci relative to the criterion Cj?

The PCMs are developed in a spreadsheet template consisting of 11 sheets in total; the first 10 PCMs are repetitively generated for each criterion (Figure 13) and the last sheet is used for comparing the criteria with respect to the goal (Figure 14).

| Question | On this criterion, how important is the categorisation in each row (rows 3-5) relative to the categorisation in each column (columns B-D)? | | |
|---|---|---|---|
| Innovation level | Market by component | Market by type | Market by application |
| Market by component | 1 | | |
| Market by type | | 1 | |
| Market by application | | | 1 |

Figure 13: Pairwise comparison of categorisation with respect to each criterion

| Question | To select a categorisation suitable to achieve NEWBITS objectives, how important is the criterion in each row (rows 3-14) relative to the criterion in each column (columns B-K)? | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Criterion | Innovation level | ITS enabling Technology | Geographic deployment | Transport mode | Transport type | Primary benefits | Institutional framework | Type of stakeholders | Transferability | Deployment period |
| Innovation level | 1 | | | | | | | | | |
| ITS enabling | | 1 | | | | | | | | |
| Geographic deployment | | | 1 | | | | | | | |
| Transport mode | | | | 1 | | | | | | |
| Transport type | | | | | 1 | | | | | |
| Primary benefits | | | | | | 1 | | | | |
| Institutional framework | | | | | | | 1 | | | |
| Type of stakeholders | | | | | | | | 1 | | |
| Transferability | | | | | | | | | 1 | |
| Deployment period | | | | | | | | | | 1 |

Figure 14: Pairwise comparison of criteria with respect to the goal

### 4.1.3 Internal voting

In this process, partners are asked to provide their responses in the decision matrix by comparing the categorisation candidates under each criterion separately as well as the 10 criteria towards achieving the goal. Partners make comparison judgements in pairs based on a scale with values from 1 to 9 (Table 15) to reflect their relative preferences.

| Intensity of importance | Definition | Explanation |
|---|---|---|
| 1 | Equally important | Two factors contribute equally to the objective |
| 3 | Moderately more important | Experience and judgment slightly favour one over the other |
| 5 | Strongly more important | Experience and judgment strongly favour one over the other |
| 7 | Very strongly more important | Experience and judgment very strongly favour one over the other. Its importance is demonstrated in practice |
| 9 | Absolutely more important | The evidence favouring one over the other is of the highest possible validity |
| 2,4,6,8 | Intermediate values between the two adjacent judgements | When compromise is needed |

Table 15 Saaty preference rating scale (Saaty, 1987)

To avoid complications in the voting process, responses are confined to the lower triangular matrix of the PCM only. So, two types of responses are possible:

a. Whole number rating (1, 3, 5, 7, 9) - When the criterion/categorisation on the row is judged to have higher preference than the one in the column.

b. Reciprocal rating (1/3, 1/5, 1/7, 1/9) - When the criterion/categorisation on the row is judged to have lower preference than the one in the column.

An example response is given in Table 16 for the pairwise comparison of the criteria.

Since it is practically impossible to have a collective judgement at the consortium level at the time of voting, a collective decision making was encouraged at partner level. So, one response per partner is collected instead of individual responses. In consequence to the number of people involved, consensus may not be reached for each pairwise judgement. An aggregated PCM is obtained from the multiple partners' responses by consolidation using the weighted geometric mean.

Table 16 shows a sample matrix of pairwise comparison of the criteria with respect to the goal of selecting a suitable categorisation scheme. In this matrix, the TRANSPORT TYPE (C5) criteria is judged to be strongly more important than the INNOVATION LEVEL (C1) and hence the reciprocal value (1/5) is entered in the (C1, C5) position. Likewise, TRANSPORT MODE (C4) is judged to be between equal and moderately more important than TYPE OF STAKEHOLDERS (C8). A rating value of 2 is placed in position (C4, C8) and the reciprocal (1/2) is entered in (C8, C2). This same process is applied to the other pairwise comparisons in the table.

| **Cat.** | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 1 | 1/6 | 1/3 | 1/4 | 1/5 | 1/8 | 1 | 1/4 | 1 | 2 |
| C2 | 6 | 1 | 2 | 1/2 | 1/2 | 1/5 | 4 | 1/2 | 2 | 1 |
| C3 | 3 | 1/2 | 1 | 2 | 1 | 1/3 | 4 | 2 | 5 | 3 |
| C4 | 4 | 2 | 1/2 | 1 | 1/3 | 1/5 | 2 | 2 | 4 | 6 |
| C5 | 5 | 2 | 1 | 3 | 1 | 1/4 | 3 | 4 | 5 | 5 |
| C6 | 8 | 5 | 3 | 5 | 4 | 1 | 5 | 6 | 4 | 6 |
| C7 | 1 | 1/4 | 1/4 | 1/2 | 1/3 | 1/5 | 1 | 1/2 | 1 | 1 |
| C8 | 4 | 2 | 1/2 | 1/2 | 1/4 | 1/6 | 2 | 1 | 3 | 3 |
| C9 | 1 | 1/2 | 1/5 | 1/4 | 1/5 | 1/4 | 1 | 1/3 | 1 | 2 |
| C10 | 1/2 | 1 | 1/3 | 1/6 | 1/5 | 1/6 | 1 | 1/3 | 1/2 | 1 |

Table 16 A sample matrix response of pairwise comparisons of the criteria with respect to the overall goal

### 4.1.4 Synthesis of judgements

Once the responses are collected for each of the PCM, the next process is to perform a synthesis of the judgements using a mathematical procedure. The synthesis procedure involves the computation of the relative priority (weights) of each of the elements compared in the PCMs, i.e. the priority of each categorisation on each criterion, and the priority of each criterion on the objective of choosing the best categorisation scheme. The mathematical procedure is based on the principal eigenvector of the decision matrix, which is outside the scope of this deliverable. To facilitate the computational process, the AHP online tool (Goepel, 2017) is employed for this purpose. Part of this procedure involves normalising the resulting PCMs and averaging the values in each row to get the corresponding weight.

This process is further divided into two: First, the weights of the criteria are calculated, and Second, the categorisations are evaluated based on the criteria weights.

(a) **Determine the weight (priority) of each criterion –** The priorities of individual partners (expressed as a percentage of weights) are shown in Table 17.

| Part. | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|
| ISSIN | 11.70% | 10.00% | 6.60% | 5.70% | 5.50% | 25.40% | 6.90% | 12.30% | 8.30% | 7.70% |
| UAB | 14.50% | 5.80% | 5.30% | 5.20% | 2.50% | 25.70% | 3.50% | 21.80% | 9.20% | 6.40% |
| TTS | 14.60% | 7.50% | 2.80% | 3.00% | 4.90% | 13.40% | 4.90% | 26.30% | 11.30% | 11.20% |
| S2i | 4.60% | 7.40% | 4.00% | 1.90% | 2.40% | 19.40% | 9.10% | 19.30% | 19.10% | 12.80% |
| ORT | 16.60% | 10.10% | 8.20% | 5.20% | 8.00% | 14.80% | 4.40% | 17.90% | 6.10% | 8.60% |
| CUE | 21.90% | 13.00% | 7.40% | 11.50% | 6.30% | 19.40% | 6.20% | 4.00% | 7.50% | 2.80% |
| CED | 3.10% | 9.00% | 11.80% | 10.40% | 15.90% | 31.70% | 3.60% | 7.80% | 3.60% | 3.20% |
| ATOS | 17.70% | 6.70% | 6.70% | 1.10% | 4.50% | 20.00% | 2.80% | 25.90% | 6.40% | 8.10% |

Table 17 Resulting weights of criteria based on the PCMs of individual partners

From the table, there is an agreement to a certain extent at the consortium level on four criteria (marked green); innovation level (C1), ITS enabling technology (C2), primary benefits (C6), and type of stakeholders (C8). The priorities are then consolidated to calculate the global priorities (Table 18). The consolidated global priorities reflect the judgement of all partners. The overall consistency ratio (CR) for the consolidated priorities is computed as 2.7%, which is within an acceptable range following Saaty's rule. Appendix 4.1 shows the consolidated decision matrix for criteria comparison.

| Category | | Priority | Rank |
|---|---|---|---|
| 1 | Innovation level | 12.70% | 3 |
| 2 | ITS enabling technology | 9.00% | 4 |
| 3 | Geographic deployment area | 7.00% | 7 |
| 4 | Transport mode | 4.50% | 10 |
| 5 | Transport type | 5.90% | 8 |
| 6 | Primary benefits | 24.00% | 1 |
| 7 | Institutional framework | 5.10% | 9 |
| 8 | Type of stakeholders | 16.70% | 2 |
| 9 | Transferability | 8.00% | 5 |
| 10 | Deployment period | 7.20% | 6 |

Table 18 Ranking of criteria with consolidated global priorities

From the consolidated priorities, the AHP group consensus indicator is calculated as 76.4%. This indicates the degree of agreement among partners (0% total disagreement, 100% total agreement), which can be considered a fairly acceptable agreement. Figure 15 shows the consolidated ranking of each criterion by priority computed from the aggregation of the individual priorities from Table 17.

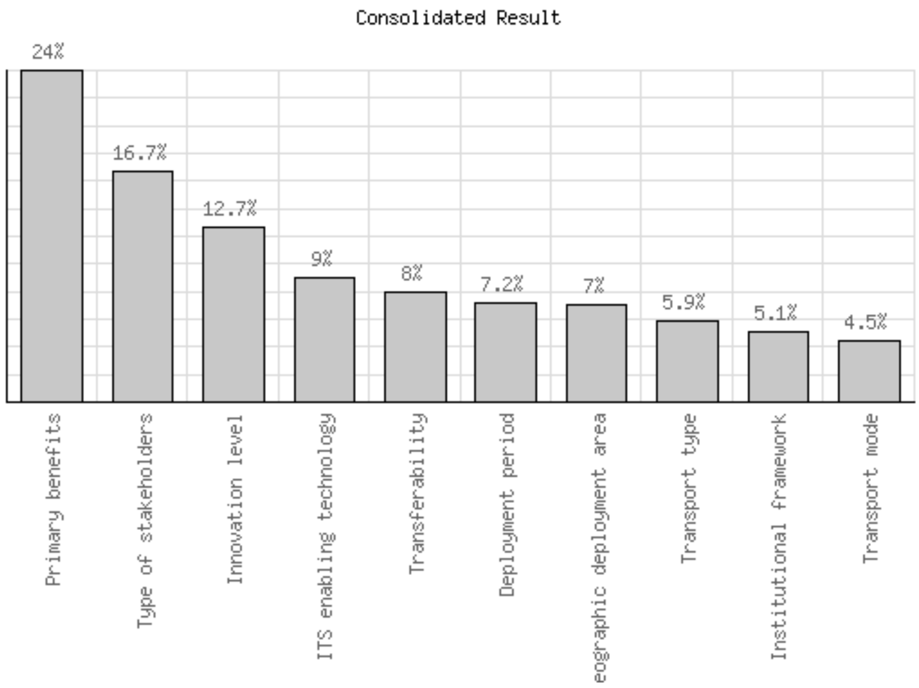



Figure 15: Consolidated global priorities of criteria towards achieving the goal

The ranking shows that three criteria (C6, C8, C1) are considered the most critical, while four criteria (C2, C9, C10, C3) are equally important. With respect to selecting an ITS market categorisation for the project, it can be concluded that:

- PRIMARY BENEFITS is the most influential criterion for categorisation going by the consolidated judgements of the partners. This can be linked with its relation to the main objectives of ITS due to its importance of the societal benefits derived from solving transportation problems by taking advantage of advanced ICT. The reported benefits have contributed to drive the deployment of ITS/C-ITS services. The result of this priority also coincides with the survey results in Grant-Muller & Usher (2014) in which stakeholders from various organisations and networks have singled out an improved demonstration of ITS benefits in enabling the greater uptake of ITS.
- TYPE OF STAKEHOLDERS is highly preferred to achieving NEWBITS objectives due to the crucial role of stakeholders' cooperation for the deployment of the value network analysis in WP4 and its importance in selecting case studies in Task 2.3.
- INNOVATION LEVEL is seen as a priority criterion relevant to NEWBITS on the basis of its importance of innovation for business models. It will help to clarify the services applied or piloted and as a consequence, to determine services that are very close to the market and those that may already have a well-defined business model.

(b) **Determine the weight of categorisation in terms of each criterion**:

The resulting priority of the evaluation process for the categorisation is presented in Table 19. The impact of each criterion is determined by analysing the importance of each categorisation on every other categorisation using the PCMs. The consolidated decision matrix for each categorisation according to each criterion can be found in Appendix 4.2.

| Cat. | Priority | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| Cat. 1 | 40.20% | 70.60% | 10.00% | 10.30% | 11.10% | 8.40% | 14.60% | 14.20% | 16.40% | 23.50% |
| Cat. 2 | 35.90% | 14.10% | 30.70% | 42.50% | 49.50% | 35.50% | 42.60% | 39.40% | 51.50% | 33.10% |
| Cat. 3 | 23.90% | 15.30% | 59.40% | 47.20% | 39.40% | 56.00% | 42.80% | 46.40% | 32.10% | 43.40% |

Cat.1 – Market by component, Cat. 2 – Market by application, Cat. 3 – Market by Type

Table 19 Consolidated priorities for categorisation with respect to each criterion

### 4.1.5 Develop priority ranking and determine the best categorisation

In this process, the selection of the best categorisation depends on the priorities obtained in the previous process. The weighted average rating of each categorisation is computed taking into account the weights of each criterion and its impact on the overall goal. Table 20 shows the breakdown of the individual ranking of categorisations by partner.

| Partners | Market by Component | Market by Application | Market by Type | CR |
|---|---|---|---|---|
| ISSINOVA | 25.10% | 32.30% | 42.60% | 0.00% |
| UAB | 18.80% | 41.60% | 39.60% | 0.00% |
| TTS | 20.80% | 33.80% | 45.50% | 0.00% |
| S2i | 21.60% | 27.70% | 50.70% | 0.00% |
| ORT | 22.90% | 40.50% | 36.60% | 0.00% |
| CUE | 26.90% | 30.60% | 42.50% | 0.00% |
| CED | 22.70% | 36.10% | 41.20% | 0.00% |
| ATOS | 24.50% | 46.90% | 28.60% | 0.00% |

Table 20 Categorisation ranking per partners

There is total agreement in the assigned preferences by partners with a group consensus indicator of 98.4%. Based on this evaluation, the weights of categorisations are then consolidated in order to identify the right categorisation (Figure 16).

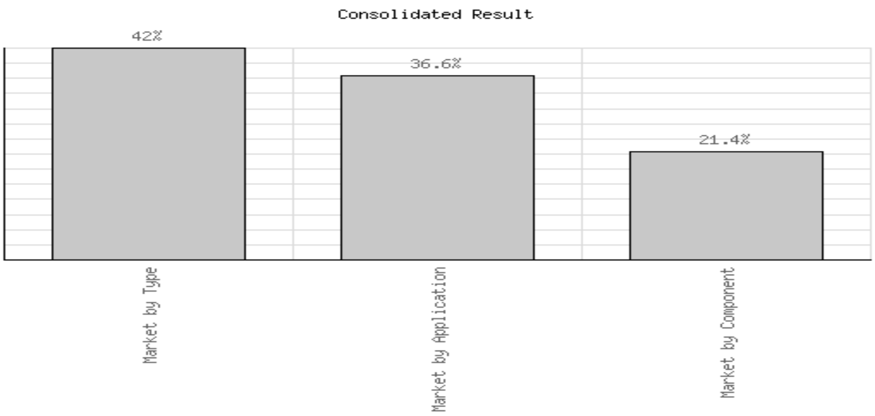



Figure 16: Consolidated weights (ranking) of categorisations

As shown Figure 16, the MARKET BY TYPE categorisation (ATMS, ATIS, ATPS, APTS, CVS) proves to be the best categorisation alternative suitable to achieve NEWBITS objectives. Overall, the partners' judgements in the whole AHP have taken into consideration criteria that are most critical to meet the requirements of the respective work packages in the project. The decision hierarchy of the entire AHP is presented in Appendix 4.3.

## 4.2 Characteristics of Selected Services

The indicated projects in Appendix 3 have resulted in 160 different indicated services. However, this contained services that have been collected at initiative level making them not suitable for analysis at a service level. After removing the faulty data, we are left with 94 services. The details are shown in Appendix 5. This section will analyse the details of the services analysed by the NEWBITS consortium. The functioning of an ITS service is not correlated with the country of region in which a service is deployed. The effect often is larger if more people are affected by a service but this does not affect the functioning of a service. This section focuses on service-level analysis by looking at some functional criteria and how they are reflected by the services.

On the first criterion, the different services and based on project description assigned a primary benefit. For example, the primary benefit of road works warnings is safety, whereas a real-time route planner improves comfort of travellers. Many ITS services offer multiple benefits simultaneously. However, the NEWBITS project has decided on the primary benefit in order to enable it to be used as part of the mapping procedure. The primary benefit is mostly discussed in the project information; this has been decided based on the expert opinion of the NEWBITS partners. Efficiency is the most common primary benefit with a share of 44% of the services as shown in Figure 17. The other benefits are also well represented by the list of selected services.

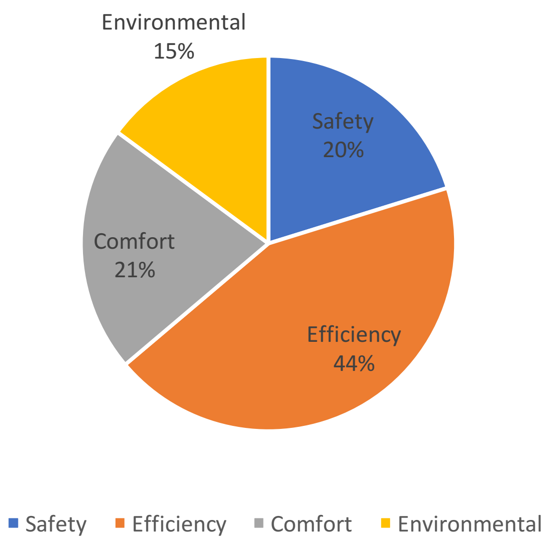
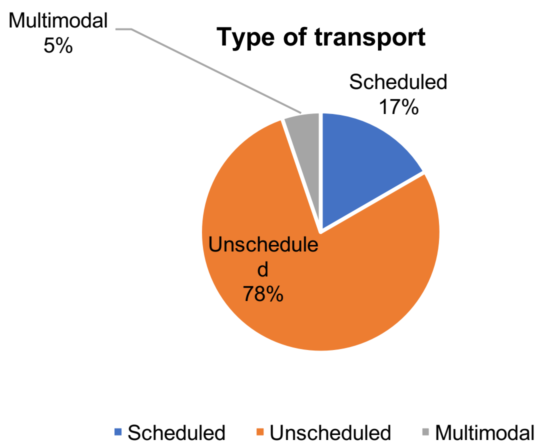
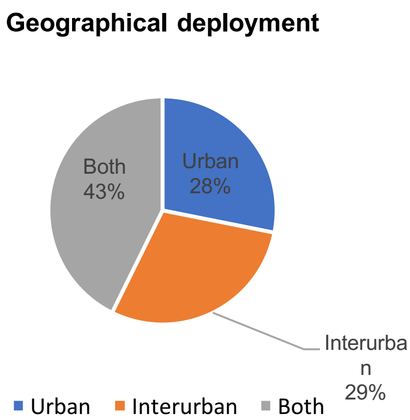



Figure 17: Representation of primary benefits

The selected services offer a good coverage of the different ITS areas and goals of ITS services. Another element is to see the types of transport covered by the list of services. Figure 4.8 shows that about 30% of the services apply to an urban context, examples are inner city parking guidance and smart pedestrian crossing. Another 30% of the services specifically aims at highways, for example highway monitoring systems and cooperative truck platooning. The largest entry involves services that apply for an urban and interurban context. Examples are weather warning systems and real time route planners. The majority of the services apply to unscheduled transport, being freight trucks, passenger cars and other road users. Scheduled transport incorporates public transport (Buses, rail transport) and air transport.

Communication technologies are most often the key technology in the set of identified of services (Figure 18). In 50% of the identified services, communication technologies are key to the functioning of the service. This illustrates the emphasis on connected and cooperative driving at the macro level. The other technologies are also relevant in certain services as well. The only exception being energy related technologies, which is not a key technology in the group of ITS services identified by the NEWBITS consortium.



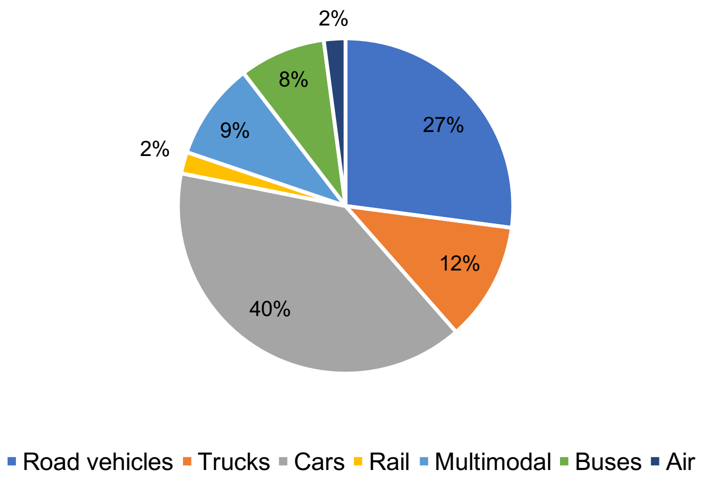



Figure 18: Representation of transport type, mode and geographic deployment criteria

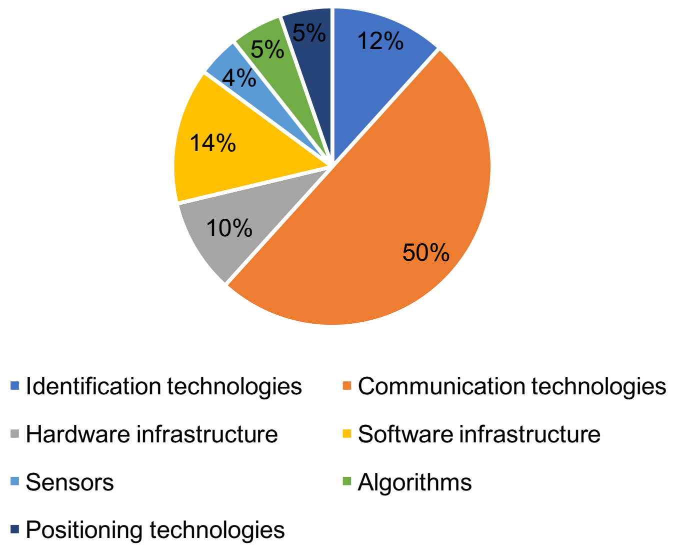



Figure 19: Representation of key enabling technology criterion

## 4.3 Mapping

The key activity to be deployed in this step is to organise and map the identified services.

In a broader sense, a categorisation scheme otherwise called classification (Tan et. al 2006) would allow the mapping of a service or a group of services to a specific category without any form of ambiguity. In other words, a service must belong to a category that must be as unique as possible and most likely be different from the services in the other categories. Ideally, the mapping will be based on the services identified in the inventory and include the most important criteria resulting from the ranking established in the AHP procedure.

### 4.3.1 Identification of Subcategories for Service Differentiation

Following the selection of the appropriate market segment, the first task is to organise the services by establishing a one-to-one mapping of each service to its respective category according to the Market by Type segmentation. This exercise seems straightforward from the outset. However, some categories are somewhat implicit except for the description of the CVS category whose characteristics can be directly interpreted from its name. To allow for the correct mapping of the services, we first identify all the possible subcategories under each category.

ITS subcategories are discussed by the Information Technology & Innovation Foundation in Ezell (2010). A wide range of ITS applications are available, and it is useful to categorise them to some extent beyond the market segmentation. Therefore, Ezell (2010) introduce subcategories that cover the main purposes of ITS applications. It is important to note that applications could have functionalities that fall into multiple subcategories. The list of subcategories defined by Ezell (2010) was not meant to be inclusive, but should contain the most prominent ones. The NEWBITS consortium adopted a similar approach to define the most prominent subcategories within each market segment. The NEWBITS consortium has updated the main subcategories defined by Ezell (2010) based on the following literature; Amitran (2014), C-ITS platform (2016), Ricardo 2016, and the market research during Step 2. Table 4.7 summarizes the description of each category with its associated (updated) subcategories. The market segment of CVS is currently in development and no clear subcategories have emerged as of yet. V2V services, platooning and emergency braking systems represent one large category. V2I services represent another large category

| **Market by Type Category** | **Description** | **Subcategory** |
|---|---|---|
| **ATMS** | "ITS services that focus on traffic control devices, such as traffic signals, ramp metering, and the dynamic (or “variable”) message signs on highways that provide drivers real-time messaging about traffic or highway status" (ITIF 2010). | Signal control<br>Highway systems<br>Enforcement systems<br>Parking management<br>Traffic monitoring<br>Demand and access management |
| **ATIS** | ITS services that "provide drivers with real-time travel and traffic information, such as transit routes and schedules; navigation directions; and information about delays due to congestion, accidents, weather conditions, or road repair work" (ITIF 2010). | In-vehicle route and navigation systems<br>In-vehicle motorist service information systems<br>In-vehicle signing information systems<br>In-vehicle safety and warning systems<br>Commercial vehicle operations |

| Market by Type Category | Description | Subcategory |
|---|---|---|
| **APTS** | "ITS services that enable transit vehicles, whether bus or rail, to report their current location, making it possible for traffic operations managers to construct a real-time view of the status of all assets in the public transportation system " (ITIF 2010). | Journey planners multimodal<br>Multi & smart ticketing<br>Optimized fleet management<br>Real time system status information<br>Schedule optimization<br>Mobile video surveillance<br>Passenger information systems |
| **ATPS** | "ITS-Enabled transportation pricing system is mainly used for electronic toll collection purpose, through which the drivers can pay tolls automatically through the on-board device. Other applications which are included in this segment are: congestion charging, fee high-occupancy toll lanes and vehicle-miles travelled usage fees" (Markets & Markets, ITS Forecast 2014). | Vehicle miles travelled systems<br>Fee-based express lanes<br>Congestion pricing<br>Electronic toll collection |
| **CVS** | "A subset of the overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems". (EC, 2016) | V2V, V2I |

Table 21 Overview of ITS market by type and subcategories

### 4.3.2 Tabular One-to-One Mapping

Given these categories, we moved on to map the services. Initially, we noticed transversality, where some services can serve multiple purposes. In other words, some services that have been identified originally belonging to a subcategory, but still share certain properties with other services in a different category. As clearly described by Figueiredo et al 2010, there is a cross-relationship between some of these categories. ATIS is dependent on ATMS since the real-time information supplied to the travellers in ATIS is based on the information derived from ATMS. Likewise, APTS use technologies from ATMS and ATIS. In a situation where a service cannot be uniquely mapped to a category, we use the primary benefit/application area criterion to identify its right category. While this situation is not uncommon during categorisation, we believe this compromise has been justified using a top-ranked criterion in the AHP.

Appendix 6 presents a tabular mapping of the ITS/C-ITS services to Market by Type segmentation and their associated subcategories. This mapping takes into account the characteristics of each service and its fitness into each category depending on the purpose, function, and whether it involves some sort of communication between vehicles, vehicles and infrastructure, and/or between vehicles and other transport participants.

The resulting classification of the services is shown in Figure 20 according to the different subcategories identified in each market segment. It illustrates the distribution of the identified services over the ITS market segment. The largest proportion of the services comes from CVS, which accounts for about 28%, approximately one-third of the total (26). This is then followed by the second largest segments with an equal proportion of ATIS and ATMS services, making up 23 each of the total. These three areas are influenced mostly by the developments in connected, automated and cooperative driving. European and US policies focus on connected and cooperative driving (C-ITS Action plan & US policy), and as a consequence, this type of services is well represented in our long list of services. The remaining services in the APTS and ATPS segments are much smaller accounting for 23% combined, with 15 and 7 services, respectively. CVS is dominant because its scope extends beyond the road transport mode. Overall, we are able to cover all the five segments in the chosen ITS market categorisation. This is considered paramount if the case studies to be selected in Task 2.3 must be representative of the variety in types of the ITS market segments.

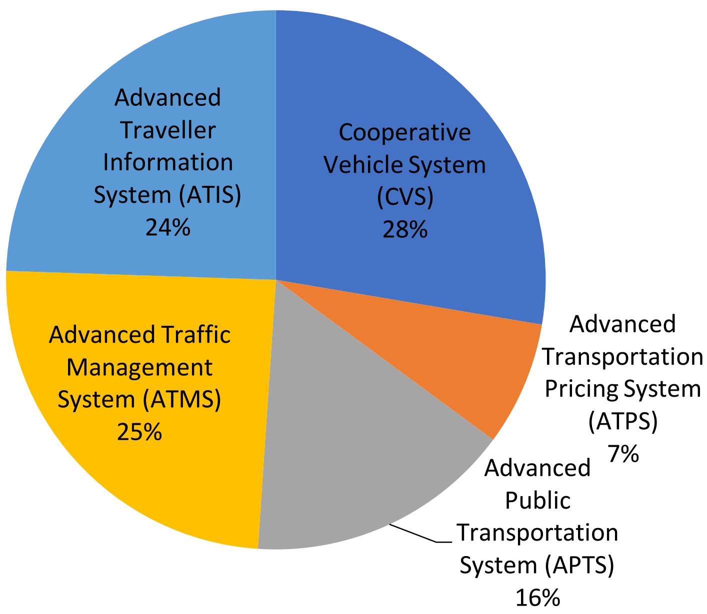



Figure 20: ITS/C-ITS services per category

### 4.3.3 Three-dimensional Mapping and Classification

Going forward, we limit the short list of criteria to the top 5 according to the priority ranking; Primary benefits, Type of stakeholders, Innovation level, ITS enabling technology, and transferability. For mapping purpose, we consider three criteria from this short list for mapping purposes. Type of stakeholders does not allow one-to-one mapping due to the varying number of stakeholder groups involved in the deployment of each service, while transferability is more of a qualitative criterion. Subsequent deliverables in WP3 will consider the degree of similarity between the stakeholders involved across the different services. This can reveal a cluster of stakeholders, which would then identify the different classes from the most important group to the less important ones.

As a first level mapping, we consider a three-dimensional (3D) space to map the identified services (Figure 21) by the primary benefit and innovation level criteria with respect to the classification of the services by market segment, and then quantifying the key enabling technology. Each point in the 3D map represents each of the 94 services in Appendix 5.

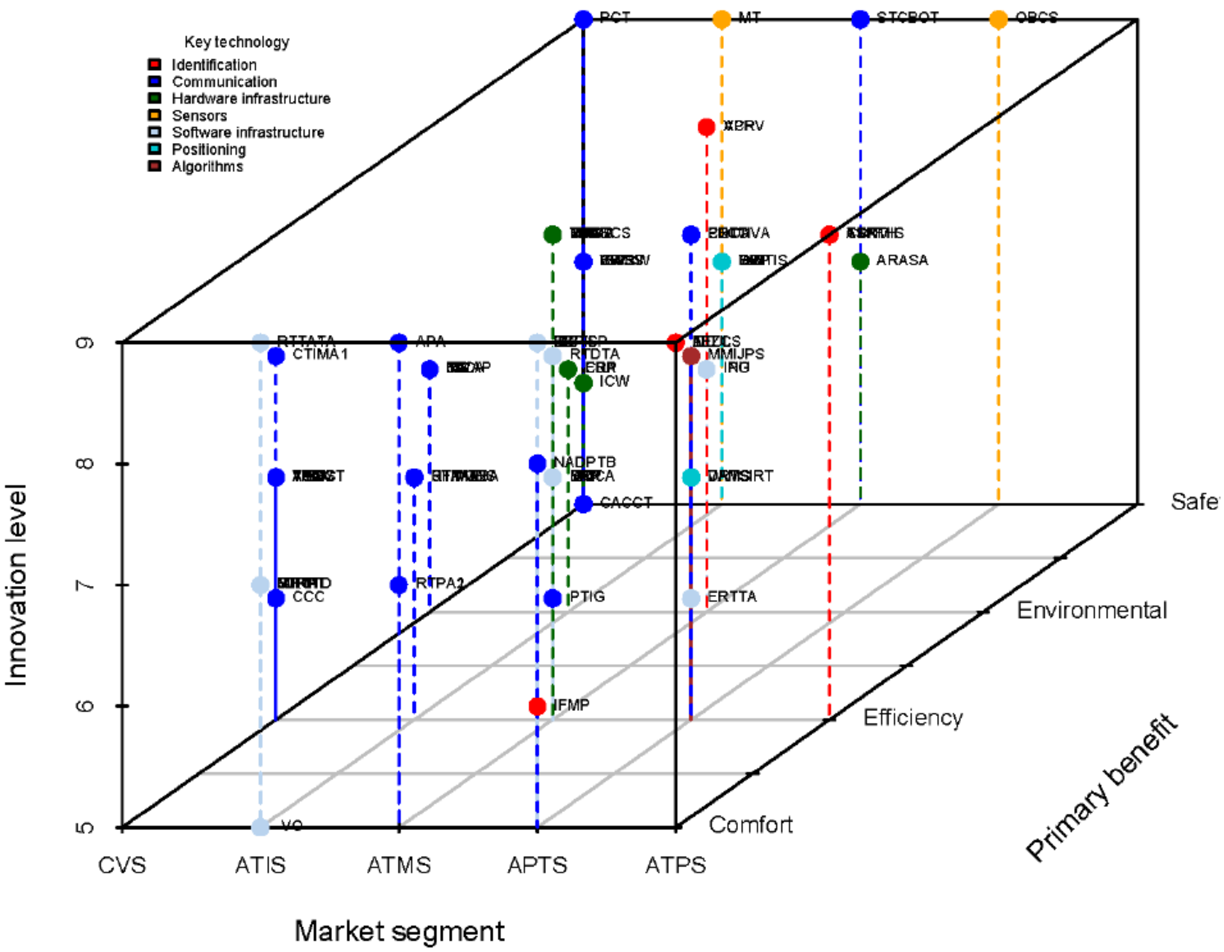



Figure 21: 3-dimensional mapping of services

To better understand the distribution of the services in the 3D mapping, mapping by classification is used to fit services into boxes. Figure 22 shows the classification of the services according to their (1) market segment, (2) primary benefit, and (3) innovation level. Figure 23 also depicts the classification of services by primary benefit and by key enabling technology. All the market segments are mostly dominated by communication technologies as their key enabling technology.

| Market by type | Primary benefits | Innovation level 5 | 6 | 7 | 8 | 9 | Grand total |
|---|---|---|---|---|---|---|---|
| APTS | Comfort | - | 1 | - | 1 | 4 | 6 |
| | Efficiency | - | 1 | 2 | 1 | 4 | 8 |
| | Safety | - | - | - | - | 1 | 1 |
| ATIS | Comfort | 1 | - | 5 | - | 2 | 8 |
| | Efficiency | - | - | 5 | - | - | 5 |
| | Environmental | - | - | 3 | - | - | 3 |
| | Safety | - | - | 6 | - | 1 | 7 |
| ATMS | Comfort | - | - | 2 | - | 1 | 3 |
| | Efficiency | - | 1 | 4 | 1 | 8 | 14 |
| | Environmental | - | - | 2 | - | 2 | 4 |
| | Safety | - | - | 1 | - | 1 | 2 |
| ATPS | Comfort | - | - | - | - | 3 | 3 |
| | Efficiency | - | - | - | - | 4 | 4 |
| CVS | Efficiency | - | 1 | 8 | 1 | - | 10 |
| | Environmental | - | - | 7 | - | - | 7 |
| | Safety | 1 | 1 | 6 | - | 1 | 9 |
| Grand total | | 2 | 5 | 51 | 4 | 32 | 94 |

Count(Service)

Figure 22: Classification per market segment, primary benefit and innovation level

| Market by type | Primary benefits | Key enabling technology: Algorithms | Communica... | Hardware in... | Identification | Positioning | Sensors | Software inf... | Grand total |
|---|---|---|---|---|---|---|---|---|---|
| APTS | Comfort | - | 2 | - | 3 | - | - | 1 | 6 |
| | Efficiency | 1 | 4 | - | - | 1 | - | 2 | 8 |
| | Safety | - | - | - | - | - | 1 | - | 1 |
| ATIS | Comfort | - | 3 | - | - | 1 | - | 4 | 8 |
| | Efficiency | - | 3 | - | - | 1 | - | 1 | 5 |
| | Environmental | - | - | 3 | - | - | - | - | 3 |
| | Safety | - | 3 | - | - | 2 | 1 | 1 | 7 |
| ATMS | Comfort | - | 3 | - | - | - | - | - | 3 |
| | Efficiency | 4 | 3 | 2 | - | - | 2 | 3 | 14 |
| | Environmental | - | 1 | - | 2 | - | - | 1 | 4 |
| | Safety | - | 1 | 1 | - | - | - | - | 2 |
| ATPS | Comfort | - | - | 1 | 2 | - | - | - | 3 |
| | Efficiency | - | - | - | 4 | - | - | - | 4 |
| CVS | Efficiency | - | 10 | - | - | - | - | - | 10 |
| | Environmental | - | 7 | - | - | - | - | - | 7 |
| | Safety | - | 7 | 2 | - | - | - | - | 9 |
| Grand total | | 5 | 47 | 9 | 11 | 5 | 4 | 13 | 94 |

Count(Service)

Figure 23: Classification per market by type, primary benefits and key enabling technology

Finally, tree maps are used to visualise the mapping of the market segments by primary benefits and technology (Appendix 7). The dominant enabling technologies for CVS and ATPS services are communication and identification technologies, respectively. For the other services that fall into the ATMS, ATIS and APTS market segments, the six key technologies are sparsely distributed. Though communication still remains significant, software infrastructure is also significant. This classification is based on the data collected but could be seen as a useful tool for mapping a wider variety of services.

### 4.3.4 Extended Visualisation of Mappings

Beyond the market segment, we noticed that there is some overlapping of services occupying one or regions in the 3D map. Actually, not all the services are separately represented on the map. Some have been deployed in the same market segment and also have similar enabling technology and primary benefit, and currently at the same innovation level.

Clustering methods and self-organising maps (SOM) are some of the most popular techniques for customer segmentation (Hanafizadeh & Mirzazadeh (2011)) and georeferenced data (Gorricha & Lobo, V. J. (2011)).

To further improve the mapping, a hierarchical clustering method is used to identify possible clusters or groups of services sharing similar characteristics based on the combination of market segment and the selected three criteria.

The possible sets of clusters are represented using a dendogram (Figure 24) to provide a visual representation of the similarity between services. From the dendogram, it is quite difficult to determine the appropriate number of clusters and also, visualise patterns in order to discover more information about the data.

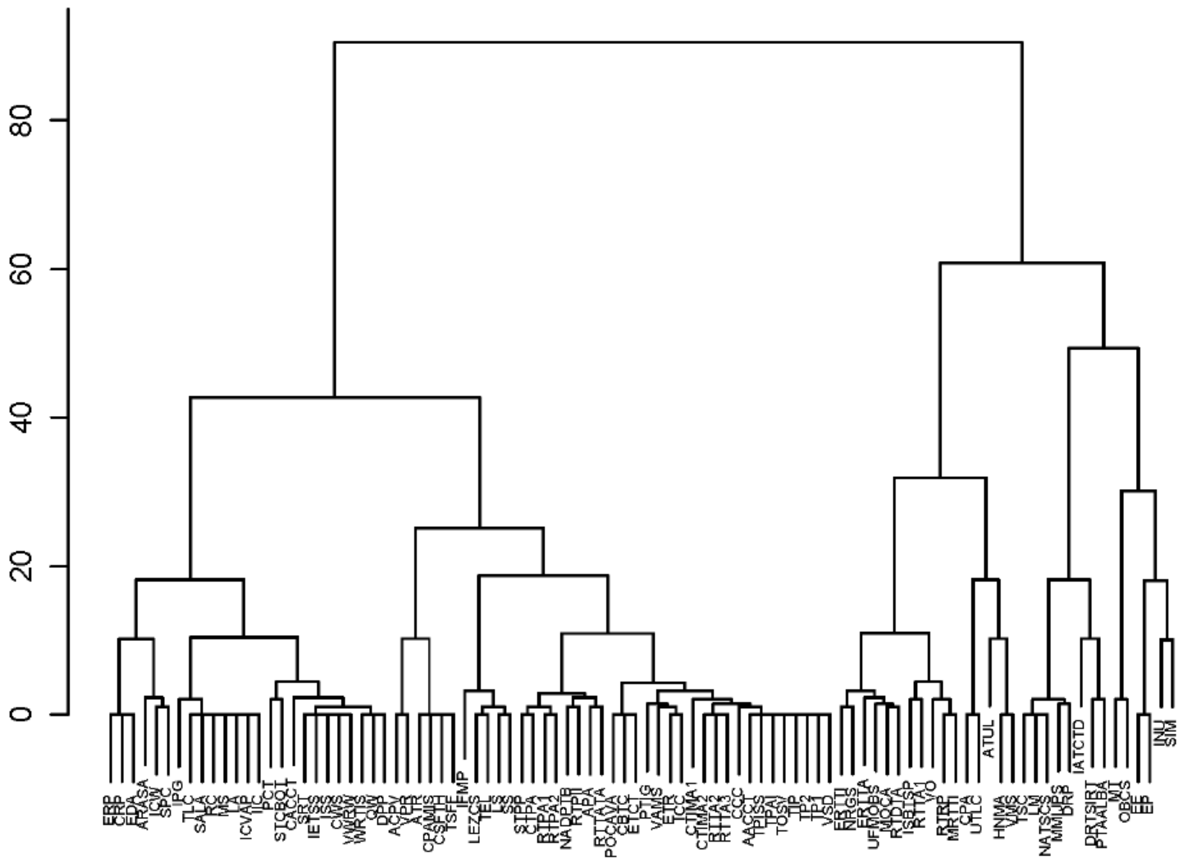



Figure 24: Cluster dendogram of services

To overcome this limitation, SOM is employed to visualise the clustering. SOM is a tool that provides the visualisation of high-dimensional data which implements an orderly mapping of a high-dimensional distribution onto a regular low-dimensional grid (Kohonen, 1998).

SOM can be used to reveal the true characteristics of the data/patterns in the distributions of the services and criteria. Figure 25 shows the SOM of the patterns displayed by the services given the market segment and the criteria. The individual fan diagram in the visual map represents the magnitude of each variable (criterion) in each node.

To determine the optimum number of clusters that correctly describes the services, we perform several iterations with different number of clusters. Finally, we obtained a map consisting of four cluster types that is well represented by the data. Each cluster is separated by a black line. The dominant criteria in each cluster are well illustrated. Figure 25 describes the mapping of each service to its own cluster.

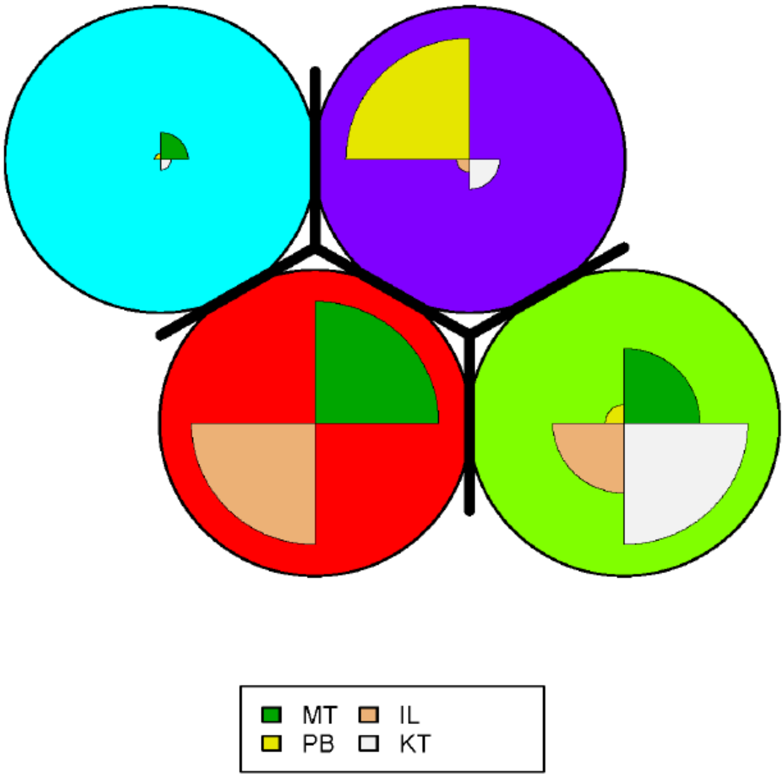



Figure 25: SOM of the patterns exhibited by the services, divided into four clusters

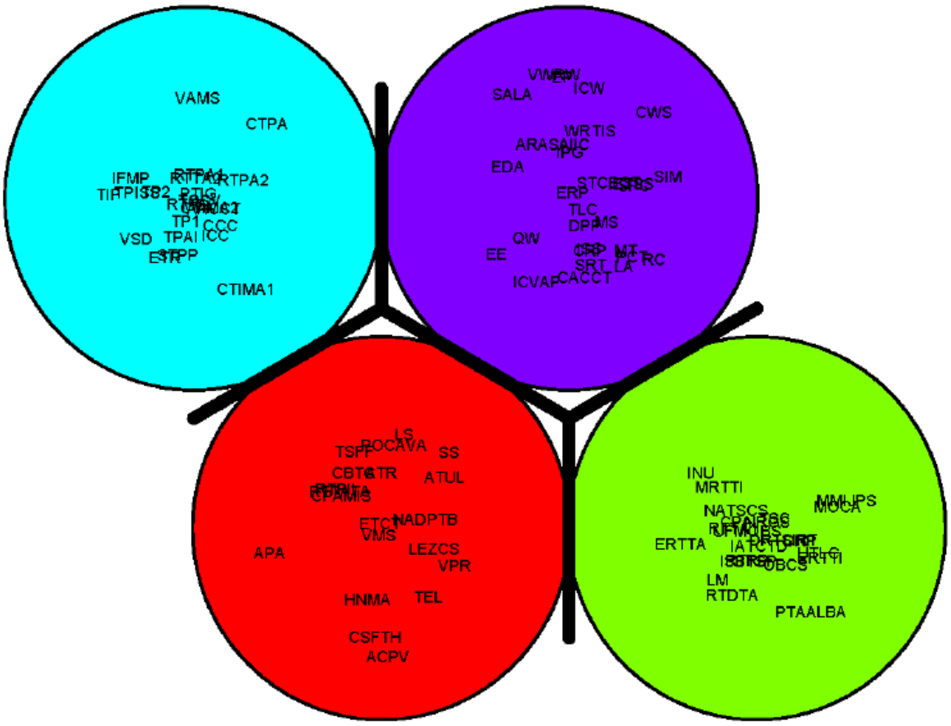



Figure 26: Self-organized mapping of the services to the four clusters

From the SOMs, we can deduce that these clusters define the different groups of services that can be offered and reveal some knowledge underlying the collected services. The definition of each cluster is given as follows:

1. Type 1 Service: These are services found in the red area of the map. This cluster is largely dominated by services that are already in the market (IL=9) spreading over three different market segments (ATMS, APTS, and ATPS). Comfort and efficiency are the most common primary benefits, while the key enabling technologies are restricted to three technologies; identification, communication, and hardware infrastructure.

2. Type 2 Service: This cluster is characterised by services whose primary benefits are safety and environmental. These are in the purple area of the map and are mainly dominated by the CVS and ATIS market segments. The technology readiness level of these services is mostly at IL=7 with the enabling technologies concentrated at communication and hardware infrastructure.

3. Type 3 Service: These services are represented in the green area of the map. The cluster comprises services having significant usage of a mix of three technologies; software infrastructure, positioning, and algorithms. It also has a heterogeneous mix of three market segments (ATIS, ATMS, and APTS) and innovation levels of 7, 8, and 9, while the dominating primary benefit is efficiency.

4. Type 4 Service: A particular market segment is well represented in this cluster (greenish-blue area of the map), the CVS. The main primary benefit is efficiency, while the dominating technology is communication. Most of the services in this cluster are at innovation level of 7.

A snapshot of the validation and mapping steps:

1. **Five criteria** are considered to be highly relevant to NEWBITS objectives following a general group consensus indicator of 76.4%: Primary benefits, Type of stakeholders, Innovation level, ITS enabling technology, and Transferability.
2. The **Market by Type** segment is ranked the best ITS market categorisation with a consortium agreement of 98.4%. It outperforms the Market by Application and Market by Component by relative gaps of 6% and 21%, respectively.
3. The selected services provide a **well-balanced picture of the ITS market categorisation**. This will maximise the usefulness of the results and recommendations provided by the NEWBITS project in the real world.
4. **Four types** of services are determined using the self-organising maps given the characteristics reflected by the dominant criteria in each cluster.

# 5. Conclusions

Intelligent Transport Systems have become an integrated element in modern day transportation by offering services for multiple application areas, transport modes and types of transport. Companies, organizations and policy makers have acknowledged the potential of ITS in order to tackle transportation related issues, like congestion, emissions and safety related incidents. Furthermore, ITS offers secondary benefits by reducing the costs of transport and increasing the quality of transport.

ITS services help to manage traffic, inform travellers, improve logistical processes, offer emergency services, provide real time information among many other purposes. Advanced traffic lights, integrated on board units, and traffic management systems are examples of ITS stations used to offer these services. Often, ITS services require cooperation of many stakeholders bringing service providers, research and development, public authorities and traffic managers together. Although the added value of ITS is commonly acknowledged, their deployment is considered to be slow and fragmented (C-ITS Platform, 2016; Ricardo, 2016). The NEWBITS project will introduce a business modelling approach in order to accelerate future ITS deployment.

The first step of the NEWBITS project is to provide a good framework for the assessments to be carried out in the next WPs. An initial step in this process is to provide NEWBITS with a framework at ITS macro-level by identifying ITS and C-ITS initiatives at EU and US levels, and generating a rough inventory collating the information gathered. The analysis has indicated four prominent types of initiatives:

- Academic literature
- FP7 & H2020 studies
- Grey literature
- Policy documents

The results from this analysis on a macro level showed a high conceptual and contextual disparity, based on the own heterogeneous and unparalleled character of the types of initiatives.

An internal discussion of the NEWBITS partners concluded that a categorisation could not be deployed due to the high disparity of the elements. The approach towards the categorisation was reassessed based on NEWBITS purposes. In line with the objectives of NEWBITS a market driven approach was preferred. The focus for the mapping exercise shifted towards one typology of initiatives: projects.  Projects provide with a more homogeny base to apply a categorisation method. Furthermore, projects embed outcomes in the form of services, being a catalyser between the macro and meso levels as defined in NEWBITS.

The market oriented framework and the need to build a well-organised and comprehensive inventory required to iterate the data identification moving from the initial initiative level (macro) towards a service-application level (meso). This shift towards a meso level induced a second phase of data gathering. The criteria to guide this data search are based on a review of existing literature and input from the NEWBITS consortium.

The literature uses a variety of criteria in order to define the technological maturity, deployment area, type and mode of transport for ITS services. The NEWBITS consortium has included three criteria based on NEWBITS objectives: Institutional framework, stakeholders and transferability. A fiche has been constructed to collect the information required for the long list of criteria.

In total 94 services have been selected by the NEWBITS consortium based on pilot projects and operational applications. The desk research by NEWBITS partners captured ITS services operating in Europe, the United States and Australia. The details of the selected services are presented in Annex 3.

A systematic methodology using AHP has been deployed for ranking the long list of criteria and selecting the best ITS market categorisation for NEWBITS. The outcome of the process established the selection of the market by type segment over markets by application and by component after a consortium agreement of 98.4%. It is worth mentioning that market by application can be given due consideration in related future projects since the relative gap from market by type is considerably small.

Within the same AHP process, five criteria were considered to be highly relevant to NEWBITS objectives following a general group consensus indicator of 76.4%:

- Primary benefits
- Type of stakeholders
- Innovation level
- ITS enabling technology
- Transferability.

However, for mapping purposes, the Type of stakeholders does not allow one-to-one mapping due to the varying number of stakeholder groups involved in the deployment of each service, while transferability is more of a qualitative criterion.

Subsequently, a service-level analysis is performed for the short list of 94 services by looking at some functional criteria and how they are reflected by the services. The results indicate that the selected services provide a well-balanced picture of the chosen ITS market categorisation. This will maximise the usefulness of the results and recommendations provided by the NEWBITS project in the real world.

We applied three criteria for mapping purposes, and the initial 3D mapping reveals the possibility of clusters of services since some of the services are not separately represented on the map. To further reveal the true characteristics of the patterns in the distributions of the services, an extended visualisation of service mapping is done using the combination of self-organising maps and clustering. This results in the identification of four types (clusters) of services given the characteristics reflected by the dominant market segment and criteria in each cluster.

The four clusters of services will be used in the following processes of the NEWBITS project. For each cluster of services, barriers, enablers and KPIs will be investigated. Furthermore, the validation and taxonomy of case studies will be supported by the clusters. This deliverable has therefore provided important steps for the construction of a framework for the NEWBITS project, key objective of WP2.

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# Appendices

## Appendix 1 Long list of initiatives

Table A.1.i Other

| Authors | Title | Year | Brief summary |
|---|---|---|---|
| A. Luis Osorio et al | Towards a Reference Architecture for a Collaborative Intelligent Transport System Infrastructure | 2014 | This paper discusses an approach to the required ICT-based intelligent infrastructure based on a collaborative network of stakeholders as contributors to the business service offering |
| AECOM for DG MOVE | Key Performance Indicators (KPIs) for road transport Intelligent Transport Systems (ITS), | 2015 | This study was commissioned by DG MOVE to establish a set of common Key Performance Indicators (KPIs) for road transport Intelligent Transport Systems (ITS), with supporting guidance on their application, presentation and reporting |
| Algoé Consultants SA, Rapp Trans, Alain Bensoussan Avocats, Liberty Incentives & Congresses | ITS Action Plan | 2012 | Final report on DG MOVE study on the adoption of an open in-vehicle platform architecture for the provision of ITS services and applications, including standard interfaces |
| Amsterdam Group | Roadmap between automotive industry and infrastructure organisations on initial deployment of Cooperative ITS in Europe | 2013 | The intention of this Road Map document is the identification and agreement: 1) on necessary steps regarding Cooperative Systems and Services, in this way defining a Joint Deployment Strategy for those who are eager to go for C-ITS implementations; 2) on common open issues / necessary activities required to be solved for the initial deployment of Cooperative Systems and Services in vehicles and at infrastructure side; 3) on a timeline to accomplish the open issues / necessary activities. This document on the road map therefore aims at practical recommendations (not binding) for their members for the initial deployment of (Day One) cooperative services. Information exchange, discussion and creation of solutions between the involved stakeholders in the context of C-ITS are key for forming these recommendations. |
| Andreas Festag | Cooperative ITS standards in Europe (IEEE Com. Mag) | 2014 | Provides a comprehensive overview of standards |
| BETA | Towards an architecture for CITS applications in the Netherlands | 2015 | Describe the architecture for C_ITS in the Netherlands. Discussing role of stakeholders in the Dutch context |
| Car-to-Car Consortium Statement | Deployment of V2X services based on ITS-G5 | 2016 | Communication on the development of to deploy wireless Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication based on the ITS-G5 standard (IEEE 802.11p). |
| C-ITS platform | C-ITS final Report | 2016 | Extensive report on C-ITS its barriers and uses |
| Cristofer Englund et. al | The Grand Cooperative Driving Challenge 2016: boosting the introduction of cooperative automated vehicles | 2016 | The article discusses the motivation of the GCDC challenge based on the context of intensive work in C-ITS. GCDC is a unique event for worldwide researchers to showcase their recent developments on cooperative and automated vehicles based on the newly finalized C-ITS standards. |
| Dr. Evangelia Portouli, Dr. Angelos Amditis, Dr. Panagiotis Lytrivis, Dr. Johanna Tzanidaki, Josep Laborda, Nuno Rodrigues, Frans van Waes, Johannes Liebermann, Pablo | Traffic management of the future and road automation | 2016 | How traffic management must prepare for the road automation. |

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| Dafonte García | | | |
| E. Strn Chalmers University | "On Medium Access and Physical | 2011 | Spectrum allocation and the physical and medium access control layers of |
| EC JRC Ispra | Informed consent in Internet of Things: The case study of cooperative intelligent transport systems | 2016 | Describe a potential implementation for informed consent in C-ITS using a policy-based framework, where privacy settings and preferences can be defined by the user, thus empowering the user in the control of his/her private data. |
| Elyes Ben Hamida; Hassan Noura; Wassim Znaidi | Security of Cooperative Intelligent Transport Systems: Standards, Threats Analysis and Cryptographic Countermeasures [Part Of: Electronics (Basel), 01 July 2015, Vol.4(3), pp.380-423] | 2015 | This article reviews the current research challenges and opportunities related to the development of secure and safe ITS applications. It first explores the architecture and main characteristics of ITS systems and surveys the key enabling standards and projects. Then, various ITS security threats are analyzed and classified, along with their corresponding cryptographic countermeasures. Finally, a detailed ITS safety application case study is analyzed and evaluated in light of the European ETSI TC ITS standard. An experimental test-bed is presented, and several elliptic curve digital signature algorithms (ECDSA) are benchmarked for signing and verifying ITS safety messages. To conclude, lessons learned, open research challenges and opportunities are discussed. |
| ERTICO | Guide about technologies for future C-ITS service scenarios | 2015 | The Guide was developed by the ERTICO Task Force on Communication Technologies for C-ITS services. The document, which has laid the foundation for the report on C-ITS service scenarios, is the result of the joint efforts of 26 members of the ERTICO Partnership, under the guidance Anders Fagerholt (Ericsson) and Francois Fischer (ERTICO office). This guide is intended as a tutorial or guidance for those who need a more detailed insight in the ITS technologies, standards and initiatives. |
| European Commission Communication | A Master Plan for the deployment of Interoperable Cooperative Intelligent Transport Systems in the EU | 2016 | EC Roadmap to the adoption of a Masterplan for the deployment of C-ITS appliocations |
| European Telecommunications Standards Institute | Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; | 2011 | Review of standards and architecture for C-ITS applications |
| EU-US ITS Task Force Standards Harmonization Working Group Harmonization Task Group 3 | Status of ITS Communication Standards | 2012 | List of references for standardization documentation concerning C-ITS |
| F Verweij, N Hoose, S Sondeijker, M Kuiken, J Pommer and W Savenije | Guidelines for policy makers: policy challenges on the way to the development of CVIS | 2010 | Overview of the main Areas of policy that CVIS will interact with and to provide a number of recommendations from the policy perspective |
| Festag, Andreas | Cooperative intelligent transport systems standards in Europe [IEEE Communications Magazine, Vol. 52, Issue 12, pp.64–70, December 2015] | 2015 | This article provides a comprehensive overview of standards and complementary industry specifications for cooperative systems in Europe, covering relevant aspects of access technologies, network and transport protocols, facilities, applications, security, and management. |
| Hugo Chauvin, Cornelie van Driel, Karl-Gerhard Freyer, Philippe Gaches, Peter Rapp, Ian Wilkinson | ITS Action Plan Study regarding Reservation Services for Safe and Secure Parking Places for Trucks and Commercial Vehicles | | Final Report on the study regarding Reservation Services for Safe and Secure Parking Places for Trucks and Commercial Vehicles. Technologies for making reservation have been analysed |
| John B. Kenney Toyota Info Technology Centre, USA | C-ITS in the USA: A Status Update on 5.9 GHz DSRC | 2016 | Short range communication |
| Karl Rehrl, Josep Maria Salanova | Traffic management 2.0 - The Win-Win | 2016 | Exchange of data and information from the road vehicles and the Traffic Management and Control |

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| Grau, Josep Laborda, Johanna Despoina Tzanidaki, Frans van Waes | | | Centres |
| Konstantinos Katsaros, Ralf Kernchen, Mehrdad Dianati, David Rieck | Performance study of a Green Light Optimized Speed Advisory (GLOSA) application using an integrated cooperative ITS simulation platform | 2011 | This paper aims to implement a GLOSA system to reduce traffic congestion by decreasing the average stop time behind traffic lights while reducing fuel consumption and CO2 emissions. The GLOSA application provides the advantage of timely and accurate information about traffic lights cycles and traffic lights position information through infrastructure-to vehicle (I2V) communication, and provides drivers with speed advice guiding them with a more constant speed and with less stopping time through traffic lights |
| Lei Chen and Cristofer Englund | Cooperative ITS — EU standards to accelerate cooperative mobility | 2014 | EU standards for C-ITS |
| Lei Chen, Azra Habibovic, Cristofer Englund, Alexey Voronov, and Anders Lindgren Walter | Coordinating dangerous goods vehicles: C-ITS applications for safe road tunnels | 2015 | Investigates the potential of C-ITS applications for coordinating dangerous goods vehicles to minimize the risk by maintaining safe distances between them in road tunnels. |
| Marcel van Sambeek et. Al | Towards an Architecture for Cooperative-Intelligent Transport System (C-ITS) Applications in the Netherlands | 2015 | Discusses the C-ITS applications of 7 projects in the Netherlands, the business model design, system and implementation architectures |
| Marcus Burke and James Williams, NTA Australia | Cooperative ITS Regulatory Policy Issues Discussion Paper | 2012 | Regulatory options for the safe and effective deployment and support of Cooperative Intelligent Transport Systems in Australia |
| Michele Rondinone et al. | iTETRIS: A modular simulation platform for the large-scale evaluation of cooperative ITS applications | 2013 | Presentation of the ITETRIS simulation platform capable to test, with high modelling accuracy, cooperative ITS systems and applications in large scale scenarios |
| Ministry of land, infrastructures, transport and Tourism | ITS initiative in Japan | 2014 | Platooning, C-ITS is a priority |
| Onno Tool, Rijkswaterstaat; Fred Verweij, Rijkswaterstaat | Website report on state-of-the-art strategy for C-ITS deployment | 2015 | Starting point for this research on strategic issues for C-ITS deployment are the country reports submitted to the European Commission within the framework of the ITS Directive 2010-40. Following this directive, countries are requested to submit reports on the status and plans with respect to ITS. In this inventory, in total 61 reports have been reviewed, including initial ITS reports, national five year ITS plan reports, progress reports and other reports discussing C-ITS. The main focus of the report will be on cooperative ITS related to road transport. |
| Pac | Connected Car in Europe | 2015 | Strategies and technologies for connected driving in Europe |
| Ramboll | Mid-term evaluation of the implementation of the ITS Action Plan | 2013 | The report contains the findings of the “Mid-term evaluation of the implementation of the ITS" performed by Ramboll Management Consulting between July 2012 and February 2013 in the context of the ITS Action Plan’ |
| Rathenau Institute | Converging Roads - Linking self-driving cars to public goals | 2015 | About the trouble and challenges of rapid autonomous development and the development of cooperate ITS |
| Robbin Blokpoel, Md. Faqhrul Islam, Jaap Vreeswijk | Impact analysis of the ecoApproach advice application | 2014 | Ecoapproach advice is one of the cooperative applications developed in the ecomove project with a view to avoid excessive stops, unnecessary acceleration and braking. |
| Salanova Grau, Josep Maria; Rusich, Andrea; Mitsakis, Evangelos; Ukovich, Walter; Fanti, Maria Pia; Aifadopoulou, Georgia; | Evaluation framework in Cooperative Intelligent Transport Systems (C-ITS) for freight transport: the case of the CO-GISTICS speed advice service [Part Of: International Journal of | 2016 | The current paper overviews the impact assessment methodologies applied in recent founded projects with the aim of defining an evaluation framework for the ongoing 7th Framework Program project “cooperative logistics for sustainable mobility of goods (CO-GISTICS)”. |

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| Nolich, Massimiliano; Scala, Elisabetta; Papadopoulos, Christos | Advanced Logistics, 02 January 2016, Vol.5(1), p.30-43] | | |
| Sheng-Hai An, university of South Korea | A Survey of Intelligent Transportation Systems | 2011 | Focuses on the comparison and analysis of international ITS research and |
| Smart Cities Stakeholder Platform Karl Oskar Proskawetz | C-ITS and Services | 2013 | Analysis of C-ITS key innovations with higher potential impact to be deployed into smart cities framework |
| Stefan Klug, Bernd Beckert (Fraunhofer ISI/D) | Cooperative Intelligent Transport Systems and Services | 2013 | Description of C-ICT application in the context of EU Smart Cities Stakeholders Platform |
| Steven E. Shladover | Deployment Path Analysis for Cooperative ITS Systems | 2008 | Discusses the deployment (institutional and technological) challenges faced by cooperative information systems and cooperative vehicle-highway automation systems, both of which require coordination of deployment of vehicle and infrastructure-based elements |
| TISA | TISA Provision of EU-wide multimodal travel information services | | Multimodal travel |
| TISA | TISA position concerning a public consultation of the European Commission on the Provision of EU-wide Real-time Traffic Information Services | 2014 | Real-time Traffic Data and Real-time Traffic Information Services |
| TISA | Quality on traffic information | 2016 | Travel and traffic information service perspective about quality of traffic information |
| TNO | Whitepaper on truck platooning | 2015 | Paper about the current situation and development of Truck Platooning |
| Tom van de Ven, Mark Wedlock (RAPPTRANS) for DG MOVE | ITS Action Plan Action C - Free Road Safety Traffic Information | 2013 | The report provides an overview of the current situation of safety related traffic information (SRTI) in Member States |
| Tom van de Ven, Mark Wedlock (RAPPTRANS) for DG MOVE | ITS Action Plan Action B - EU-wide real-time traffic information services | 2014 | Final Report on the necessary requirements to make EU-wide real-time traffic information (RTTI) services accurate and available across borders to ITS users |
| Transport Research & Innovation Portal (TRIP) | Research Theme Analysis Report - Cooperative Intelligent Transport Systems | 2016 | This report gives an overview of research performed (mostly) in the EU collated by TRIP, providing a view across many projects that fall under the cooperative intelligent transport systems (ITS) theme title |
| UNECE (United Nations Economic Commission for Europe) | Road map for promoting ITS – 20 global actions – 2014/2020 | 2014 | Road map for the ITS implementation |
| US Department of Transportation | Planning for the future of transportation: connected vehicles and ITS | 2015 | Planning for the future of transportation: connected vehicles and ITS |
| US DOT | USDoT ITS Strategic Plan 2015- 2019 | 2014 | priorities on V2V connection and automate guidance |
| van Wees and K Brookhuis, Delft University of Technology | Product liability for ADAS; legal and human factors perspectives, | 2005 | contribution the European Product Liability Directive's concept of a defective product is described and analysed from both a legal and a human factors perspective |
| Vittorio Astarita, Giuseppe Guido, Domenico Mongelli & Vincenzo Pasquale Giofrè | A co-operative methodology to estimate car fuel consumption by using smartphone sensors; Eco smart and TutorDrive: tools for fuel consumption reduction | 2015 | A co-operative system which offer drivers the ability to manage their consumption and driving style, suggesting corrections to the usually adopted behaviour. The proposed system allows drivers to analyse detailed information about their individual driving style and statistics on their fuel consumption. |
| Walter Balzano, Maria Rosaria Del Sorbo, Domenico Del Prete | SoCar: A Social Car2Car Framework to Refine Routes Information Based on Road Events and GPS | 2015 | Deals with an enhancement of the maps for satellite navigation with additional information layers, containing current events observed by the vehicles and transmitted by Car2Car (C2C) exchange and not by a centralized infrastructure. |
| Zeppelin University, Amadeus, Thales, UNIFE, IATA | All Ways Travelling: To develop and validate a European passenger transport information and booking system across transport modes | 2014 | Final report for the DG MOVE establishment of a well-functioning marketplace for MultiModal Information and Ticketing Systems (MMITS) |

Table A.1.ii FP7/H2020 projects

| Project acronym | Begin | End | Project description | Website | Organisation |
|---|---|---|---|---|---|
| 79GHZ | 2011 | 2014 | An international automotive 79 ghz frequency harmonisation initiative and worldwide operating vehicular radar frequency standardisation platform | Http://www.79ghz.eu/ | |
| Adaptive | 2014 | Ongoing | Various automated driving functions for daily traffic by dynamically adapting the level of automation to situation and driver. | Https://www.adaptive-ip.eu/ | Volkswagen group research |
| Amidst | 2015 | 2010 | Analysis of massive data streams | Http://amidst.eu/ | Hugin expert |
| Amitran | 2011 | 2014 | The Amitran project defined a reference methodology to assess the impact of intelligent transport systems on CO2 emissions. | Http://www.amitran.eu/ | |
| Assess | 2009 | 2013 | Mobilises the European research community and car industry to develop a relevant set of test and assessment methods applicable to a wide range of integrated vehicle safety systems. | Http://www.assess-project.eu/ | Humanetics |
| Carnet | 2015 | 2017 | KDPOF in the automotive market for increased data use | http://cordis.europa.eu/project/rcn/196392_en.html | |
| CHARM PCP | 2012 | 2017 | Stimulating innovations to improve traffic management centres. -> C--ITS module | Https://staticresources.rijkswaterstaat.nl/binaries/CHARM%20factsheet_tcm21-36475.pdf | Highways Agency UK |
| CIMEC | 2015 | 2017 | Cimec will explore the role C-ITS can play to support city authorities, both in managing their transport networks and the delivery of other transport-linked services. Reaching out to key stakeholders to ensure smooth and efficient deployment | Cimec-project.eu | |
| Civitas | 2002 | 2005 | Platform to exchange ideas and experiences about cleaner transport in cities | Www.civitas.eu | Regional Environmental Center Hungary |
| Co-Cities | 2011 | 2013 | Closed the 'feedback loop' of cooperative mobility services and elaborated a development path for traffic management in European cities | Http://www.co-cities.eu/ | Austriatech |
| Codecs | 2015 | 2018 | Cooperative ITS Deployment Coordination Support | www.codec-project.eu | |
| Cogistics | 2014 | 2016 | Deployment of C-ITS focused-on logistics. | Http://cogistics.eu/factsheet/ | Ertico |
| Colombo | 2012 | 2015 | How to overcome the need for a large penetration rate with C-ITS | Http://www.colombo-fp7.eu/ | Imtech travel |
| Comesafety2 | 2011 | 2014 | Coordinating all activities towards the realisation of cooperative systems on EU roads | Http://cordis.europa.eu/project/rcn/80584_en.html | Bmw |
| Companion | 2013 | 2016 | Platooning project with Scania using V2V | http://www.companion-project.eu/ | Scania |
| COMPASS4D | 2013 | 2015 | Field testing three C-ITS services: Energy efficient intersection, road hazard warning, red light violation warning | Http://www.compass4d.eu/en/about/ | Ertico |
| Cover | 2009 | 2013 | Coordination of vehicle and road safety initiatives. Also, comparison with an US system. | Http://cordis.europa.eu/project/rcn/90174_en.html | Humanetics |
| DRIVE C2X | 2005 | 2005 | Laying foundation for c-its systems in Europe | Http://www.drive-c2x.eu/ | Daimler AG |
| Ecogem | 2010 | 2013 | Full electric vehicle energy efficiency in route possible. And using information services and adjusting route on the move. | http://www.ecogem.eu/ | |
| Ecohubs | 2012 | 2015 | Ecohubs provides models and capabilities for cooperation and communication between green hubs' stakeholders, plus establishing value added services making co-modal networks attractive to use | Http://www.ecohubs.eu/ | |

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| | | | and, at the same time, contributors to reduction in greenhouse gas emissions and other pollutants. | | |
| Ecomove | 2010 | 2014 | To create an integrated solution for road transport energy efficiency to help drivers, freight and road operators to reduce unnecessary kilometres, save fuel and manage traffic more efficiently | Http://www.ecomove-project.eu/about-ecomove/ | Ertico Europe |
| Efuture | 2010 | 2013 | Efuture wants to prepare the next generation of electric vehicle based on our first prototype by creating a platform which minimises its energy needs but can still optimise dynamically its decision between safety and energy efficiency. | http://www.efuture-eu.org/ | |
| Eranet | 2008 | 2018 | One of these horizontal future initiatives will be the provision of a database on national transport research programmes and national R&D results. Furthermore, the Era-net Transport sees a need to encourage and enable less-experienced partners to participate in trans-national cooperation as well as in the European Framework Program | Http://transport-era.net/results/sustainable/ | Rijkswaterstaat |
| Esbf_2 | 2015 | Ongoing | European bus system of the future phase 2 | Http://ebsf2.eu/ | |
| ETNA 2020 | 2016 | 2019 | Linkage between the 'Smart, Green and Integrated Transport' NCPs and all the research and business stakeholders in the transport sector, including all the transport modes and several cross-cutting areas | Http://www.transport-ncps.net/funding-map-database/ | ETNA 2020 |
| Euridice | 2008 | 2012 | Project that will create the necessary concepts, technological solutions and business models to establish an information services platform centred on the context of individual cargo items and their interaction with the surrounding environment and the types of users | http://cordis.europa.eu/project/rcn/85573_en.html | |
| Eurofot | 2008 | 2012 | European Field operational test on active safety systems | Http://www.eurofot-ip.eu/ | Ertico |
| Fot-net | 2014 | 2016 | The FOT-Net project has been in place for six years (2008-2013) as the networking platform for stakeholders involved or interested in Field Operational Tests | Http://fot-net.eu/context/ | Ertico |
| Fotsis | 2011 | 2015 | Largescale field testing of the road infrastructure management systems needed for the operation of seven close-to-market cooperative I2V, V2I & I2I technologies (Fotsis Services), in order to assess in detail both 1) their effectiveness and 2) their potential for a full-scale deployment in European roads. | Http://www.fotsis.com/ | |
| Green emotion | 2011 | 2015 | The project has defined and demonstrated a European framework that connects all electro mobility stakeholders for a seamless, cost-efficient, and interoperable electro mobility ecosystem | http://cordis.europa.eu/project/rcn/186970_en.html | |
| HIGHTS | 2015 | 2018 | Precise location position for C-ITS applications | Http://hights.eu/ | Jacobs university bremen |
| Icar support | 2009 | 2012 | The objective of Icar was to give support to the implementation of actions and recommendations resulting from the work of the imobility Forum and the Intelligent Car Initiative | Http://www.transport-research.info/project/intelligent-car-support | Ertico |
| Icargo | 2011 | 2015 | Icargo will build an open affordable information architecture that allows real world objects, existing systems, and new applications to efficiently co-operate, enabling more cost effective and lower-CO2 logistics through improved synchronisation and load factors across all transport modes. | Http://i-cargo.eu/partners | |
| ICSI | 2012 | 2015 | Proposing a new architecture where the intelligence for sensing and actuation is distributed over some of the elements, called gateways, which host a software platform for running ITS applications, using the local storage and computation capabilities available. | Http://www.ict-icsi.eu/ | Intecs spa |
| Inroads | 2011 | 2015 | "This project aims to develop Intelligent Road Studs (IRS) combining LED lighting, sensor systems and communication technologies to gain a better understanding of driver interactions with In-Vehicle Technologies | http://cordis.europa.eu/project/rcn/102011_en.html | |
| Intersafe @ | 2008 | 2011 | Develop and demonstrate a CISS (cooperative intersection safety systems using v2v and v2i | Http://cordis.europa.eu/project/r | IBEO |

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| | | | | cn/87267_en.html | |
| Itetris | 2001 | 2010 | Itetris is aimed at producing the necessary building blocks and interfaces to conduct large-scale tests in open source integrated wireless and traffic emulation platforms to propose and optimize innovative V2V and V2I communication capabilities to improve road traffic management. Such type of evaluations cannot be carried out today with the required level of accuracy | Http://www.ict-itetris.eu/simulator/objectives.htm | |
| I-Tour | 2014 | 2014 | The I-TOUR project is designed to promote the use of public transport by encouraging sustainable travel choices and by providing rewarding mechanisms for users choosing public travel options | http://cordis.europa.eu/result/rcn/141312_en.html | FORMIT SERVIZI S.p.A |
| ITS observatory | | | Platform that maps all ITS community, data bank with impact and benefits etc. | Http://its-observatory.eu/ | |
| Local 4 Global | 2013 | 2016 | Test and TMCS elements to be fully autonomous and make smart decisions | Http://local4global-fp7.eu/ | Cetre for research and technology Hellas |
| Mobility 2.0 | 2012 | 2015 | C-ITS communication between electric vehicles | Http://mobility2.eu/ | |
| Mobincity | 2014 | 2015 | Smart mobility in smart city | http://www.mobincity.eu/ | |
| Nearctis | | 2013 | Grouping academics to find main problems with cooperative traffic | Http://www.nearctis.org/home/project/ | IFSTTAR |
| Nodes | 2005 | 2005 | Efficient integration of public transport services | Http://www.nodes-interchanges.eu/ | FORMIT SERVIZI S.p.A. |
| Optimism | 2005 | 2005 | OPTIMISM project will propose a set of strategies, recommendations and policy measures, through the scientific analysis of social behaviour, mobility patterns and business models, for integrating and optimising transport system. | http://www.optimismtransport.eu/ | |
| Optimum | 2015 | 2018 | Setting up a big data infrastructure. Deploy in real life and integrate with Car2x | http://www.optimumproject.eu/ | |
| PRESERVE | 2011 | 2015 | Design, implement and test a secure and scalable V2X security subsystem | Https://preserve-project.eu/about | University Twente |
| Roadart | 2015 | 2018 | To investigate and optimise the integration of ITS communication in trucking. T2T and T2I | Http://www.roadart.eu/ | IMST GMBH |
| Safetrip | 2009 | 2013 | To provide an integrated system platform that will allow any third-party company to develop applications for the road market. During the project, the safetrip platform developed and demonstrated the following applications: Provision of real-time traffic information and warnings generated by the collection of data from other vehicles, -emergency call system, -tracking in real-time of vulnerable passenger’s transports. | Http://www.safetrip.eu/ | Sanef |
| Satre | 2008 | 2012 | Safe road trains with platooning | http://www.sartre-project.eu | Ricardo |
| Scout | 2016 | 2018 | Identifying pathways for an accelerated proliferation of safe and connected high-degree automated driving. | VDI/VDE | |
| Straightsol | 2011 | 2014 | Creation of new smart urban freight systems. | Https://drive.google.com/file/d/0byctqr4yifydufu1x2d5dkdreek/view | Institute of Transport Economics, Oslo, Norway |
| Tide | 2012 | 2015 | The mission of the TIDE project is to enhance the broad transfer and take-up of 15 innovative urban transport and mobility measures throughout Europe and to make a visible contribution to establish them as mainstream measures. | http://www.tide-project.eu/ | |
| Timon | 2015 | 2018 | TIMON aims to deliver a framework of services to all users of the transport ecosystem – drivers, vulnerable road users, and businesses. | http://www.timon-project.eu/ | |

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| Tips | 2012 | 2014 | Good practices for transport, transforming and helping FP projects | Http://www.transport-tips.eu/useful_material | Steinbeis innovation ggmbh |
| Ttrim | 2011 | 2014 | To map the needs for monitoring data and develop a means of cost-benefit analysis of monitoring techniques and utilisation in asset management | Http://trimm.fehrl.org/ | Vti |
| Usemobility | 2005 | 2005 | The EU project Usemobility applies a new approach to the analysis of European mobility behaviour. It particularly aims to find out why people decided to switch from pure car use to public transport within the past 5 years. | Http://www.usemobility.eu/ | Allianz |
| VRA | 2013 | 2016 | Maintain a vehicle and road network, coordinate with US and Japan. Identify and promote research | Http://vra-net.eu/about-the-vra-network/ | Ertico |
| Vruits | 2012 | 2016 | ITS used for vulnerable road users | www.vruits.eu | Temsa blobal |

# Appendix 2 Interview Format

## Questionnaire on ITS applications

**A. Background**

For a European Commission funded research project, entitled NEWBITS (see Box 1 for more information), we aim, among other things, to identify and assess current initiatives in the field of intelligent transport systems (ITS). ITS applications refer to ITS technologies that allow vehicles to communicate with other vehicles (vehicle-to-vehicle systems) or with infrastructure (vehicle-to-infrastructure or infrastructure-to-vehicle systems). In this respect we apply a broad scope, including ITS applications for all types of transport modes and all types of transport (e.g. both long- and short-distance trips).

As input for our analyses we will use several assessment methods, one of which is interviewing some relevant experts/stakeholders from all over Europe and the US. The first objective of these interviews is to identify specific ITS applications that are currently implemented/tested in Europe and the US. Secondly, we would like to gather data on the key performance indicators used with respect to ITS applications as well as information on the main barriers and enablers for these applications.

In the remainder of this note you find the questions we would like to discuss with you face-to-face or by phone.

**Box 1 NEWBITS – NEW business models for ITS**

The main objective of the NEWBITS project is to improve the understanding of the changing conditions and dynamics that affect and/or influence the deployment and performance of innovative ITS innovations. This knowledge should minimize the failures inherent to (C-)ITS innovation diffusion, evolve present business models, and identify effective incentives to accelerate ITS deployment. To acquire this knowledge, an in-depth analysis of current/future ITS applications , their barriers and enablers, market conditions, user preferences, etc. will be carried out. Additionally, NEWBTIS acknowledge the fundamental importance of people in implementing complex innovations like ITS. The project will therefore thoroughly study the networks of ITS innovations, both internal and external to the organisations acting in the ITS fields, in order to provide insight in the different roles stakeholders have in these networks, their interactions and the added value of cooperation between these actors. Based on all knowledge acquired in this project, guidelines and strategies to foster ITS deployment and performance will be developed as well as a training program for specific stakeholders.

**B. General information**

Name of organisation:
Name of Interviewee(s):
Position of the interviewee:
Interviewer(s):
Date and Time:
Location:

1) In what way are you (or is your organisation) involved in the field of ITS solutions?

## C. ITS applications

2) What are/should be, in your opinion, the main objectives of implementing ITS applications (e.g. reducing traffic jams, improving traffic safety, reducing emissions, etc.)? Multiple answers possible.

3) What are, to your knowledge, the main ITS applications that are currently applied/tested?

4) To your expectations, which developments will affect ITS most in the medium term (2025)? Please consider technological, financial/economic, social, and policy related developments.

## D. Key performance indicators

5) What are in your opinion the preferred KPIs with respect to:
   a. the deployment of ITS applications?
   b. the performance of ITS applications?
   How do these preferred KPIs differ between various types of ITS applications?

6) What are the main barriers to apply these KPIs? And how could these barriers be overcome?

7) What are the KPIs that are actually applied for the specific ITS applications identified in question 3? Please consider both KPIs for the deployment and performance of the specific ITS application.

## E. Barriers

8) What are, in general, the most important barriers currently for:
   a. the deployment of ITS applications;
   b. the performance of ITS applications.
   How do these barriers differ between various types of ITS applications?

9) What are the main barriers with respect to the specific ITS applications identified in question 3? Please consider both barriers for the deployment and performance of the specific ITS application.

10) What do you foresee to be the largest barriers for the deployment and performance of ITS applications in the future?

11) What are, in your opinion, the best options to tackle the barriers identified in questions 8-10?

## F. Enablers

12) What are, in general, the main enablers for:
   a. the deployment of ITS applications;
   b. the performance of ITS applications.
   How do these enablers differ between various types of ITS applications?

13) What are the main enablers with respect to the specific ITS applications identified in question 3? Please consider both enablers for the deployment and performance of the specific ITS application.

14) What are, in your opinion, the main options to strengthen the enablers identified by question 12 and 13?

## G. Final questions

15) Is there anything else you would like to add to this interview?

16) Could you recommend two additional stakeholders who you feel it might be useful to speak to for this study?

17) We would like to provide a summary of names of people interviewed in a NEWBITS deliverable. Is this fine by you?

18) If there are any further questions/clarifications needed, do you mind if we get in touch with you again?

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# Appendix 3 Long list of services

Table A.3 Long list of services

| Project | Short description of service | Key enabling technology | TRL | Geographic area | Type of transport | Transport mode | Primary benefits of ITS | Institutional arrangements |
|---|---|---|---|---|---|---|---|---|
| Belfast rapid transit | new and dynamic public transport Belfast | Communication | 7 | Interurban | Unscheduled | Road | Safety | PPP |
| CBTC | Communication based train control | Identification | 9 | Urban | Unscheduled | Road | Environmental | Public |
| Co-Cities | European real time traffic information | Hardware | 9 | Interurban | Unscheduled | Road | Efficiency | PPP |
| eBrio+ (VIX) | innovative smart booking, ticketing and payment | Sensors | 9 | Both | Scheduled | Buses | Efficiency | Private |
| Enhanced Wisetrip | multi modal international journey planning system | Communication | 9 | Urban | Scheduled | Rail | Efficiency | Private |
| ERMTS | European train communication technology | Communication | 7 | Interurban | Unscheduled | Trucks | Efficiency | PPP |
| FAMS | Testing GPs, GPRS to assist DRT | Identification | 9 | Urban | Unscheduled | Road | Efficiency | Public |
| FAMS | virtual agency model service | Software | 7 | Urban | Unscheduled | Road | Efficiency | PPP |
| IFM | interoperable fare management project | Communication | 8 | Both | Scheduled | Buses | Comfort | PPP |
| On vehicle CCTV | On board camera systems | Communication | 7 | Interurban | Unscheduled | Cars | Efficiency | PPP |
| Onschedule and Ontime | Planning of crew and vehicle assignment | Communication | 7 | Interurban | Unscheduled | Cars | Safety | PPP |
| Oyster Card | London smartcard | Communication | 5 | Interurban | Unscheduled | Cars | Safety | PPP |
| RTPI | Real time passenger information Ireland | Software | 9 | Urban | Scheduled | Multimodal | Efficiency | PPP |
| Scot Rail smartcard | Scottish smartcard | Communication | 7 | Interurban | Unscheduled | Trucks | Efficiency | PPP |
| TIMON | Enhanced real time traffic API | Communication | 9 | Both | Scheduled | Air | Safety | PPP |
| EcoGem | Cooperative route planning | Hardware | 6 | Urban | Unscheduled | Road | Safety | PPP |
| Ecomove | Environmental driving advice (ecoSmartDriving) | Communication | 7 | Interurban | Unscheduled | Cars | Environmental | PPP |
| Ecomove | Environmental route planner (EcoTRip) | Communication | 7 | Urban | Unscheduled | Cars | Environmental | PPP |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ecomove | Real time route planner | Software | 7 | Both | Both | Multimodal | Comfort | PPP |
| Flitsmeister | Real time traffic advice | Communication | 7 | Interurban | Unscheduled | Road | Environmental | PPP |
| Fotsis | Extended Ecall | Communication | 7 | Urban | Unscheduled | Cars | Environmental | PPP |
| Fotsis | Safety incident management | Communication | 7 | Urban | Unscheduled | Road | Safety | PPP |
| HeEro | eCall pilots | Software | 7 | Urban | Unscheduled | Cars | Environmental | PPP |
| I-5 smart truck parking | Smart truck parking project | Positioning | 7 | Both | Both | Multimodal | Efficiency | PPP |
| In-Time | multimodal real time traffic information | Communication | 7 | Both | Unscheduled | Cars | Environmental | PPP |
| Mobility 2.0 | App for electric vehicle optimization | Communication | 6 | Interurban | Unscheduled | Cars | Efficiency | PPP |
| Octo U | Measuring telematics | Communication | 7 | Both | Unscheduled | Cars | Environmental | PPP |
| Parckr | Cooperative truck parking app | Software | 9 | Both | Both | Multimodal | Comfort | Private |
| Praktijkproef Amsterdam Adam | Real time travel advice | Hardware | 7 | Both | Unscheduled | Trucks | Environmental | PPP |
| Praktijkproef Amsterdam Superroute | Real time travel advice | Algorithms | 8 | Both | Scheduled | Multimodal | Efficiency | PPP |
| ProbeIT foresight vehicle | Providing timely and location based advise | Communication | 7 | Interurban | Unscheduled | Cars | Environmental | PPP |
| Q-Warn | Queue warning | Hardware | 7 | Both | Unscheduled | Cars | Environmental | PPP |
| Smartfreight | Urban freight management on board system | Communication | 7 | Both | Both | Road | Efficiency | PPP |
| SmarTrAC | innovative application that collects travel data | Communication | 7 | Urban | Unscheduled | Cars | Environmental | PPP |
| VSC -A | DSRC 5.9 GHZ positioning project | Hardware | 7 | Urban | Unscheduled | Cars | Environmental | PPP |
| Vx-TINFO | Weather response traffic information systems | Software | 9 | Both | Unscheduled | Cars | Comfort | Private |
| Waze | Real time travel and traffic advice | Communication | 9 | Both | Scheduled | Rail | Efficiency | PPP |
| Zoof | Cooperative traffic information mobile application | Software | 8 | Interurban | Scheduled | Air | Efficiency | PPP |
| Access control in Rome | Access control for polluting vehicles | Communication | 8 | Interurban | Unscheduled | Cars | Efficiency | PPP |
| ASPI | Highway management Autostrada per L'Italia | Communication | 7 | Interurban | Unscheduled | Trucks | Efficiency | PPP |
| Automatic passenger counting systems | Counts passengers automatically | Hardware | 7 | Both | Unscheduled | Cars | Safety | PPP |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Connected Boulevard Nice | Manage and optimize city aspects | Positioning | 7 | Both | Unscheduled | Cars | Safety | PPP |
| Departure planning information | Real time departure times of airplanes | Communication | 7 | Interurban | Unscheduled | Road | Safety | PPP |
| Ecomove | Improve network usage | Communication | 7 | Urban | Unscheduled | Trucks | Efficiency | PPP |
| Ecomove | Improve parking guidance | Communication | 7 | Urban | Unscheduled | Trucks | Efficiency | PPP |
| Fotsis | Accident reconstruction and safety analysis | Communication | 7 | Both | Unscheduled | Cars | Efficiency | PPP |
| Fotsis | Balance traffic load (Intelligent congestion control) | Algorithms | 7 | Both | Unscheduled | Cars | Efficiency | PPP |
| Fotsis | Dynamic Route planning | Software | 7 | Both | Unscheduled | Cars | Safety | PPP |
| Fotsis | Enforcing traffic rules | Positioning | 7 | Both | Unscheduled | Cars | Safety | PPP |
| GUIADE | Public transport information guidance | Identification | 6 | Both | Scheduled | Multimodal | Comfort | PPP |
| HOGIA | Secure transport communication based on TETRA | Identification | 9 | Urban | Unscheduled | Cars | Environmental | PPP |
| Lane management USA | Lane management to regulate lane modes | Communication | 6 | Both | Scheduled | Buses | Efficiency | PPP |
| Madrid smart parking | Variable parking rate based on emissions | Software | 5 | Both | Unscheduled | Cars | Comfort | PPP |
| Multi use lane Barcelona | VMS that show who are allowed on the street | Hardware | 9 | Urban | Unscheduled | Road | Efficiency | PPP |
| NY MiM | NY adaptive traffic signal control system | Communication | 7 | Interurban | Unscheduled | Trucks | Comfort | PPP |
| Piedmont regional traffic centre | Traffic supervision centre in Piedomt (IT) | Identification | 9 | Interurban | Unscheduled | Trucks | Efficiency | PPP |
| Praktijkproef Amsterdam Eva | Real time parking advice | Software | 7 | Urban | Unscheduled | Road | Comfort | PPP |
| Praktijkproef Amsterdam Superroute P | Real time parking advice | Algorithms | 9 | Interurban | Unscheduled | Road | Efficiency | Public |
| Sensit Nedap | Automated parking advice | Communication | 7 | Interurban | Unscheduled | Cars | Efficiency | PPP |
| Traffic information system Romania | national route guidance system | Communication | 9 | Both | Both | Road | Safety | PPP |
| UTC London | Urban traffic light control based on demand | Identification | 9 | Urban | Unscheduled | Road | Comfort | Public |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Congestion charge London | Charge system for traffic (peak) hours | Sensors | 9 | Both | Scheduled | Buses | Safety | Private |
| Maut | German and Austrian km toll system for freight | Identification | 9 | Both | Scheduled | Multimodal | Comfort | PPP |
| Milano Area C | Low emission zone & charging scheme | Communication | 7 | Interurban | Unscheduled | Trucks | Comfort | PPP |
| Sanef | Automated toll Uk Liber-t | Sensors | 9 | Both | Unscheduled | Cars | Safety | Private |
| Stockholm congestion pricing | Congestion pricing and management in Stockholm | Communication | 9 | Both | Scheduled | Buses | Efficiency | Private |
| Telepass | Automated toll recognition | Algorithms | 9 | Urban | Unscheduled | Road | Efficiency | PPP |
| TEXpress | Texan express lane | Algorithms | 9 | Both | Unscheduled | Road | Efficiency | PPP |
| ADS-B | Plane communication technology | Communication | 9 | Urban | Unscheduled | Cars | Comfort | Private |
| Austroads heavy vehicle platooning | Truck platooning | Software | 9 | Interurban | Unscheduled | Road | Efficiency | PPP |
| C-ACC | Cooperative adaptive cruise control test in United States | Communication | 7 | Urban | Unscheduled | Cars | Comfort | PPP |
| CITI | Collision warning system | Communication | 7 | Urban | Unscheduled | Cars | Comfort | PPP |
| C-ITS corridor Netherlands | Vehicles receive a warning about road works | Communication | 9 | Both | Unscheduled | Cars | Comfort | Private |
| C-ITS corridor Netherlands | Vehicles send data automatically to probes | Communication | 7 | Interurban | Unscheduled | Cars | Efficiency | PPP |
| Companion | Truck platooning | Communication | 7 | Both | Unscheduled | Cars | Efficiency | PPP |
| Connected cruise control | Connected cruise control | Communication | 7 | Both | Unscheduled | Cars | Efficiency | PPP |
| Dante | Intersection collision warning | Hardware | 7 | Urban | Unscheduled | Cars | Safety | PPP |
| Ecomove | Improve intersection control | Communication | 7 | Interurban | Unscheduled | Road | Safety | PPP |
| Ecomove | Intersection control, visualisation and prioritisation | Hardware | 9 | Interurban | Unscheduled | Cars | Comfort | Private |
| Ecomove | Lane advice | Communication | 7 | Interurban | Unscheduled | Road | Safety | PPP |
| Ecomove | Merging support | Identification | 9 | Both | Scheduled | Multimodal | Comfort | Private |
| Ecomove | Ramp control | Software | 7 | Urban | Unscheduled | Trucks | Efficiency | PPP |
| Ecomove | Speed and lane advice | Identification | 9 | Interurban | Unscheduled | Road | Efficiency | Private |
| Ecomove | Traffic light control (GLOSA) | Software | 6 | Both | Scheduled | Buses | Efficiency | PPP |
| eSENAL | Intelligent signalling system | Communication | 9 | Both | Scheduled | Buses | Comfort | Private |
| Flowpatrol | Cooperative traffic information mobile application | Positioning | 7 | Interurban | Unscheduled | Road | Efficiency | PPP |
| Fotsis | Tracking of special vehicles | Identification | 9 | Interurban | Unscheduled | Road | Comfort | PPP |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fotsis | Trucks intersection priority | Communication | 7 | Both | Unscheduled | Road | Safety | PPP |
| Freilot | Truck priority at intersections | Communication | 7 | Both | Unscheduled | Cars | Safety | PPP |
| Intelvia | Intelligent Electronic Traffic Signalling System | Communication | 7 | Both | Unscheduled | Trucks | Efficiency | PPP |
| Roadart | Truck platooning in special situations | Sensors | 9 | Urban | Unscheduled | Road | Efficiency | Public |
| Safecross | Smart pedestrian crossing. | Identification | 9 | Urban | Unscheduled | Road | Efficiency | PPP |
| Satre Road train | Safe road train | Positioning | 7 | Both | Unscheduled | Multimodal | Comfort | PPP |
| Uk Autodrive | automated and connected car trial | Communication | 7 | Both | Unscheduled | Cars | Efficiency | PPP |

# Appendix 4 Synthesis of Judgement process

## Appendix 4.1. Consolidated Decision Matrix for Criteria Comparison

Aggregation of individual judgments for 8 Partners

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 1 | 1.75 | 3.07 | 2.61 | 1.86 | 0.48 | 2.82 | 0.59 | 1.25 | 1.83 |
| C2 | 0.57 | 1 | 1.63 | 2.48 | 2.38 | 0.23 | 2.52 | 0.50 | 1.08 | 0.71 |
| C3 | 0.33 | 0.61 | 1 | 1.48 | 1.99 | 0.28 | 1.47 | 0.42 | 0.96 | 1.16 |
| C4 | 0.38 | 0.40 | 0.67 | 1 | 0.93 | 0.20 | 0.55 | 0.32 | 0.40 | 0.96 |
| C5 | 0.54 | 0.42 | 0.50 | 1.08 | 1 | 0.23 | 1.76 | 0.48 | 0.53 | 1.39 |
| C6 | 2.09 | 4.28 | 3.63 | 4.94 | 4.37 | 1 | 3.87 | 1.30 | 2.97 | 3.01 |
| C7 | 0.35 | 0.40 | 0.68 | 1.80 | 0.57 | 0.26 | 1 | 0.41 | 0.81 | 0.54 |
| C8 | 1.68 | 2.01 | 2.38 | 3.16 | 2.07 | 0.77 | 2.46 | 1 | 2.59 | 3.07 |
| C9 | 0.80 | 0.93 | 1.04 | 2.53 | 1.89 | 0.34 | 1.23 | 0.39 | 1 | 0.76 |
| C10 | 0.55 | 1.42 | 0.86 | 1.04 | 0.72 | 0.33 | 1.85 | 0.33 | 1.32 | 1 |

## Appendix 4.2 Consolidated Decision Matrix for Categorisation with respect to each criterion

Aggregation of individual judgments for 8 Partners

| **Criterion** | **Innovation level** | | |
|---|---|---|---|
| | 1 | 1.39 | 1.36 |
| | 0.72 | 1 | 1.87 |
| | 0.74 | 0.54 | 1 |
| **Criterion** | **ITS enabling Technology** | | |
| | 1 | 4.88 | 4.73 |
| | 0.20 | 1 | 0.90 |
| | 0.21 | 1.11 | 1 |
| **Criterion** | **Geographic scope** | | |
| | 1 | 0.27 | 0.20 |
| | 3.67 | 1 | 0.43 |
| | 4.99 | 2.31 | 1 |
| **Criterion** | **Transport mode** | | |
| | 1 | 0.23 | 0.22 |
| | 4.26 | 1 | 0.87 |
| | 4.45 | 1.15 | 1 |
| **Criterion** | **Transport type** | | |
| | 1 | 0.25 | 0.25 |
| | 4.00 | 1 | 1.40 |
| | 3.97 | 0.71 | 1 |
| **Criterion** | **Primary benefits** | | |
| | 1 | 0.23 | 0.16 |
| | 4.41 | 1 | 0.61 |

| | | | |
|---|---|---|---|
| | 6.37 | 1.65 | 1 |
| **Criterion** | **Institutional framework** | | |
| | 1 | 0.39 | 0.30 |
| | 2.60 | 1 | 1.12 |
| | 3.31 | 0.89 | 1 |
| **Criterion** | **Type of stakeholders** | | |
| | 1 | 0.37 | 0.30 |
| | 2.73 | 1 | 0.86 |
| | 3.31 | 1.16 | 1 |
| **Criterion** | **Transferability** | | |
| | 1 | 0.51 | 0.32 |
| | 1.95 | 1 | 2.59 |
| | 3.17 | 0.39 | 1 |
| **Criterion** | **Deployment period** | | |
| | 1 | 0.58 | 0.66 |
| | 1.72 | 1 | 0.62 |
| | 1.51 | 1.61 | 1 |
| **Consensus** | 98.39% | | |

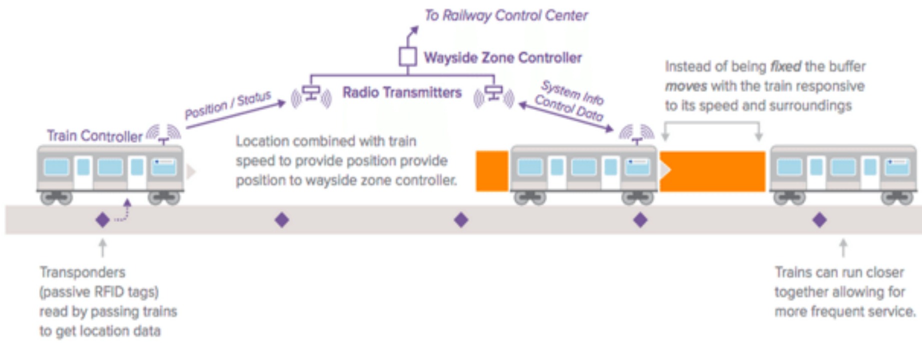
## Appendix 4.3 The overall AHP decision hierarchy

**Decision Hierarchy**

| Level 0 | Level 1 | | Global Priorities | Market by Component | Market by Application | Market by Type |
|---|---|---|---|---|---|---|
| Choose an ITS market categorisation | Innovation level | 0.1268 | 12.7 % | 0.051 | 0.0455 | 0.0302 |
| | ITS enabling technology | 0.0898 | 9.0 % | 0.0634 | 0.0127 | 0.0137 |
| | Geographic deployment area | 0.0696 | 7.0 % | 0.0069 | 0.0213 | 0.0413 |
| | Transport mode | 0.0446 | 4.5 % | 0.0046 | 0.019 | 0.0211 |
| | Transport type | 0.0594 | 5.9 % | 0.0066 | 0.0294 | 0.0234 |
| | Primary benefits | 0.2401 | 24.0 % | 0.0202 | 0.0853 | 0.1346 |
| | Institutional framework | 0.0508 | 5.1 % | 0.0074 | 0.0217 | 0.0217 |
| | Type of stakeholders | 0.1668 | 16.7 % | 0.0237 | 0.0657 | 0.0773 |
| | Transferability | 0.0796 | 8.0 % | 0.013 | 0.041 | 0.0256 |
| | Deployment period | 0.0724 | 7.2 % | 0.017 | 0.0239 | 0.0315 |
| | | | 1.0 | 21.4 % | 36.6 % | 42.0 % |

# Appendix 5 Service Fiches

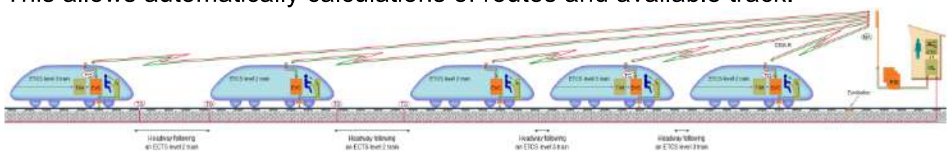
| Belfast Rapid Transit | |
|---|---|
| Description | |
| Status | Ongoing (2013 – 2018) |
| Country | Northern Ireland, UK |
| Description of service | Belfast Rapid Transit (BRT) is an innovative and ambitious project that will create a new and dynamic public transport system for Belfast. The system will use high quality rapid transit vehicles which will provide a modern, comfortable environment for passengers in terms of space, security and on-board information. the BRT vehicles will have on-board information screens providing real time journey information and audio visual next halt and destination announcements. Free on-board Wi-Fi will also be provided. The BRT vehicles will be equipped with CCTV for both passenger and driver safety. Also, the halts will provide travel information. |
| Main objective | There will be a noticeable impact on the general traffic that uses the BRT corridors, particularly as the system gets established, but the impact will reduce as more people realise the benefits of using BRT.<br>It is acknowledged that there is a need for many people to continue using their cars and for commercial traffic to be able to move about the city. It is therefore the aim to deliver an appropriate balance between the competing demands. Also, users will be better informed and make safer, more coordinated, and 'smarter' use of public transport networks (efficiency and environment). |
| Innovation phase | 8 |
| Type of ITS | The main type of ITS used seems to be APTS, Real time system status update. Stations used are: on-board information screens, mobile phones, automatic vehicle location system and signal control systems. |
| Technology used | The technologies used seem to be:<br>• cellular;<br>• internet/wi-fi;<br>• automatic vehicle location system technology;<br>• signal control systems technology. |
| Geographical scale | The first phase of the BRT network, which is currently being implemented, will link East Belfast, West Belfast and Titanic Quarter via the City Centre.<br>It is the intention to extend the BRT network to other areas of Belfast, subject to the success of phase 1 and the availability of funding. The Department is already engaging with those responsible for proposed developments on potential routes outside the current network to ensure as far as possible that the future provision of BRT to key areas is not prejudiced. |
| Type of transport | Buses |
| Type of stakeholders | The investment comes from the Department for Regional Development of Northern Ireland.<br>Belgian-based company Van Hool won the contract. They are a highly regarded independent manufacturer of buses, coaches and industrial vehicles and the 4th largest employer in Belgium.<br>They will be supported locally by Road Trucks Limited, based in Larne, which will provide commissioning, maintenance and specialist support services for the BRT vehicles. The BRT system will be operated by Translink when it begins services in September 2018. |
| Institutional arrangements | The funds seem to be entirely public (it's not very clear). |
| Transferability | The service can be transferred to other regions and modes of transport. |

| Communications based train control | |
|---|---|
| Description | |
| Status | Applied in multiple initiatives |
| Country | Globally. Paris, New York, London |
| Description of service | Urban Metro communicates their location directly to the traffic management centre. This allows them to continuously broadcast their location, allowing a more efficient use of the system. Train have safety barriers (blocks) before and after their occupancy. In older systems, this was fixed depending on points that the train passed. CBTC allows these safety blocks to move along with the train. Even controlling metros automatically and thus removing the driver. An example of the system is Bombardier CityFlo<br><br> |
| Main objective | • Efficiency: trains are able to drive closer to each other as the safety distance is applied better<br>• Environmental: less energy used due to less unnecessary braking |
| Innovation phase | Operational. TRL 9 |
| Type of ITS | APTS Real time system status information |
| Technology used | The following technologies are used:<br>GSM-R |
| Geographical scale | Regional level: on specific parts of national highways and local test facilities. |
| Type of transport | Trains and specifically metro and subway |
| Type of stakeholders | • Railway operators<br>• Manufacturers of metros<br>• Service providers of rail management systems |
| Institutional arrangements | Not applicable |
| Transferability | Transferable to other cities and countries. Limited to rail transport |

| European Real Time Traffic Information (Co-Cities) | |
|---|---|
| Description | |
| Status | Co Cities Project started 2011 to 2014 |
| Country | UK, Spain, Czech Republic, Austria, Belgium, Germany, Italy |
| Description of service | Co-Cities focused on providing one standardized interface between city traffic information and the Traffic Information Service Providers, the In-Time common interface.<br>The availability of the full “feedback loop” enables an end-to-end testing and validation process for the single traffic information service in the cities and elaborates the future expansion steps for cities and service providers. The core service provided by Co-Cities being Interoperable and multimodal RTTI services to end-users, offered by Traffic Information Service Providers (TISPs). |
| Main objective | The increased reliability and actual real-time delivery of the traffic and travel information services to the individual traveller and to the traffic management centres (efficiency); the extension of the In-Time Commonly Agreed Interface to a number of EU cities in order to increase the data and information flow and management; the reduction of energy consumption in urban areas (environment) across different modes of transport; the increased attractiveness of transport information services to users in urban areas. |
| Innovation phase | TRL9. Based on the outcomes from In-TIME and Co-Cities services were piloted in diverse cities. The proposed service model of Co-Cities CAI (Commonly Agreed Interface) was made fully operative at the end of the project. |
| Type of ITS | APTS Real Time Passenger Transport Information |
| Technology used | Co-Cities used different hardware and software platforms such as personal navigation devices, smart phones and web services and developed Europe–wide services based on regional traffic and travel data. |
| Geographical scale | Urban level, EU wide. |
| Type of transport | Multi modal applications covering both passenger and freight applications |
| Type of stakeholders | • Government/cities<br>• European Union<br>• Service providers<br>• Research institutes<br>• OEMS<br>• Automotive suppliers<br>• Emergency services<br>• Parking operators<br>• Travellers/passengers<br>• Road operators |
| Institutional arrangements | PPP<br>Co-Cities was a CIP/ ICT PSP project under the 7th Framework Programme |
| Transferability | Co-Cities highlighted global possibilities where consistent standards are adopted throughout Regions, Countries.   Technologies can be applied across all modes |

| eBrio+ (VIX) | |
|---|---|
| Description | |
| Status | On-going |
| Country | Australia |
| Description of service | Vix Technology has been designing, delivering, operating and maintaining some of the world's leading transit ticketing systems for the past 30 years.<br>The VIX portfolio includes innovative smart booking, ticketing and secure payment systems.<br>eBrio+ is an integrated, multi-modal, multi-operator and multi-media closed-loop ticketing solution. This ticketing solution can manage multiple transport operators and a variety of fare payment media including contactless magnetic cards, paper tickets and smartphone apps. Vix eBrio+ is implemented as a complete end-to-end fare collection system including devices and back office systems. |
| Main objective | • Efficiency<br>• Comfort<br>• Environment |
| Innovation phase | Mature for global market |
| Type of ITS | APTS Smart Ticketing |
| Technology used | Key Enabling technology:<br>• Identification technologies (smart card)<br>• Hardware: contactless readers, ticketing machines (on-vehicle, on-platform), portable terminals<br>• Communication technologies (Wi-Fi, Bluetooth, LTE, WLAN)<br>• Software infrastructure: Electronic data interchange<br>• Identification technologies |
| Geographical scale | Global |
| Type of transport | Multi Modal Passenger Transport |
| Type of stakeholders | • Government/cities<br>• Service providers<br>• Automotive suppliers<br>• Travellers/passengers |
| Institutional arrangements | Private |
| Transferability | Can be used by any operator, transport authority |

| Multi Modal International Journey Planning system (Enhanced Wisetrip) | |
|---|---|
| Description | |
| Status | Wisetrip and Enhanced Wisetrip were EU funded research projects under the FP7 programme.<br>They were implemented from 2008 to 2014. |
| Country | UK, Netherlands, Finland, Italy, Spain, Greece, China, Brazil. |
| Description of service | Building on the knowledge developed in the **WISETRIP** project, **Enhanced WISETRIP** aimed to improve the possibilities for individual planning, booking and making multimodal journeys. The system is designed to take into consideration all user needs, multiple trip criteria, environmental impact and personal preferences using ITS services in real time covering: Bus, Coach, Rail, Ferry, Flights etc. In real time. |
| Main objective | The key objective of WISETRIP being to increase accuracy of travel information data and facilitate exchange of data.<br>• Safety<br>• Efficiency<br>• Comfort<br>• Environment |
| Innovation phase | TRL 8. Platform now used by Google transit. |
| Type of ITS | APTS. WISETRIP platform falls under the ITS subcategory (or market sub-segment) of Multimodal Journey Planners.<br>A multimodal journey planner (JP) is an IT system able to propose a set of one or more transport services answering at least the question “How can I go from location A to location B at a given departure/arrival date and time and under which conditions”.<br>Simplistically, the system operates with information taken from participating Journey Planning systems that receive real time information from buses, coaches, trains, ferries, planes. |
| Technology used | Key “technology blocks” used and developed in WISETRIP platform are:<br>Advanced real time integration technologies, sourced from variant data providers allowing Real-time event data and consideration of extraordinary conditions;<br>Dynamic trip re-planning.<br>Software Infrastructure: Flexible Application Programming Interface (API) allowing mobile demonstrator and integrated ticket approach.<br>Algorithms: A backward label-setting algorithm is proposed for solving the multi-criteria time-dependent shortest path problem in a multimodal network. |
| Geographical scale | Enhanced WISETRIP platform aimed to support a EU level integrated multimodal journey planner. |
| Type of transport | All types / modes of PT at Local, Regional, National and International level.<br>Scheduled terrestrial collective transport services are the core object of multimodal travel information. |
| Type of stakeholders | • Government/cities<br>• European Union<br>• Service provider<br>• Research institutes<br>• Travellers/passengers<br>• Road operators |
| Institutional arrangements | Wisetrip platform is a Public-Private Partnership, being developed under European Commission FP7 Programme. |
| Transferability | This application is easily transferable where other Journey Planning providers agree to share real time information and integrate systems. |

| European rail traffic management system | |
|---|---|
| Description | |
| Status | Being deployed |
| Country | Global, EU initiative |
| Description of service | Standardisation of train management systems. Cooperative system that should allow trains to operate cross border (if track gauges are same) as the communication language is the same. The ERTMS provides standardized rail messages to trains. Using (wireless) communication trains could transmit location, speed, direction and more route information to the traffic centre and other trains. This allows automatically calculations of routes and available track.  |
| Main objective | Efficiency (Cross border operations and higher track capacity)<br>Safety (often replaces outdated equipment) |
| Innovation phase | 9 Operational but not fully deployed |
| Type of ITS | APTS Real time system status information |
| Technology used | GSM-R for wireless communication |
| Geographical scale | Railway |
| Type of transport | Scheduled trains |
| Type of stakeholders | • Train manufacturers<br>• Railway managers<br>• Train drivers<br>• European Union |
| Institutional arrangements | ERTMS is developed as an initiative from the European Union and now has become a standard. |
| Transferability | Transferable to other railways |

| Testing GPs, GPRS to assist the development of Demand Responsive Transport services in real time (FAMS) | |
|---|---|
| Description | |
| Status | Research project funded by EU ITS programme 2002 -2004. |
| Country | UK (Scotland) and Denmark |
| Description of service | Testing how GPS, GPRS, could assist development of Multi Modal Transport Solutions using Travel Dispatch Centre to broker solutions between users and multi modal supply chain. Contact centre takes bookings from individuals and stakeholders to provide multi modal solutions using ITS platform to send information to/from vehicle to allow real time services to operate in the most cost effective manner.<br>GPS, GPRS was used to track vehicles and allocate trips in real time to vehicles within pilot area. Reduction in duplication of resources, maximising use of resources to meet known demands. |
| Main objective | Results have demonstrated significant savings in costs, reduction in journey time, increased customer satisfaction. Reduced pollution due to less vehicles usage (environment), increased comfort (best vehicle used to meet client requirements) and increased passenger numbers. |
| Innovation phase | Technologies are now mature. UBER business model is based on this concept. |
| Type of ITS | Public Transport Information: Real time system status information and Schedule optimization |
| Technology used | Key enabling technologies:<br>• Positioning technologies: Global Navigation Satellite Systems (GNSS, GPS); Real time locating Systems (RTLS); On-board Antenna receive and forward units<br>• Communication technologies (GSM-R Antenna, GSM/GPRS, Internet, Wi-Fi)<br>• Hardware (On-board computers, CBI) |
| Geographical scale | Application can work in any area globally. Depends on ability to provide sufficient bandwidth to cope with data demands from 100s of vehicles and 1000s of passengers. |
| Type of transport | Business model (FAMS) can support passenger transport, freight using multi modal supply chain. |
| Type of stakeholders | • Government/cities<br>• European Union<br>• Service providers<br>• Research institutes<br>• OEMS<br>• Automotive suppliers<br>• Emergency services<br>• Parking operators<br>• Travellers/passengers<br>• Road operators |
| Institutional arrangements | PPP<br>This service was tested under FAMS project, funded by EC ITS Programe |
| Transferability | Model has been transferred over the years with UBER, Lyft, Parcel Delivery Companies using agency model. Basic model can be adopted to meet all transport demands. Data input requirement required in real time to link needs of customer with availability of vehicles to provide services. |

| Virtual Agency Model Service (FAMS) | |
|---|---|
| Description | |
| Status | Pilot project (2002-2004) |
| Country | Scotland, Italy |
| Description of service | The objective of the FAMS (Flexible Agency for Collective Demand Responsive Mobility Services) Trial Project was to scale up technology, services and business models currently adopted in DRT and to support the evolution from single DRT applications towards the concept of a Flexible Agency for Collective Demand Responsive Mobility Services.<br><br>FAMS has innovated solutions for DRT planning and operation by the implementation and trial of the Flexible Agency. Existing DRT management tools have been adapted and made interoperable within an e-Business collaborative environment allowing cooperation amongst transport service suppliers. |
| Main objective | The main objective of this application is to improve Demand Responsive Transport Concept utilising ITS platform to create a virtual agency to provide cost effective solutions, reducing duplication in services, increase number of passengers at reduced travel times, increasing traffic safety and reduce the number of incidents (safety), to reduce the number of traffic jams and improve the efficiency of road use (efficiency), and to ensure that traffic flows are smoother resulting in less CO2-emission (environment). |
| Innovation phase | TRL 7 |
| Type of ITS | APTS: Demand Responsive Transport is not an ITS “per se”, but a form of shared-ride public transport that requires of multi-data sourced information to be put in place, as well as several enabling ITS such as AVM and AVL. As Flexible Routing and Scheduling applications, DRTs could be at the intersection of Schedule Optimization and Optimized Fleet Management. |
| Technology used | FAMS utilised several enabling ICTs:<br>• Booking and reservation systems to manage customer requests<br>• Internet, IVRS and palm-top devices (PDAs, smart phones)<br>• Dispatching software<br>• Communication systems to link TDC software platform with drivers and customers<br>• GPS based or GMS-based vehicle location systems<br>• Smart card<br>• Management information systems for data analysis |
| Geographical scale | Local-Regional level.<br>FAMS involved 4 EU countries and pilots were deployed at two cities (Florence Metropolitan Area and Angus). |
| Type of transport | FAMS model was tested for Cars, Taxis, Community Transport, Bus, Coach. The service is useful for all type of PT real time demands. |
| Type of stakeholders | • Local Authorities<br>• Operators<br>• ITS providers<br>• User groups |
| Institutional arrangements | PPP<br>FAMS platform was developed under a EC funded project. |
| Transferability | service can be transferred anywhere globally. UBER, Lyft have adopted concept |

| Interoperable Fare Management Project – IFM | |
|---|---|
| Description | |
| Status | Finished (duration January 2008 – December 2009) |
| Country | The partners involved in the project were based in United Kingdom, Germany, Belgium and France. |
| Description of service | In 2006, the French, German and UK based national interoperable transport organisations, who with many others across the world had been working together to write the International Standard on IFM (ISO EN 20014), came together to propose a project to the European Commission relating to IFM.<br>Its main objective was to provide travellers with common styles of contactless media throughout Europe which can be used for multiple transport products in different geographic areas and for sustainable modal switching, such as the use of 'Park and Ride', unlike existing smart cards which are restricted to specific city or regional geographies.<br>The project expected to significantly lower the barriers to mobility and encourage the use of public transport, contributing to a reduction of carbon emissions and a reduction or elimination of paper tickets, thus further enhancing the impact of smart media on environment and on the efficiency of public transport. |
| Main objective | The project was aimed at making the mobility of people more efficient and environmentally sustainable by facilitating informed modal switching and the seamless accessibility of public transport. It aimed at innovative, safe and reliable ticketing and fare management across Europe using interoperable smart media with the specific aim of encouraging increased usage of public transport. |
| Innovation phase | 6 |
| Type of ITS | APTS. Smart & multi ticketing |
| Technology used | Smartcard technology. |
| Geographical scale | The partners involved in the project were based in United Kingdom, Germany, Belgium and France. However, the main National IFM organisations had a shared vision to create an EU-IFM network to provide direction, co-ordination, networking of Best Practice; implement a pan-European IFM initiative; promote further links to ISO and European Standards including NFC and the Security and Certification of devices. |
| Type of transport | Public passenger transport. |
| Type of stakeholders | The Partners involved in the projects were:<br>• United Kingdom: ITSO Limited (Coordinator); University of Newcastle upon Tyne<br>• Germany: TUV Rheinland Consulting GmbH; VDV Kernapplikations GmbH & Co-KG<br>• Belgium: International Association of Public Transport<br>• France: PREDIM / Urba 2000; Societe National des Chemins de fer France; Université Paris Ouest Nanterre La Défense; Regie Autonome des Transports Parisiens |
| Institutional arrangements | The IFM project has been funded by the European Commission under the 7$^{th}$ Community Framework Programme for research and technological development, as the first project of the IFM initiative. |
| Transferability | The service was designed to provide world leadership in its segment and to deliver results which can be transferred to areas outside of the transportation sector world-wide. |

| On Vehicle CCTV Systems | |
|---|---|
| Description | |
| Status | On-going. Commercial products manufactured and commercialized globally. |
| Country | Global solutions |
| Description of service | Passenger security and driving surveillance using UMTS / WLAN. Video cameras installed inside and outside bus to monitor passenger behaviour and other road users. |
| Main objective | • Safety<br>• Comfort |
| Innovation phase | Mature market, TRL 9 |
| Type of ITS | APTS On Vehicle CCTV Systems can be considered in the category of Mobile Video Surveillance applications for transport. The term *Mobile* is added to most computer based systems as synonymous of several different concepts, ranging on ubiquitousness, wireless connection, and portability.<br>On Vehicle CCTV Systems refer to the instalment of surveillance systems in portable environments (such as buses or trains), which require wireless access for infrastructure and internet services. Furthermore, camera devices might connect to the system core by wireless links to address/overcome the environmental conditions. |
| Technology used | Surveillance systems are typically made of:<br>Several sensors, analysis units and actuators. Those can be deployed with several degrees of mobility.<br><br>The key enabler technologies to support portability/mobility are related to Communication technologies. Precisely, wireless communication and mobile technologies (UMTS/WLAN/Wi-Fi), which allow efficient transmission, feature rich and powerful mobile and wireless devices. |
| Geographical scale | Mobile CCTV systems and applications for train and buses are currently available globally |
| Type of transport | All modes both public and freight transport |
| Type of stakeholders | • ITS Service providers (R2P, Synectics, Vidiwave, Viseum, Tactical Micro…)<br>• Emergency services (Law Enforcement Agencies, Health)<br>• Road operators<br>• Public Transport Operators<br>• Public Transport Authorities |
| Institutional arrangements | Due to the maturity of the key technologies involved, on vehicle CCTV Private companies offer services and applications to Public or Private Operators in the Train and Bus modes. |
| Transferability | High level of transferability. Mobile CCTV systems can be installed and operate on any vehicle |

| Optibus: Ontime & Onschedule | |
|---|---|
| Description | |
| Status | On-going. |
| Country | Israel |
| Description of service | Optimization application, based on new patent pending algorithms. OnSchedule™, powered by Optibize™, plans crew and vehicle assignments using Interactive Schedule Optimization (ISO) methodology. Schedulers compare and evaluate different alternatives, immediately choosing the one that is most efficient and appropriate. Optibus OnTime™, also powered by Optibize™, lets control room operators respond in real time to unplanned incidents or changes, preventing negative implications on passenger service and cost. |
| Main objective | The main objective of this application is to improve public transport companies to operate more efficiently, reducing cost (efficiency) and delivering better passenger service. |
| Innovation phase | TRL 9. Mature and already deployed in global markets |
| Type of ITS | APTS Real time scheduling Solutions (Scheduling optimization) |
| Technology used | Communication technologies (WLAN/WiFi, Bluetooth, Zigbee, LTE)<br>Software infrastructure: cloud computing (SaaS)<br>Hardware (Smartphones and mobile computing devices, CBI computer)<br>Algorithms (routing) |
| Geographical scale | Local, Regional, National |
| Type of transport | Initially used by Bus companies (Road mode, Public transport). |
| Type of stakeholders | Service providers |
| Institutional arrangements | Private funding |
| Transferability | Any operator could purchase and link to their systems to provide real time up to date solutions to optimise performance of networks. Highly transferable to Multi Modal Public Transport. |

| Oyster card | |
|---|---|
| Description | |
| Status | On-going |
| Country | UK (London) |
| Description of service | Oyster is a smartcard which can hold pay as you go credit, Travelcard and Bus & Tram Pass season tickets. Use it to travel on bus, Tube, tram, DLR, London Overground, TfL Rail, Emirates Air Line, River Bus services and most National Rail services in London. |
| Main objective | • Efficiency<br>• Comfort<br>• Environment |
| Innovation phase | Mature transferrable |
| Type of ITS | APTS Multi Modal Smart Ticketing Systems using Mobile devices and smartcards |
| Technology used | Key Enabling technology:<br>• Identification technologies (smart card)<br>• Data storage technologies: RFID |
| Geographical scale | Greater London |
| Type of transport | All modes of public transport |
| Type of stakeholders | • Government/cities<br>• Service providers<br>• Travellers/passengers |
| Institutional arrangements | PPP<br>Public Transport Authority supported by ITS providers (DLR) |
| Transferability | Could work anywhere where operators and authorities agree on system and funding costs |

| Real Time Passenger Information | |
|---|---|
| Description | |
| Status | Application in use. |
| Country | Ireland |
| Description of service | Real Time Passenger Information (RTPI) shows when the bus is due to arrive at the bus stop so the journey can be planned more accurately. RTPI is displayed on signs at bus stops and shelters. |
| Main objective | The RTPI shows when the bus is due to arrive at the bus stop so the journey can be planned more accurately (efficiency).<br>In addition, the experience of real time bus arrival systems in other countries has shown that they can contribute to an increase in the number of people choosing to use the bus (environment). |
| Innovation phase | 8 |
| Type of ITS | APTS. Passenger information systems |
| Technology used | Buses must be equipped with an Automatic Vehicle Location transmitter, which can track the bus, using a Global Positioning System (GPS) and transmit the data in a standard protocol. On-board software predicts the arrival time at the next bus stop. This information is then sent to the sign through a central control system. The screen at the bus stop counts down the minutes until the bus arrives. Updates are usually received from the vehicle location system at 30 second intervals, so information on the signs is regularly updated. |
| Geographical scale | The National Transport Authority is currently providing a RTPI service for bus passengers in the Greater Dublin Area and the regional cities (Cork, Galway, Limerick and Waterford). |
| Type of transport | The application is used for buses. |
| Type of stakeholders | The National Transport Authority is responsible for the Real Time Passenger Information service. Established in December 2009, they have responsibility for contracting and securing the provision of public passenger transport services for the travelling public, including information services.<br>The RTPI service is delivered in co-operation with Dublin Bus and Bus Éireann, which is responsible for the roll out of the automatic vehicle location system and the real time arrival predictions for its buses.<br>Dublin City Council provided technical expertise, managed the procurement of the signs and software system and it is also coordinating the installation of signs, in tandem with the relevant local authorities.<br>As the service is launched in other cities across Ireland, the National Transport Authority is working to ensure that other public transport operators are included in the future. |
| Institutional arrangements | National Transport Authority seems to be an investor, but it is not clear. |
| Transferability | The application could be transferred to other regions and mode of transport.<br>The Real Time Passenger Information system is designed to be able to take information from other licenced bus operators, once information for their fleet is available and tested. The National Transport Authority is in discussions with representatives of LUAS and Irish Rail on their feeds. |

| Scot Rail Smartcard | |
|---|---|
| Description | |
| Status | In operation |
| Country | United Kingdom |
| Description of service | This is a smartcard that can be used on Scottish Rail services and on the SPT Subway.<br>With a Smartcard there isn't any need for paper tickets as they are all loaded onto a single, reusable card. Several types of tickets are available, depending on the type of travelling. The price is the same than the paper tickets, but some benefits are available only on Smartcard.<br>It's also faster and easier as the tickets can be bought online and there's no need to queue at the ticket office. |
| Main objective | The main objectives were efficiency for both passengers (ease of use, greater choice on how to pay for travel, time saving) and operators (less cash handling, more information about customers, more marketing opportunities, quicker boarding times, improvement of journey times and connection), economic (access to new ticket types and discounts for passengers), environment (reduce emissions, more use of public transport). |
| Innovation phase | 9 |
| Type of ITS | APTS Smartcard. |
| Technology used | Smartcard technology. |
| Geographical scale | Scotland |
| Type of transport | Passenger rail and subway transport. |
| Type of stakeholders | The main stakeholder is ScotRail (operated by Dutch firm Abellio). |
| Institutional arrangements | Private. |
| Transferability | The service could be transferred to other regions or modes of transport. |
| KPIs, barriers and enablers | |
| Performance indicators | No information available. |
| Barriers | No information available. |
| Enablers | An important enabler is the general reduction of travelling time and costs for both passengers and operators. |
| Impacts | |
| Evidenced impacts | No information available. |
| Evidenced costs | No information available. |

| Enhanced Real Time Traffic API (TIMON project) | |
|---|---|
| Description | |
| Status | On-going (01/6/2015 to 30/11/18) |
| Country | Germany, Spain, Italy, UK, Hungary, Slovenia, Belgium, Netherlands |
| Description of service | TIMON aims to deliver a framework of services to all users of the transport ecosystem – drivers, vulnerable road users, and businesses. Enhanced Real Time Traffic API is on service offered.<br>An amount of services will be gathered in an API that can be used to improve functionalities of other smartphone applications focused on enhancing road transport efficiency, such as car sharing applications, Electro Mobility services. The application will be capable of providing highly accurate predictions on traffic congestion based on ITS and open data. This service is also intended for business-oriented applications, such as fleet management companies (logistics companies, postal services, etc.), requiring a reliable estimation of the time delay on the selected route. |
| Main objective | The main objective of this application is to enhance real time traffic information, thus improving the efficiency of road use (efficiency), supporting traffic safety and response to contingencies in the network (traffic) and reducing CO2 emissions (environment) by means of an optimized road transport network use.<br>The services to be provided by the application aim at supporting the overall project view for building a cooperative ecosystem in which people, vehicles, infrastructure and businesses are connected. This ecosystem will rely on cooperative networks and open data (TIMON Collaborative ecosystem). |
| Innovation phase | TRL 6 |
| Type of ITS | APTS Real Time Information |
| Technology used | • Positioning technologies: GNNS, GPS<br>• Sensors<br>• Software infrastructure (Decision support systems, cloud computing, extensible mark-up language)<br>• Hardware (Smartphones and mobile computing devices)<br>• Communication technologies (GSM, STM, WLAN-WiFi, LTE |
| Geographical scale | Local, Regional, National, International |
| Type of transport | Initially focused on Road mode, both public and freight |
| Type of stakeholders | • Government/cities<br>• European Union<br>• Service providers<br>• Research institutes<br>• Automotive suppliers<br>• Travellers/passengers<br>• Road operators |
| Institutional arrangements | PPP<br>Funded by EC Horizon 2020 |
| Transferability | Could be adopted globally |

| EcoGem - Cooperative Advanced Driver Assistance System for Green Cars | |
|---|---|
| Description | |
| Status | Finished (2010-2013) |
| Country | Italy, Turkey, Germany |
| Description of service | Taking into account the limited energy storage capabilities and recharging time of fully-electric vehicles (FEVs), EcoGem aims to design and develop an FEV-oriented Advanced Driver Assistance System (ADAS) equipped with suitable monitoring, learning, reasoning and management capabilities to automatically manage battery charging, energy saving, and route planning (that will help increase the FEV's autonomy and energy efficiency) |
| Main objective | To reduce energy consumption through autonomous and cooperative route planning as well as the optimisation of recharging points while increasing the energy efficiency and autonomy of electric vehicles. |
| Innovation phase | 7 |
| Type of ITS | ATIS IRANS |
| Technology used | • Satellite<br>• Sensor<br>• Wireless<br>• Cellular networks<br>• Radio |
| Geographical scale | Urban |
| Type of transport | Road – passenger cars |
| Type of stakeholders | • OEMs – FEV manufacturers<br>• Research institutes<br>• Application developers (ICT solutions providers)<br>• Telecoms operator<br>• Mapping industry<br>• Transport organisations<br>• European Commission: Financing |
| Institutional arrangements | Public-private partnership. The project is co-funded by the EU 7th framework programme for research and technological development. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| EcoMove SP3 – ecoSmartDriving | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Ecosmartdriving exist out of a combination of several services that reduce inefficiencies for passenger cars that influence fuel consumption. Several-ITS services to reduce emissions are introduced, For instance:<br>• Control vehicle condition (tyre pressure)<br>• EcoUse of vehicle (no airco, seat heating)<br>• Support EcoDriving<br>• In & off board feedback on Economic driving behaviour |
| Main objective | Sustainably changing the driving behaviour of individual drivers to a more fuel-efficient driving style, both during the trip as well as by learning from previous trips.<br>Supporting drivers in choosing the route with the lowest fuel consumption. |
| Innovation phase | 7 |
| Type of ITS | ATIS IRANS |
| Technology used | • Nomadic devices on board→ stand alone<br>• Integrated on board units<br>• Sensors that measure driving situation |
| Geographical scale | Diverse types of roads. |
| Type of transport | Behaviour of passenger cars. |
| Type of stakeholders | • Automotive suppliers<br>• Service providers<br>• Technology providers<br>• Vehicle manufacturer<br>• Car clubs<br>• Vehicle drivers |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other systems |

| EcoMove SP3 – dynamic navigation | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Ecosmartdriving exist out of a combination of several services that reduce inefficiencies for passenger cars that influence fuel consumption.<br>• Planning ecoTrip<br>• Dynamic ecoNavigation<br>• Dynamic ecoGuidance |
| Main objective | • Sustainably changing the driving behaviour of individual drivers to a more fuel-efficient driving style, both during the trip as well as by learning from previous trips.<br>• Supporting drivers in choosing the route with the lowest fuel consumption. |
| Innovation phase | 7 |
| Type of ITS | ATIS IRANS |
| Technology used | • Nomadic devices on board→ stand alone<br>• Integrated on board units<br>• Sensors that measure driving situation |
| Geographical scale | Diverse types of roads. |
| Type of transport | Behaviour of passenger cars. |
| Type of stakeholders | • Automotive suppliers<br>• Service providers<br>• Technology providers<br>• Vehicle manufacturer<br>• Car clubs<br>• Vehicle drivers |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other systems |

| EcoMove Sp4 Freight - EcoTRIP | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | SP4 of EcoMove aims to reduce fuel use of trucks by several cooperative and non-cooperative solutions. Cooperative solution are included in EcoTrip, an environmental based trip planner using:<br>• Efficient planning based on emissions with use of real time information<br>• Active guidance of drivers based on navigation that combines fuel use and travel time and providing fuel efficient advise by a coaching system.<br>• Driver evaluation based on post trip analysis on defined performance criteria<br>• Truck authorization based on quality of trucks (zoning) |
| Main objective | • Increase awareness about CO2 emissions caused by road transport<br>• Minimize CO2 emissions caused by road transport as much as feasible |
| Innovation phase | 7 |
| Type of -ITS | ATIS IRANS |
| Technology used | • On-board navigation/application<br>• Floating vehicle data |
| Geographical scale | Mixed settings. |
| Type of transport | Trucks |
| Type of stakeholders | • Carriers<br>• Transport planners<br>• Consumers<br>• Vehicle manufacturer<br>• Local authorities<br>• Truck driver/owner/driving schools |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other systems |

| Flitsmeister | |
|---|---|
| Description | |
| Status | Active service since 2010 |
| Country | Netherlands origin. Services (partly) available in all EU countries. |
| Description of service | Real time traffic information application with over 1 million users in the Netherlands. Originally aimed at providing location of speed traps via user reports. Currently more functions have been used and the service is integrated with other service operators. The main functions are (mobile) Speed traps and traffic jam. Secondary functions included are reports of:<br>• Accident<br>• Stationary vehicle on the road<br>• Object on the road<br>• Congestion<br>• Road works<br>• Slippery roads<br>• Bad road conditions<br>• Wrong-way driver<br>• Mist/ bad visibility<br>Users can report these situations, and this will be displayed to other app users. Services are expanding The Netherlands, providing real time information for 7 other European countries. The app is currently available inside Tesla vehicles. The app uses voice messages and audio to alarm drivers. This allows the app to run in the background which reduces battery dependency and reduces the change to distract drivers. |
| Main objective | Improving comfort and efficiency were the original goals. As services expand safety becomes more important. |
| Innovation phase | 9 |
| Type of ITS | ATIS. IRANS |
| Technology used | Cellular network |
| Geographical scale | Full road coverage |
| Type of transport | Aimed towards passenger cars, but other road users can use the service as well. |
| Type of stakeholders | Private company that cooperates with:<br>• Media services (radio, car platforms)<br>• Car consumer institute (ANWB)<br>• Software developer (Bemobile)<br>• Road operator (Rijkswaterstaat) |
| Institutional arrangements | Private company |
| Transferability | This service has the potential to be applied across Europe. Services might depend on local legislation: ability to report speed traps. |

| FOTsis 1 emergency management service/extended eCall | |
|---|---|
| Description | |
| Status | Finished (2011-2015) |
| Country | Tested in Spain and Greece on stretches of highways |
| Description of service | An extended emergency call (eCall) system that bring fast assistance to motorist through:<br>An emergency message send via the smartphone of the driver towards the public safety answering point (PSAP)<br>Existing road side infrastructure detects an accident (loops, CCTV). The road side managers than informs the public safety answering point.<br>Both measures aim to reduce the notification times necessary for accidents. After an incident, the road operator and emergency vehicles will be notified if necessary. Furthermore, other road users will be informed after an accident occurs. Emergency vehicles are equipped with a tablet pc that informs, recommends and communicates with the PSAP. Furthermore, vehicles could be equipped with a mobile router to manage communication with the On Board Unit of a car and the traffic control centre. This project, as well as FOTsis in general is aimed towards a well-functioning infrastructure/i.e. the. Backoffice. |
| Main objective | The main objective is to improve the quality and speed of the infrastructure behind emergency systems. Informing emergencies earlier reduces time before emergency services arrive (safety) as well as reducing the congestion after an accident (efficiency). Furthermore, the information is better specified increasing the efficiency of emergency services (better informed increased the safety of all road users) and reducing the change for secondary accidents. Furthermore, the lower congestion improves emissions. |
| Innovation phase | 7 |
| Type of ITS | ATIS ISAWS |
| Technology used | The following technologies are used:<br>3G/4G cellular network<br>GPS to locate the position of the vehicle/accident |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | Road managers : management and development<br>Research institutes<br>ITS companies<br>Emergency services<br>Road users |
| Institutional arrangements | Partly EU funded under FP7. Consortium with 25 Partners from 9 European Countries. Partners include Road operators, universities, telecom operators, maps providers, technology integrators, research centres, users' association, and industry associations. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| FOTsis 2- Safety incident management | |
|---|---|
| Description | |
| Status | Finished (2011-2015) |
| Country | Spain, two stretches of highway |
| Description of service | F-SIMS provides real time information to drivers in order to warn them against risks or critical situations that have been detected by the road infrastructure.<br>Warnings include<br>Congestion and other incidents<br>Recommended travel speed<br>Difficult driving conditions due to observed or forecasted weather<br>Information is gathered by the Highway Control Centre operator through roadside equipment.:<br>Automatically detected via infrastructure systems<br>Congestion via loop detection<br>Bad weather via meteorological sensors<br>HCC operator will assign the alert back through road side infrastructure or via smartphone. |
| Main objective | Real time warnings towards drivers. This improves awareness which increases the safety on the road and improves mobility. Additionally, this improves sustainability as well. |
| Innovation phase | 7 |
| Type of ITS | ATMS traffic monitoring |
| Technology used | The following technologies are used:<br>3G/4G cellular network<br>Highway detection infrastructure: loops, cameras, etc.<br>WiFi-P if available |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | Road managers : management and development<br>Research institutes<br>ITS companies<br>Highway drivers |
| Institutional arrangements | Partly EU funded under FP7. Consortium with 25 Partners from 9 European Countries. Partners include Road operators, universities, telecom operators, maps providers, technology integrators, research centres, users’ association, and industry associations. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| HeERO | |
|---|---|
| Description | |
| Status | 2011-2013 & 2013-2015. Two phases with different countries. |
| Country | Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland Germany, Greece, Luxembourg, Italy, Spain, The Netherlands, Turkey, Romania, Sweden |
| Description of service | The project will prepare, carry-out and coordinate 112 eCall pre-deployment pilots at EU level considering common EU standards. As soon as the eCall device in your car senses a severe impact in an accident, it automatically initiates a 112 emergency call to the nearest emergency center and transmits it the exact geographic location of the accident scene and other data. With the same effect, eCalls can also be made manually, at the push of a button. This is convenient if, for instance, you become witness of an accident. Whether the call is made manually or automatically, there will always be a voice connection between the vehicle and the emergency call center in addition to the automatic data link. This way, any car occupant capable of answering questions can provide the call center with additional details of the accident. |
| Main objective | • Safety for service user<br>• Safety increase other road users |
| Innovation phase | TRL 7. Tested on public roads during traffic |
| Type of ITS | ATIS. ISAWS |
| Technology used | • GPS for evaluation<br>• Android based on board unit<br>• GPRS |
| Geographical scale | Urban and Interurban |
| Type of transport | Tested with passenger cars |
| Type of stakeholders | • Emergency services<br>• Road users<br>• Service users<br>• Car manufacturers<br>• Other road users |
| Institutional arrangements | Eu Funded FP 7 Public private partnership<br>Phase 1: 10 million, 5 million EU funded<br>Phase 2: 6 million budget. 3 million EU funded |
| Transferability | High |

| I-5 Smart Truck Parking | |
|---|---|
| Description | |
| Status | Finished (2015) |
| Country | USA |
| Description of service | Truck drivers are faced with a critical shortage in truck parking due to a dramatic growth in commercial vehicle truck travel on US nation's roads. A fatigued driver that must drive to search for a parking place can become not only a roadway hazard but an environmental hazard because they generate unnecessary diesel emissions. In this project, sponsored by FHWA (Federal Highway Administration), TSRC (Transportation Sustainability Research Center) is partnering with Caltrans to explore possible roles for Intelligent Transportation Systems (ITS) in alleviating the truck parking problem. The I-5 corridor in California will serve as a test bed for the use of ITS technologies to determine parking availability at participating truck stops. This information, as well as truck stop amenities and the opportunity to make a reservation, will be transmitted to commercial vehicle drivers. This suite of information may allow truckers to better plan and to operate more efficiently when they can by-pass a full truck stop and go directly to one that has space available. ParkingCarma and NAVTEQ are assisting TSRC with the parking availability, reservations, truck stop amenities, and routing. The information may be collected and disseminated through a variety of means including sensors, the Internet, mobile phones, changeable message signs, and radio. |
| Main objective | • Broadcast truck parking information to truckers through web and mobile applications<br>• Display of dynamic truck parking availability, so truckers can use information to understand when and where parking is available<br>• Provide truck stop attributes.<br>• Capability to make advanced parking reservations |
| Innovation phase | 7 |
| Type of ITS | Advanced Traveller Information Systems (ATIS), Commercial Vehicle Operations (CVO) |
| Technology used | • Cellular<br>• Radio<br>• RFID<br>• GPS |
| Geographical scale | Regional |
| Type of transport | Freight transport (trucks) |
| Type of stakeholders | • Government<br>• Research institutes<br>• Service Providers<br>• Road Operators<br>• Truck Drivers |
| Institutional arrangements | Private/public collaboration |
| Transferability | Several other US regions are testing similar solutions so the applications is perfectly transferable. |

| In-TIME | |
|---|---|
| Description | |
| Status | Finished (2009-2012) |
| Country | Austria |
| Description of service | Multimodal Real Time Traffic and Travel Information (RTTI) services are seen as strategic measures for drastically reducing energy consumption in urban areas across the different modes of transport, by changing the mobility behaviour (modal shift) of the individual traveller from car to more sustainable means of collective transport. This change of traveller behaviour will result in less pollution and CO2emissions, less particle emissions, and less noise.<br>In-Time aims to address these challenges by implementing and piloting an ICT infrastructure to facilitate the deployment and delivery of Multimodal RTTI services for drivers and travellers in European cities. In-Time aims to deploy and validate and innovative pan-European approach to Real Time Traffic and Travel Information (RTTI) services, largely based on ICT and ITS European standards, enabling the interoperability of information and services between local data/service providers, end-user Travel/Traffic Information Service Providers (TISPs) and across European cities. |
| Main objective | • Efficiency<br>• Comfort<br>• Environmental |
| Innovation phase | 7 |
| Type of ITS | Advanced Traveller Information Systems (ATIS), In-vehicle Route and Navigation Systems (IRANS) and In-vehicle Motorist Service Information Systems (IMSIS) |
| Technology used | • Cellular<br>• GPS<br>• SoA<br>• Web Services<br>• EU ITS Standards (DATEX 2, TPEG, IFOPT, SIRI, JourneyWeb, OpenLS) |
| Geographical scale | Urban. In-Time implemented pilots in 6 sites: Brno, Bucharest, Florence, Munich, Oslo and Vienna. |
| Type of transport | Passenger transport (car, cycle or pedestrian). At some extent, public transport. |
| Type of stakeholders | • European Commission.<br>• Government/cities<br>• Service providers<br>• Research institutes<br>• Travelers/passengers |
| Institutional arrangements | Public-Private Partnership |
| Transferability | Should be transferable to other cities. |

| Mobiliy 2.0 | |
|---|---|
| Description | |
| Status | Completed (2012 - 2015). |
| Country | 11 partners from 7 countries: Slovakia, France, The Netherlands, UK, Italy, Spain, Greece |

| | |
|---|---|
| Description of service | The project developed an integrated approach to enhance the catch up of the use of fully electric vehicles (FEV). The integrated approach has implied that the application developed by Mobility2.0 has utilised co-operative systems to simultaneously consider the bottlenecks undermining the FEV use, so that an overall optimisation in the use of FEV has been achieved. Mobility2.0 has focused on assisting the daily urban commute, which represents the bulk of urban mobility in order to compensate for the limited autonomy range |
| Main objective | Mobility2.0 has developed and tested an in-vehicle commuting assistant for FEV mobility, resulting in more reliable and energy-efficient electro-mobility. |
| Innovation phase | Technology readiness level 5. The project has validated the approach in the relevant environment. |
| Type of ITS | ATIS. In vehicle services |
| Technology used | • the FEV inherent relation with the smart grid (while plugged-in) as well as the FEV capability of sending and receiving internet data is expected to complement the ability of 5.9GH communication abilities of modern electric vehicles<br>• Recharging spot notification geo-broadcasting data. The broadcasted data includes varying application types, such as EGNOS data (corrections to GPS raw data), digital map databases, or vehicle firmware updated over the air. |
| Geographical scale | Urban |
| Type of transport | Tested with passenger cars |
| Type of stakeholders | • Municipalities<br>• Research institutes<br>• SMEs<br>• Service providers |
| Institutional arrangements | The project has received public funding from the European Union's Horizon 2020 FP7-ICT - Information and Communication Technologies |
| Transferability | The system has been tested in two cities: Barcelona and Reggio Emilia, setting the pre-conditions for the transferability to other municipalities |

| OCTO U | |
|---|---|
| Description | |
| Status | Ongoing application (2015 -) |
| Country | Italy, UK, Spain, France, US |

| | |
|---|---|
| Description of the application | Octo Telematics is an Italian company, whose headquarter has been recently shifted to London, with offices in US, France and Spain. The company was founded in 2002, pioneering the use of telematics in the car insurance sector. Octo applies proprietary algorithms to this market to deliver information into driver risk, informing solutions that benefit both auto insurance companies and drivers.<br><br>In 2015, a new Octo U app was launched. The app Octo U uses telematics technology to monitor and score driver behaviour, measuring speed, braking intensity and acceleration. Drivers who obtain the satisfactory score of 7.5 and above are then rewarded with the service of submitting their score to a panel of insurers for a quote discount of up to 10%, which they can choose to accept at their discretion.<br><br>The app key algorithm is based on GPS point-retrieving technology to gather journey information and ranking each trip based on factors such as speed, breaking and acceleration, OCTO U also takes into account outside variables often directly affected by weather, such as road and traffic conditions, to determine driver scoring. For example, in the UK, drivers with good scores are rewarded with the service of a discounted insurance. The Octo company is in advanced discussions with insurance partners to launch this model in a growing number of international markets. |
| Main objective | The main objectives of the service concern with improving safety in road transport. |
| Innovation phase | Technology readiness level 9. The app is fully operational. |
| Type of ITS | ATIS. CVO |
| Technology used | The following technologies are used:<br>Once downloaded and registered directly from Apple Store, and Google Play Octo U begins immediately to collect data on the movements of the conductor.<br>The app collects and sends data from the front end of the mobile device to the back end of intelligence, which analyses the trip in order to ensure the integrity and reliability of the scoring mechanism.<br>The application detects, reconstructs and analyses the events that occurred during the trip, such as sudden braking, rapid acceleration, excessive speed or way of taking curves.<br>Using a proprietary GPS algorithm, the app calculates the "g force" generated during the events of driving without the corruption inherent in non-fixed accelerometer data. OCTO U then assigns a score to the trip. |
| Geographical scale | Urban and extra-urban scale. |
| Type of transport | Passenger and freight vehicles, long and short distance trips. |
| Type of stakeholders | • ICT companies<br>• Insurance companies<br>• Service providers |
| Institutional arrangements | Private company, start-up initially funded by venture capital, then owned by Investment Funds. |
| Transferability | This service is currently operating in Italy, Spain, France, UK and US. |

| Parckr Cooperative truck parking | |
|---|---|
| Description | |
| Status | 2011 – 2012 tested, active currently |
| Country | Netherlands |
| Description of service | Informing Truck users about actual (via cooperative system in app) and predicted/future availability of parking spots. This allows drivers to better adjust driving times and reduces the necessity of dangerous parking. It uses historical data, real time traffic data and reported availability by other truck drivers. The service uses a mobile application called Parckr. About 2000 Benelux parking places are included. Available in France, Dutch, German, English and Polish. |
| Main objective | • Increasing efficiency as drivers can find the best suitable parking place on their route<br>• Increases safety as there will be less dangerous parking as drivers are better informed. Furthermore, they do not have to park on parking places considered dangerous.<br>• Increase comfort of drivers. Less stress about finding a suitable parking place, less worries about driving times. |
| Innovation phase | 7 |
| Type of ITS | ATIS IMSIS |
| Technology used | 3g/4g |
| Geographical scale | Highways and parking spots close to highways |
| Type of transport | Truck |
| Type of stakeholders | • Public authorities: province, municipality, ministry of infrastructure<br>• Industry: OEM, research institutes, traffic research<br>• Universities<br>• App users |
| Institutional arrangements | 850.000 budget, Of which 465.000 privately financed. |
| Transferability | Transferable to other Roads and Countries. Not to other types of vehicles as they don't have regulated resting periods. |

| Praktijkproef Amsterdam ADAM application: cooperative travel app | |
|---|---|
| Description | |
| Status | finished, 1-2014 until 1-2015 active tested |
| Country | Netherlands |
| Description of service | Mobile application like superroute app but designed by a different consortium and in a different year. The application provided real time information about people who are entering/ exiting Amsterdam during rush hour especially. Information is gathered using floating car data (FCD) from app users and other sources available for road managers. App provides following advice:<br>• Pre tip information<br>• Optimal route/ alternative routes<br>• Travel times<br>• Parking information<br>• Congestion<br>• Real time information and push up messages in the case of relevant changes.<br>App users can send voicetweet to traffic centres about relevant conditions.<br>The app enables users to make the best choices before and during their trip. It is aimed at commuters who are familiar with the possible routes. |
| Main objective | Increasing efficiency |
| Innovation phase | TRL 7 |
| Type of ITS | ATIS. IRANS |
| Geographical scale | Regional level: on all roads around Amsterdam |
| Technology used | 3g/4g cellular network |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Service/app users<br>• Road authority<br>• Municipality<br>• Research institutes<br>• Service providers/app developer |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources: |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| Praktijproef Amsterdam (PPA) –Superroute  app: Real time travel advice | |
|---|---|
| Description | |
| Status | Finished, Active during the year 2015 |
| Country | The Netherlands |
| Description of service | Supperroute is a mobile application for smartphones that provides real time information for people who are entering Amsterdam. Information is gathered using floating car data (FCD) from app users and other sources available to road managers. The mobile application provides following advice:<br>• Departure time<br>• Optimal route<br>• Travel times<br>• Navigation<br>• Speed limit<br>• Congestion<br>• Real time information and push up messages in the case of relevant changes<br>Before the first use users have filled in a questionnaire which determines a type of traveller: comfort, speed, reliability and adventure. Based on this types different routes are advised. Furthermore, in the case of a change in route due to for example a closed route, different users get different advises. This reduces the change of a congested secondary/alternative road. |
| Main objective | Higher efficiency through optimal advice<br>Less congestion by spreading traffic |
| Innovation phase | TRL 7 |
| Type of ITS | ATIS. IRANS |
| Technology used | • Cellular 3g/4g network<br>• Existing sensor systems |
| Geographical scale | Regional level: on all roads around Amsterdam |
| Type of transport | This ITS service is tested for passenger cars in and near Amsterdam using both urban roads as highways. |
| Type of stakeholders | • Municipality of Amsterdam<br>• Research institutes<br>• Service provider<br>• Passengers/ App users<br>• Road Authority |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| PROBEIT Foresight Vehicle | |
|---|---|
| Description | |
| Status | Finished (08/00 – 12/03) |
| Country | United Kingdom |
| Description of service | The ProbeIT project aims to build and demonstrate a system that will both allow dynamically changing information from traffic authority databases to be transmitted to vehicles, and for sensor data from vehicles to be received back and processed.<br>The work was undertaken in 3 phases of integration:<br>Non-dynamic data flow phase involved the collection of underlying map data to be used in the digital maps for navigation;<br>The dynamic data flow phase involved production of data concerning speed limits, parking, dynamic navigation, real-time speed/traffic information;<br>The final floating vehicle application phase concerned advanced probe vehicle information such as road works or air bag alert |
| Main objective | The objective of the project was to develop an end-to-end process for the sourcing and exchange of geo-referenced information between traffic management systems, a uniform data source and vehicles utilising the Travel Information Highway (TIH) and cellular communication.<br>The aim of this process was to provide timely and accurate location-based information in the vehicle, such that Advanced Driver Assistance Systems (ADAS) are possible (efficiency and safety). |
| Innovation phase | 7 |
| Type of-ITS | ATIS. In vehicle motorist service information |
| Technology used | Mainly cellular. Also positioning technologies. |
| Geographical scale | The primary test site location for the project was the 5 mile square located around the town of Braintree, Essex, UK.<br>A separate test route on the motorway M25 to the west of London was identified to represent the corresponding physical factor combinations. |
| Type of transport | The service is for vehicles in general. There are not specific details. |
| Type of stakeholders | ProbeIT is a Foresight Vehicle project, 50% funded by the Highways Agency (HA) and supported by Essex County Council. The research is performed by a UK consortium, which includes WS Atkins Transport Systems Limited, Jaguar Cars Ltd, Navigation Technologies, Kingston University and the University of Southampton's Transportation Research Group<br>Besides funding, Essex County Council provides views on potential benefits of such a system and how traffic regulation data can be integrated. |
| Institutional arrangements | The financial sources are mainly public and come from the Highways Agency (replaced by Highways England in April 2015) and Essex County Council. |
| Transferability | This service is potentially transferable to any vehicle and any region. |

| Queue Warning (Q-WARN) | |
|---|---|
| Description | |
| Status | Finished (2012-2015) |
| Country | USA |
| Description of service | The application concept aims to minimize or prevent impacts of rear-end or secondary collisions by utilizing I2V and V2V communication to detect existing queues and/or predict impending queues; and communicate advisory queue warning messages to drivers in advance of roadway segments with existing or developing vehicle queues. The Q-WARN concept reflects an operational environment in which two essential tasks are performed: queue determination (detection and/or prediction) and queue information dissemination. In such an environment, the Q-WARN application may reside in the vehicle or within an infrastructure-based entity, or utilize a combination of both. The queue warning messages may either be communicated by the infrastructure-based entity using I2V communication or broadcast by vehicles that are in a queued state to nearby vehicles and infrastructure based entities. It is important to note that the Q-WARN application concept is not intended to operate as a crash avoidance system (e.g., like the forward collision warning safety application). In contrast to such systems, Q-WARN will engage well in advance of any potential crash situation, providing messages and information to the driver in order to minimize the likelihood of a crash avoidance or mitigation actions later. As such, Q-WARN-related driver communication will always give priority to crash avoidance/mitigation safety applications when such applications determine that a safety-related alert is necessary. |
| Main objective | Detect existing queues and predict impending queues. This will be performed by a Virtual Traffic Management Entity gathering data from connected vehicles and infrastructures<br>Provide the driver with information about queues in advance of road segments. The Q-WARN core in-vehicle application is able to process real-time data and inform the driver. |
| Innovation phase | 7 |
| Type of ITS | Advanced Traveller Information Systems (ATIS), In-vehicle Motorist Service Information Systems (IMSIS). |
| Technology used | • V2V and I2V<br>• Cellular<br>• Bluetooth<br>• DSRC Radio<br>• On-Board Diagnostic System<br>• GPS<br>• Road Side Units |
| Geographical scale | Local. This has been tested in the local area of Seattle (I-5). |
| Type of transport | Motorway, Passenger transport and freight transport |
| Type of stakeholders | • Government<br>• Research institutes<br>• Travelers/passengers |
| Institutional arrangements | Private/public partnership. |
| Transferability | Should be transferable to any other location. |

| Smartfreight | |
|---|---|
| Description | |
| Status | Finished (2008-2011) |
| Country | Norway |
| Description of service | This project aimed to make urban freight transport more efficient, environmentally friendly and safe through smarter use of the distribution networks and improved delivery and return-load systems. The basic idea was to integrate urban traffic management systems with freight management and on board systems. |
| Main objective | Develop new traffic management measures towards individual freight vehicles through open ICT services, on-board equipment and integrated wireless communication infrastructure |
| Innovation phase | 7 |
| Type of ITS | Advanced Traveller Information Systems (ATIS), Commercial Vehicle Operations (CVO) |
| Technology used | • Cellular<br>• Radio<br>• DSRC<br>• CALM standard<br>• Sensors |
| Geographical scale | Test site studies in Winchester, Bologna, Dublin and Trondheim |
| Type of transport | Freight transport |
| Type of stakeholders | • European Commission.<br>• Government/cities<br>• Service providers<br>• Research institutes<br>• Travelers/passengers |
| Institutional arrangements | Private/public collaboration |
| Transferability | Transferable to other regions |

| SmarTrAC | |
|---|---|
| Description | |
| Status | Finished (07/2014-02/2015) |
| Country | USA |
| Description of service | SmarTrAC is an innovative smart phone application that collects highly-detailed activity and travel behaviour data with minimal user burden, providing a compelling alternative to the traditional diary-based method typically used to collect individual travel and activity information.<br><br>Key features:<br>It automatically detects and classifies daily activity and travel episodes using smartphone GPS and accelerometer data.<br>It allows users to view, correct, and augments the automatically detected and classified information.<br>It provides annotated and aggregated activity/trip details. |
| Main objective | Combine smartphone sensing with advanced data mining techniques to automatically detect and classify daily activity and travel episodes.<br>It further integrates the data mining function with effective user communication to allow users to view, correct and augment the automatically classified information, as well as to allow the use of user input data to continuously optimize the data mining function |
| Innovation phase | 7 |
| Type of ITS | Advanced Traveller Information Systems (ATIS), In-vehicle Route and Navigation Systems (IRANS). |
| Technology used | Sensors<br>Cellular |
| Geographical scale | Urban and interurban service |
| Type of transport | Applies for passenger transport |
| Type of stakeholders | • Government<br>• Research institutes<br>• Travelers/passengers |
| Institutional arrangements | Public/private |
| Transferability | Yes transferable |

| VSC-A | |
|---|---|
| Description | |
| Status | Finished (2006-2009) |
| Country | USA |
| Description of service | Determine if DSRC (Dedicated Short Range Communications) @5.9 GHz & Vehicle Positioning can improve upon autonomous vehicle-based safety systems and/or enable new communication-based safety applications.<br>Strong emphasis on resolving current communication and vehicle positioning issues so that the interoperable future deployments of DSRC+Positioning based safety systems will be enabled |
| Main objective | Assess how previously identified crash imminent safety scenarios in autonomous systems could be addressed and improved by DSRC+Positioning Systems<br>Define a set of DSRC+Positioning based vehicle safety applications and application specification including minimum system performance requirements.<br>Develop a well understood and agreed upon benefits versus market penetration analysis and potential deployment models for a selected set of communication-based vehicle safety systems.<br>Develop scalable, common vehicle safety communication architecture, protocols and messaging framework (interfaces) necessary to achieve interoperability and cohesiveness among different vehicle manufacturers. Standardize this messaging framework and the communication protocols (including message sets) to facilitate future deployments.<br>Develop accurate and affordable vehicle positioning technology needed, in conjunction with the 5.9 GHz DSRC, to support most of the safety applications with high-potential benefits.<br>Develop and verify a set of Objective Test Procedures (OTP) for the vehicle safety communication applications. |
| Innovation phase | 7 |
| Type of ITS | Advanced Traveller Information Systems (ATIS), In-Vehicle Safety and Warning Systems (IVSAWS) |
| Technology used | • GPS and Real-Time Kinematic (RTK)<br>• ECDSA (Elliptic Curve Digital Signature Algorithm)<br>• TESLA (Timed Efficient Stream Loss-Tolerant Authentication)<br>• OTA (Over-the-air) messages |
| Geographical scale | Urban and Freeway |
| Type of transport | Passenger transport (car) |
| Type of stakeholders | 5 OMS (Ford, GM, Honda, Mercedes, Toyota) and US Department of Transport. |
| Institutional arrangements | Private/public collaboration |
| Transferability | Yes |

| Vx-TINFO | |
|---|---|
| Description | |
| Status | Finished (2016) |
| Country | USA |
| Description of service | Weather Response Traffic Information System (Wx-TINFO) project's purpose is to design a system that brings together near- time environmental/weather-related data collected from both fixed and mobile data sources.<br>Fixed:<br>• Road Weather Information Systems (RWIS) Stations.<br>• National Weather Service (NWS) Stations.<br>• NWS Radar.<br>• NWS Warnings (text)<br>Mobile:<br>• Integrated Mobile Observations (IMO) Project Fleet<br>• Safety Pilot Model Deployment Project Fleet. |
| Main objective | • Improve the real-time traffic management capabilities of Michigan Department of Transportation (MDOT) Transportation Operation Center (TOC) staff during weather events.<br>• Improve the timeliness and content of road weather condition reporting updates to the traveling public.<br>• Provide road weather condition information that MDOT Maintenance staff perceive as valuable for possible use in future road weather maintenance operations. |
| Innovation phase | 7 |
| Type of ITS | Advanced Traveller Information Systems (ATIS), In-vehicle Motorist Service Information Systems (IMSIS).<br>Advanced Traffic Management Systems (ATMS) |
| Technology used | • Sensors<br>• Cellular |
| Geographical scale | Regional |
| Type of transport | Passenger transport and freight transport. |
| Type of stakeholders | • Government<br>• Service Providers<br>• Research institutes<br>• Travelers/passengers |
| Institutional arrangements | Private/public partnership. |
| Transferability | Should be transferable to other regions. |

| Waze | |
|---|---|
| Description | |
| Status | Active service since 2010 |
| Country | Israel origin, globally available and used service. |
| Description of service | Community based mapping and navigation service that connects drivers with each other to offer real time information. Available for smartphones it allows users to communicate with each other to form a ‘waze community’. This community has its own ‘map developers’ to generate their maps. Users contribute due to passively reporting floating car data as well as actively by reporting accidents, speed traps, dangerous situations. Due to the accurate navigation and real time traffic information Waze has become a very large player in navigation, especially in countries where not many cars are equipped with navigation systems (Brazil) but the owners do have smartphones. Has total maps in 13 countries, ranging from western (USA, Germany) to developing (Chile, South-Africa) |
| Main objective | Improving comfort and efficiency were the original goals. As services expand safety becomes more important. |
| Innovation phase | 9 |
| Type of ITS | ATIS IMSIS |
| Technology used | Cellular network<br>GPS |
| Geographical scale | Full road coverage |
| Type of transport | Aimed towards passenger cars, but other road users can use the service as well. |
| Type of stakeholders | Private company that cooperates with:<br>• App users<br>• City partners: road authorities and transport companies of certain cities/areas provide information to Waze. The maps of Waze then become available for these partners. |
| Institutional arrangements | Private company recently acquired by Google |
| Transferability | This service has the potential to be applied across Europe. Services might depend on local legislation: ability to report speed traps. |

| ZooF : cooperative traffic information mobile app | |
|---|---|
| Description | |
| Status | Active from 2014 – currently |
| Country | Netherlands |
| Description of service | Zoof is a mobile application that provides smart advice to reduce traffic jams. It is intended to be used as a secondary screen next to navigation. The purpose of Zoof is to provide real time information about the road that is used. Zoof uses the 3g/4g network to receive information. The information includes: optimal speed, merging advice and distance in traffic jams. |
| Main objective | The goal of Zoof is to improve the efficiency. This has a positive effect on reduction congestion, and hence improving safety. |
| Innovation phase | First version tested, TRL 7 |
| Type of ITS | ATIS. IRANS |
| Technology used | 3g/4g cellular network |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Research institutes<br>• Service providers<br>• Road networking organisation |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources: Province Noord-Brabant, European Commission. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| Access Control in Rome | |
|---|---|
| Description | |
| Status | Ongoing |
| Country | Italy |
| Description of service | In Rome the structure of the city and the limited resources in term of mass transit supply requires to limit congestion and traffic environmental impacts as well as the strong need to preserve the historical and archaeological city:<br>Rome decided to implement a series of clean zones with a complex series of actions, according to the guideline provided by the Urban General Traffic Plan (PGTU), now reinforced and enlarged by the Strategic Sustainable Mobility Plan (SSMP), approved in 2010.<br><br>The turning point was the implementation of the LTZ system with “electronic gates” in October 2001. The system is based on a ANPR procedure as well as the use of OBU connected via DSRL with the entrance gantries.<br>The general idea is to forbid access to cars, increase the supply of Public Transport and increase the number of parking pricing slots along the LTZ cordons.<br>A “White List” of authorized users is defined and constantly updated, so that non-authorized vehicles acceding the zones during the enforcement times are detected by the ANPR system and automatically fined |
| Main objective | • Efficiency<br>• Environment |
| Innovation phase | 9 |
| Type of ITS | Advanced Traffic Management Systems / Demand and Access Management |
| Technology used | DSRC |
| Geographical scale | Urban level |
| Type of transport | Freight and passenger transport<br>Transport mode: car, truck,<br>Transport type/motive: urban trips |
| Type of stakeholders | • City of Rome<br>• Service providers (utilities)<br>• Emergency services<br>• Parking operators<br>• Resident associations<br>• Retail associations<br>• Disable people associations<br>• Local PT |
| Institutional arrangements | Totally public. the main financing sources for the project is represented by national public funds; the “on the way” extension to rail road is funded by EU structural funds. |
| Transferability | Fully transferrable: barriers represented by acceptance by people. Enablers: strong communication campaigns, involvement of people in the decision process. Impacts can be similar. |

| Highway network traffic management Autostrade per l'Italia (ASPI) | |
|---|---|
| Description | |
| Status | Finished and in operational |
| Country | Italy |
| Description of service | Autostrade per l'Italia (ASPI) is a motorway operator directly responsible for a network of 2,854 km and it provides systems and services to its sister companies managing approximately further 600 km. Everyday over 4 million drivers use the 3,400 km network managed by ASPI and by the other concessionaires of the Atlantia Group.<br>The system features are such that:<br>Allow operators to manage traffic in the event of incidents, road works and normal day to day activities of motorway operation;<br>Contribute to reducing congestion on the motorway;<br>Improve safety for motorway users and people working on the motorway;<br>Provide accuracy and reliability of the system;<br>Increase comfort and reduce stress for motorway users;<br>Guarantee efficient interoperability with existent systems and flexibility to future upgrades and changes;<br>The overall architecture of the ASPI system for Traffic Management is represented in the figure below. |
| Main objective | The main objectives of the ITS application.<br>• Safety<br>• Efficiency<br>• Environment<br>• Tolling<br>• Overweight of trucks |
| Innovation phase | TRL: 9 |
| Type of ITS | Advanced Traffic management Systems (ATMS)<br><br>Used stations: traffic management centres, road side units, floating car data |
| Technology used | • Cellular<br>• Satellite<br>• DSRC<br>• Sensors<br>• Variable Message Sign<br>• Monitoring systems<br>• Speed detector |
| Geographical scale | National level/large majority of the Italian motorway network |
| Type of transport | Road transport of any type (passengers on private vehicles and collective; freight) |
| Type of stakeholders | • Government: concessioner<br>• Service providers: typical on route services<br>• Emergency services: police, fire brigade, towing, repairing.<br>• Travellers/passengers |
| Institutional arrangements | Private enterprise operating on the base of concession from public body.<br>Revenues from fares agreed in the service contract. |
| Transferability | Totally transferrable: no impacts on KPI foreseen |

| Automatic Passenger Counting Systems | |
|---|---|
| Description | |
| Status | Available from numerous companies globally. |
| Country | Global |
| Description of service | Counting passengers on/off bus allows operators to manage resources to meet demands.<br>APC systems are electronic machines that count the number of passengers that board and disembark at every bus stop. Together with AVL systems, they form the two most important technologies that every transit system should have. In systems that have them, they replace the schedule checkers that previously collected ridership information manually. APC allows informed decisions about where people are riding, and when they are doing it. This is critical information for making service changes, establishing budgets, securing funding, and responding to changing ridership patterns. |
| Main objective | The main advantage of APCs are that, unlike schedule checkers, they collect ridership for as many as every single trip operated, if APC units are installed on 100% of the bus/tram fleet. They also reduce cost (efficiency), because even if initial startup costs are high in the long term it costs much less to collect ridership information via APC units than it does to hire employees to manually collect it. Other objectives of APC are linked to enhanced traffic monitoring, queue management, security and safety applications.<br><br>The main disadvantage is that APC units, while accurate, are sometimes not as accurate as manual collection - APC units collect accurate information from 80 - 95% of the time while manual collection is generally accurate between 90 and 95% of the time. |
| Innovation phase | TRL 9. |
| Type of ITS | APTS Passenger Information Systems, Fleet management optimization |
| Technology used | Key enabling technologies:<br>• Hardware Infrastructure (on-board computers/ticket printers; smartphones, analyzers for data transmission, human-machine interfaces, meters, actuators)<br>• Sensors (infrared, digital video camera)<br>• Software infrastructure (IoT, WLAN-WiFi, GPS, Ethernet, Cloud computing) |
| Geographical scale | Urban, Regional, National |
| Type of transport | All modes Public Transport (Trains, Trams, Buses). |
| Type of stakeholders | • Service providers<br>• Automotive suppliers<br>• Travellers/passenger<br>• Road operators |
| Institutional arrangements | Private, Public |
| Transferability | Can operate on any vehicle fitted with system. |

| The connected boulevard, Nice | |
|---|---|
| Description | |
| Status | Finished (2008-2014?) |
| Country | France. |
| Description of service | Manage and optimize all aspects of city management, including parking and traffic, street lighting, waste disposal and environment quality. |
| Main objective | Focusing in the smart parking and smart traffic management parts, the objectives are to reduce the number of traffic incidents (safety), reduce traffic congestion and optimize parking (efficiency and comfort) and reduce air pollution (environmental). |
| Innovation phase | 6 |
| Type of ITS | ATMS. Smart parking 200 sensors and detecting devices installed on street-lights, the roadway and garbage depositories. The data is processed into real-time information and converted into intelligence with the help of context-aware location analytics and then it is disseminated to serve multiple services in city operations and for city dwellers. |
| Technology used | The following technologies are used:<br>• Zigbee.<br>• Wireless sensor network.<br>• 3G/4G cellular network.<br>• Street network (fibre/copper/WiFi). |
| Geographical scale | Urban level. City of Nice. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for short distance trips. It also covers public transport. |
| Type of stakeholders | • City managers<br>• Service providers<br>• Parking operators<br>• Travellers/passengers |
| Institutional arrangements | Public private partnership between the city of Nice as part of the Nice Côte d'Azur Métropole and private entities such as Cisco and Think Global. |
| Transferability | The service should be transferable to other cities in the world. |

| Departure Planning Information | |
|---|---|
| Description | |
| Status | Ongoing (dates not available) |
| Country | United Kingdom |
| Description of service | The Transport Systems Catapult's Departure Planning Information (DPI) Programme is carried out in cooperation with the Civil Aviation Authority (CAA) and the National Air Traffic Services (NATS).<br>The programme is rolling out real-time flight departure technology at airports across the UK. Fully integrated with the European flight information network EuroControl, DPI allows air traffic controllers to provide real-time information about the departure of aircraft, which in turn enables EuroControl and National Air Traffic Control Centres to make much better assessments regarding the arrival times of those aircraft. |
| Main objective | The main benefits being realised by the DPI are reduced passenger delays and improved airspace efficiency (efficiency); reduction in fuel consumption, noise pollution and carbon emissions (environment). |
| Innovation phase | 8 |
| Type of ITS | ATMS Traffic monitoring |
| Technology used | Real-time flight departure technology (software). |
| Geographical scale | The service has been used in several airports across the UK. Previously only in place at Heathrow and Gatwick, DPI capability has then been successfully installed at London City, Stansted, Manchester, Edinburgh, Glasgow and Aberdeen airports, with Luton airport due to follow shortly. |
| Type of transport | The service is used for air transport. |
| Type of stakeholders | The Transport Systems Catapult cooperates with two partners, Civil Aviation Authority and National Air Traffic Services. |
| Institutional arrangements | Information not available |
| Transferability | The service is being used in several airports in the UK. It can be transferred in other areas and maybe in other modes of transport. |

| EcoMove Improve Network Usage | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | When driving in a road network, vehicles share information on their origin and destination to road side systems. By including data on green ratios and cycles times from local traffic controls, traffic state and fuel consumption data from the EnergyMap, and emission data from emission models, an optimal route distribution is computed for all origin-destination relations using specific cost and objective functions. |
| Main objective | • Determine a macroscopic network traffic state in terms of dynamic source-destination route distributions that reflects minimal fuel consumption for the totality of traffic.<br>• Provide a benchmark for optimal fuel consumption in a road network.<br>• Compute routes which serve the system and the driver requirements (win-win routes).<br>• Provide a data base for other eCoMove components / Service to support their control and management strategies. |
| Innovation phase | 7 |
| Type of ITS | ATMS. |
| Technology used | On Board Unit<br>GPS |
| Geographical scale | Inner city roads with a sequence of traffic lights |
| Type of transport | All type of vehicles |
| Type of stakeholders | • Research institutes<br>• Traffic managers |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and Countries |

| EcoMove Improve traffic flow stability | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Infrastructure systems gather information about speeds and headways of vehicles in the traffic flow. Based on this information the stability of the traffic flow is judged. Advice on speed and headway is given to drivers in order to improve the stability of the traffic flow and smooth out the speed profiles of the vehicles. |
| Main objective | • Avoid frequent heavy braking and acceleration from vehicles driving too close to each other, and thus reduce fuel consumption.<br>• Prevention of shock waves by ensuring that disturbances in traffic flow do not grow in magnitude as they propagate upstream.<br>• Indirectly, improve road safety and comfort |
| Innovation phase | 7 |
| Type of ITS | ATMS |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Dense but not yet congested traffic |
| Type of transport | All type of vehicles |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and countries |

| EcoMove Parking | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project. Tested at three France highways |
| Description of service | Improve parking guidance by providing real time information on the location of available parking spaces and dynamic routing to available parking facilities considering network state, events and current levels of pollutants. This should make finding a parking spot more efficient for road users, which reduces the stain on the traffic system. Which benefits the road operator. Road operators are aware of free parking spaces and want to advise vehicles about parking opportunities. |
| Main objective | Reducing unproductive travel kilometres and through this the environmental impact of road transport. |
| Innovation phase | 7 |
| Type of ITS | The sensors measure the cars; no direct communication is happening. Type of ITS is Traffic management, parking. |
| Technology used | Application |
| Geographical scale | Urban parking places |
| Type of transport | Inner city cars and trucks. |
| Type of stakeholders | • Road users<br>• Traffic managers<br>• Vehicle users |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and Countries |

| FOTsis 6 – Advanced Enforcement | |
|---|---|
| Description | |
| Status | Finished (2011-2015) |
| Country | 1 highway in Greece and 1 highway in Portugal |
| Description of service | This service uses different means and technologies besides the ones currently used to carry out traffic law enforcement. An example is the use of an On Board Unit that measures the maximum speed. Drivers get a warning when they exceed limits and enforcement actions when these warnings are violated. The basis of service is to see how notifications shown to drivers can be enforced. And how these data are managed and stored in the on board unit. Three elements are covered:<br>• Speed enforcement<br>• Lane enforcement<br>• Minimum distance between vehicles<br>The on board unit sends information towards the traffic centre. The road side infrastructure does the same. It is visible if the vehicle (on board unit) informs the same speed as is currently possible at the stretch of the road. It is than possible to see if the vehicle drives an acceptable speed. Non-compliance could trigger enforcement actions in real time and afterwards. This not only holds for going too fast, also slow drivers have the possibility to impose a lot of danger. |
| Main objective | Better speed enforcement has a positive influence on the safety of road users. A higher road safety reduces the number of accidents and this reduces congestion. This has a positive effect on the sustainability as emissions reduce. |
| Innovation phase | 7 |
| Type of ITS | ATMS enforcement with C-ITS V2I technology |
| Technology used | The following technologies are used:<br>• Mobile router equipped with WiFi-p<br>• Highway detection infrastructure: loops, cameras, etc.<br>• 3G |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Road managers : management and development<br>• Research institutes<br>• ITS companies<br>• Service users<br>• Road users |
| Institutional arrangements | Partly EU funded under FP7. Consortium with 25 Partners from 9 European Countries. Partners include Road operators, universities, telecom operators, maps providers, technology integrators, research centres, users' association, and industry associations. |
| Transferability | This service is applicable to other countries |

| FOTsis 3 - Intelligent Congestion Control | |
|---|---|
| Description | |
| Status | Finished (2011-2015) |
| Country | Spain 1 highway. Germany 3 highways |
| Description of service | • Improve the traffic load balancing in the road networks by introducing new algorithms to integrate dynamic data from diverse traffic information sources.<br>• Provide and integrate different data sources and deploy a suitable communication network<br>• Integrate infrastructure based detection of the traffic and weather conditions, incidents and the interaction between those<br>• Manage traffic flow by controlling maximum speed and real time communication with drivers<br>• Service based mostly on existing infrastructure |
| Main objective | Provide a high-level traffic management system. Gains are improved safety and mainly mobility through speed advice, less lane changes and less rear-end collisions. Additionally, the traffic capacity could increase and comfort and sustainability could increase. |
| Innovation phase | 7 |
| Type of ITS | ATMS demand and access management |
| Technology used | The following technologies are used:<br>• 3G/4G cellular network<br>• Highway detection infrastructure: loops, cameras, etc. |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Road managers : management and development<br>• Research institutes<br>• ITS companies<br>• Road users<br>• Policy makers<br>• Automotive associations and organisations<br>• Industry representatives. |
| Institutional arrangements | Partly EU funded under FP7. Consortium with 25 Partners from 9 European Countries. Partners include Road operators, universities, telecom operators, maps providers, technology integrators, research centres, users' association, and industry associations. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| Fotsis 4 - Dynamic Route Planning | |
|---|---|
| Description | |
| Status | Finished (2011-2015) |
| Country | Germany 3 highways and 1 highway in Spain |
| Description of service | The goal of this service is to manage traffic via dynamic route recommendations for predefined network meshes. Infrastructures generate information that provides a detailed overview of the traffic and weather situation. Based on current and forecasted traffic an optimal route is generated/altered to give a best service. The service provides a route recommendation. This improves road safety, comfort and reduces emissions. Reroutes have the costs that traffic at alternative roads is increasing. Data is collected from road side sensors and other equipment. Furthermore, data is collected from passing vehicles (position/speed). Historic data about input traffic, capacity of network, turning rates, and more is used to estimate the optimal routes given current traffic and weather conditions. |
| Main objective | Increase Efficiency and improving safety. Additionally, comfort and sustainability increase. |
| Innovation phase | 7 |
| Type of ITS | ATMS. Highway systems |
| Technology used | The following technologies are used:<br>• GPS<br>• Highway detection infrastructure: loops, cameras, etc.<br>• Smartphone<br>• Mobile router inside car -> connection via 3G and WiFi. |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Road managers: management and development<br>• Research institutes<br>• ITS companies<br>• Road users<br>• Policy makers<br>• Automotive associations and organisations<br>• Industry representatives. |
| Institutional arrangements | Partly EU funded under FP7. Consortium with 25 Partners from 9 European Countries. Partners include Road operators, universities, telecom operators, maps providers, technology integrators, research centres, users' association, and industry associations. |
| Transferability | This service is transferable to other road vehicles and to other types of roads. |

| FOTsis 7 – Infrastructure safety assessment | |
|---|---|
| Description | |
| Status | Finished (2011-2015) |
| Country | 2 highways in Portugal |
| Description of service | This service addresses the benefits of the exploitation of the information coming from the infrastructure in combination with information recorded by the on board unit. This will be used to identify and reconstruct specific related ‘situations’ that may occur in the road infrastructure. The performance of a road will be assessed post-process with use of the data measured by the on board unit. Three categories are defined:<br>• Normal driving conditions<br>• Degraded driving conditions due to weather, condition of driver, etc.<br>• Imminent crash situations<br>The data is very useful for feedback towards highway operators, emergency vehicles but also third parties, for instance insurance companies. This service is purely aimed about generating the data. |
| Main objective | As more information about road conditions become available safety increases. This has a positive effect on efficiency and sustainability. |
| Innovation phase | 7 |
| Type of ITS | ATMS Traffic monitoring |
| Technology used | On board unit/black box<br>• 3G<br>• Mobile Routers<br>• Beacons on the end of the stretch of road |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Road managers : management and development<br>• Research institutes<br>• ITS companies |
| Institutional arrangements | Partly EU funded under FP7. Consortium with 25 Partners from 9 European Countries. Partners include Road operators, universities, telecom operators, maps providers, technology integrators, research centres, users’ association, and industry associations. |
| Transferability | Transferable to other road types and vehicles |

| Guiade | |
|---|---|
| Description | |
| Status | Finished (2009-2011) |
| Country | Spain |
| Description of service | GUIADE aims to achieve automation in the positioning and guidance of public transport vehicles based on the multimodal perception of the environment, using the information collected by the vehicles as well as those supplied from the ITS infrastructure.<br><br>Equipped public transport vehicles obtain information about their local environments using vision-based vehicle detection system (cameras etc.) and floating car data (FCD) technology.<br>The cameras capture relevant information such as weather and daytime conditions, the number of vehicles in the local range of the bus as well as their relative position and velocity, while the FCD system captures information like global location, speed, and direction.<br>The vehicles transmit this information to a central control unit wireless technology via GPRS/UMTS cellular protocols.<br>The central unit then integrates the data collected by the fleet in order to generate updated traffic status and weather maps which will be used for fleet management tasks as well as to estimate the time of arrival.<br>To minimize failure points of cellular networks, a backup V2V communication system based on WiFi is used so that in-range vehicles will exchange the most updated information available.<br>Warnings of possible incidents detected by the ITS infrastructure are issued in advanced to the drivers through the ADAS systems of equipped vehicles. |
| Main objective | To improve traffic efficiency, reduce energy consumption, and improve service quality of public transport |
| Innovation phase | 6 |
| Type of ITS | APTS Real time system status information |
| Technology used | • Sensor<br>• ADAS<br>• GPS<br>• GSM<br>• WiFi (WLAN)<br>• Camera<br>• GPRS/UMTS |
| Geographical scale | Urban, interurban |
| Type of transport | Passenger transport (bus) |
| Type of stakeholders | • Universities<br>• Research institutes<br>• ICT solutions provider<br>• Wireless solutions provider<br>• Ministry of Science and Innovation (Funding) |
| Institutional arrangements | Public-private partnership. The project is funded by the Spanish Ministry of Science and Innovation (MICINN) and the European Regional Development Fund, (FEDER) |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| Secure Transport Communication based on TETRA (HOGIA) | |
|---|---|
| Description | |
| Status | On-going (recently launched, 2016) |
| Country | Sweden, UK |
| Description of service | HOGIA system helps bus companies to improve the efficiency of communication between traffic management and bus drivers. Based on TETRA technology, Hogia can link up traffic management systems to national radio communication systems. This provides buses with a stable, user-friendly radio system and creates a safer, less stressful working environment for staff. Traffic managers can create communication groups based on bus routes or departure times, without the need to track down call numbers for individual buses or drivers. Traffic controllers can also call individual buses directly. Bus drivers can also use the same features in order to contact each other. |
| Main objective | Main objective behind the application of TETRA and of specific HOGIA proposed approach is to increase efficiency of communications while creating safer environment. Main benefits rely then on enhanced security (alarm control, geo-fencing features, incident communication, coded encryption, monitoring and control); flexibility (easy-to-use, flexible configuration) and enhanced analytical approach (data reporting/logs, status, location, call records).<br>• Safety<br>• Efficiency<br>• Comfort<br>• Emergency services |
| Innovation phase | TRL 9. |
| Type of ITS | APTS Based on TETRA technologies, HOGIA system can be considered under the ITS category of Traffic Operation Control / Traffic Management |
| Technology used | Key enabling technologies are linked to the TETRA system (Communication technologies: Radio). |
| Geographical scale | Successfully implemented for Swedish public transport companies, but as most national communications systems in Europe are based on TETRA technology, the solution can be implemented across the continent. |
| Type of transport | Passenger Transport, all types. |
| Type of stakeholders | • Government/cities<br>• European Union<br>• Service providers<br>• Research institutes<br>• Automotive suppliers<br>• Emergency services<br>• Parking operators<br>• Travellers/passengers<br>• Road operators |
| Institutional arrangements | Private, PPP |
| Transferability | Can operate in any location where stakeholders agree on system spec. Can be used on any vehicle to communicate data. |

| Lanes management in USA | |
|---|---|
| Description | |
| Status | In operations |
| Country | USA |
| Description of service | In USA, by using lane management the following strategies can be implemented<br>• regulate demand<br>• separate traffic streams to reduce turbulence, and<br>• utilize available and unused capacity.<br>Examples of operating managed lane projects include high-occupancy vehicle (HOV) lanes, value priced lanes, high-occupancy toll (HOT) lanes, or exclusive or special use lanes. Each of these concepts offers unique benefits; therefore, careful consideration is given to project goals and objectives in choosing an appropriate lane management strategy or combination of strategies. Project goals may include increasing transit use, providing choices to the traveller, or generating revenue.<br>The following figure is a diagram that captures the potential lane management applications that fall into this broad definition of "managed lanes." On the left of the diagram are the applications of a single operational strategy—pricing, vehicle eligibility, or access control: |
| Main objective | • Safety<br>• Efficiency<br>• Comfort<br>• Environment |
| Innovation phase | TRL9 |
| Type of ITS | Discuss the type of ITS to which the application belongs: Advanced Traffic Management Systems / Demand and Access Management<br><br>Elaborate on the type of station(s) used: road side beacon, traffic management centre |
| Technology used | • VMS<br>• DSRC |
| Geographical scale | USA |
| Type of transport | Freight or passenger transport<br>Transport mode: passenger car, truck,<br>Transport type/motive: long distance, commuter travel, leisure travel etc. |
| Type of stakeholders | • DoT in each State<br>• Government/cities<br>• Federal Highway Administration<br>• Road operators |
| Institutional arrangements | Public |
| Transferability | Potentially high |

| Madrid smart parking | |
|---|---|
| Description | |
| Status | Finished (2014) and in operation |
| Country | Madrid (Spain) |
| Description of service | The city of Madrid has developed a Sustainable Urban Mobility Plan (SUMP) to promote more sustainable transport in the city and to reduce the use of private cars in favour of more sustainable modes. In the frame of the SUMP, thanks to the parking policy, Madrid is the first city in the world to implement a variable parking rate based on vehicle emissions<br>Those who park on-street pay according to the level of environmental friendliness of the technology of the vehicles (in Euro-class): when a car is parked the driver is asked to submit its licence plate number. This is checked against a reference database that includes the eco-performance of the vehicle. This determines the cost of parking.<br>Madrid shows that a coherent parking strategy can serve different policy goals: air quality, traffic management, energy use and clean vehicle deployment. |
| Main objective | • Efficiency<br>• Environment |
| Innovation phase | TRL9 |
| Type of ITS | The type of ITS to which the application belongs: Advanced Transportation Management Systems (ATMS).<br>Type of station(s) used: metered, traffic management centre, vehicles with cameras to read vehicle number plates parked |
| Technology used | • Cellular<br>• Radio<br>• Camera<br>• Payment systems |
| Geographical scale | Madrid |
| Type of transport | Passenger transport at urban level<br>Transport mode: passenger cars<br>Transport type/motive: urban distance, commuter travel, leisure travel etc. |
| Type of stakeholders | • Municipality of Madrid<br>• Services and technologies providers |
| Institutional arrangements | Project implementation funded by the Municipality of Madrid |
| Transferability | Madrid starts from building blocks that are available to all cities in Europe: the national vehicle register, parking hardware, parking regulations, and so on and it also offers good practice ready for transfer. |

| Multi-use lane in Barcelona | |
|---|---|
| Description | |
| Status | Finished :2006<br>Planned extensions, partially deployed |
| Country | Spain |
| Description of service | In order to develop measures against the uncontrolled growth of private vehicles operating in the City– making goods deliveries more and more difficult – the municipality initiated a project analysing the effects of urban commercial transport on the traffic situation.<br>The most advanced measure is the installation of so called multi-use lanes. Within Barcelona three lanes are used as multi-use lanes installed with VMS technology (variable message signs) which clarifies who is allowed to use the street (residents, clear-way, deliveries) according to the time of the day.<br>Some roads in inner city area are equipped with (VMS). During the day time one lane of the street is reserved for activities of different user groups (parking, loading unloading, traffic flow). The variable message signs show the actual access rights per user group to use the lane. Technically, the approach is realised in such a way that a first VMS shows whether the lane can be used for floating traffic or whether it is dedicated to parking and loading activities. In case the lane is dedicated to parking and loading activities, a second VMS shows the actual allowance for a particular user group. |
| Main objective | • Efficiency<br>• Environment |
| Innovation phase | TRL at the top |
| Type of ITS | Advanced Traffic Management Systems / Demand and Access Management |
| Technology used | VMS |
| Geographical scale | Urban level, inner city |
| Type of transport | • Freight<br>• Private vehicles<br>• Public transport |
| Type of stakeholders | The carriers doing the deliveries to the local stores as well as the retailers are involved. The municipality planned and installed the system |
| Institutional arrangements | Private, main financing sources for the project: national public funds |
| Transferability | Easy transferability, provided consensus with economic operators is reached on solid bases |

| New York's Midtown in Motion (MiM) adaptive traffic signal control system | |
|---|---|
| Description | |
| Status | Finished (2011-2013) and in operation |
| Country | New York City (USA) |
| Description of service | Midtown in Motion is the congestion management system implemented in July 2011 for improving mobility and reducing delays due to traffic congestion in Midtown (New York). The program was completed in September 2013 and it included 210 microwave sensors, 56 traffic video cameras and 48 E-ZPass RFID readers at about 10.000 intersections to measure traffic speeds.<br>The database of traffic demand was used to generate a two-level strategy: at one level, an 'algorithm of adaptive control' would respond to real-time traffic flow data, adjusting green-time signal phasing to anticipate build-ups of congestion; at a second level, TMC operators would respond to discrete incidents with appropriate action such as activation of pre-determined signal phasing, or requesting response from New York's Police Department.<br>Midtown in Motion, the TMC, and ASTCs are some of the results of the nearly $300 million DOT has invested in traffic management tools and advanced technology across the city. |
| Main objective | • Efficiency<br>• Comfort<br>• Environment |
| Innovation phase | TRL9 |
| Type of ITS | Advanced Transportation Management Systems (ATMS). It consists in three main 'building blocks':<br>a modern Traffic Management Centre (TMC) (in Queens);<br>a comprehensive wireless communications network;<br>a programme of upgrading intersection traffic signal controllers. |
| Technology used | Briefly discuss the technologies and message standards used. E.g.:<br>• Satellite<br>• WiFi<br>• RFID |
| Geographical scale | New York City (about 270 block square 'zone') |
| Type of transport | Type of transport for which the application is used:<br>Freight and passenger transport at urban level<br>Transport mode: passenger car, truck<br>Transport type/motive: urban distance, commuter travel, leisure travel etc. |
| Type of stakeholders | • New York City<br>• New York State<br>• Federal Highway Administration<br>• Service providers (Transcore) |
| Institutional arrangements | Project implementation funded by public authorities: New York city, New York State and Federal Highway Administration |
| Transferability | Totally transferrable |

| Piedmont Regional Traffic Operation Centre: Traffic Supervisor | |
|---|---|
| Description | |
| Status | In operation since 3 years |
| Country | Piedmont Region (Italy): the system covers all the region (36.000 Km) |
| Description of service | The traffic supervisor centre is the heart and the head of the Regional traffic operation centre of Piedmont Region; it gathers real time information (provided by traffic sensors, floating car data and road operators) to feed its traffic model and forecast traffic for the next hour.<br>The Supervisor is based on a traffic model that using origin and destination matrix and a graph describing the road network is able to estimate traffic conditions. The model is feed with real time measurement (traffic flows, speeds) in order to increase the reliability of traffic estimation and forecast. |
| Main objective | The system has 3 mains objectives:<br>Traffic supervision<br>Collection of traffic data and provision of instrument to support public administration in traffic (services, regulations and infrastructures) planning.<br>Real time information services devoted to general public.<br><br>These objectives can be mapped on the following categories<br>• Safety<br>• Efficiency<br>• Comfort<br>• Environment |
| Innovation phase | During the design phase the Traffic Supervisor embedded a lot of very innovative technologies and algorithms. The development lasted for several years and now after some years of operation can be considered a product on the shelf (TRL9). |
| Type of ITS | Advanced Traffic Management System (ATMS)<br>Elaborate on the type of station(s) used: traffic sensors, floating car data |
| Technology used | • Satellite<br>• WiFi<br>• Radio |
| Geographical scale | Regional level covering also regional motorways and with a special focus on Turin metropolitan area. |
| Type of transport | Mainly passenger transport<br>Transport mode: passenger car and trucks<br>Transport type/motive: long distance, commuter travel, leisure travel. |
| Type of stakeholders | • Piedmont Region (co-founder and owner of the supervisor)<br>• 5t, the mobility agency of Turin<br>• Travellers/passengers (user of services)<br>• Road operators (data providers)<br>• Service and technology providers |
| Institutional arrangements | The project has been founded by national and regional funds and carried out by a company (5T) fully owed by public administrations. |
| Transferability | Traffic supervisor can be transferred but require the presence of a traffic control centre (infrastructure and staff) and a lot of data provider providing historical and real time data. |

| Amsterdam Mobile EVA : cooperative travel parking app | |
|---|---|
| Description | |
| Status | Finished, active from 1-2014 1-2015 |
| Country | Netherlands |
| Description of service | This mobile application is similar to Super route-P but was made by a different consortium and active one year earlier. The mobile application was used to inform visitors of 10 events in Amsterdam to the optimal route as well as the best parking place. A portal behind this app and ADAM monitors the movement of participants and advices them based on their location. The application was adjusted and personalised for each event, and therefore also not available in the app stores when no event was scheduled. Go with Eva to Bruce Springsteen is one example of personalisation. Application is 'active' hours before the event, from this time onwards it is possible to plan your trip. App will provide optimal route as well as recommended departure time. If participants come close to the destinations the application will provide active and actual directions towards a parking place. Proximity is measured if the mobile phone passes a measurement point (pick-up point). The application switched from general advice (eg. Route shown on map) towards a more specified advice -> take a4, leave highway … and park at P2. Participants can use the app on departure as well.<br>Portal receives information from parking garages, road management and uses this to send push messages to participants. |
| Main objective | Increase efficiency |
| Innovation phase | Technology readiness 7 |
| Type of ITS | ATMS Parking management |
| Technology used | 3g/4g |
| Type of transport | This ITS servie is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Service/app users<br>• Road authority<br>• Municipality<br>• Research institutes<br>• Service providers/app developer |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources: |
| Transferability | Event based solution. Actual information for Amsterdam area, Scalable but not profitable in its current form. The system in general could be used for events in other cities or at other large events. |

| Amsterdam onderweg Super P-route : cooperative travel/parking app | |
|---|---|
| Description | |
| Status | Finished, active during 2015-2016 |
| Country | Netherlands |
| Description of service | Mobile application that advices participants about parking opportunities and optimal routes during large events in Amsterdam and its surroundings. Gives advice on departure time and the ability to reserve a parking spot. Smart Routing algorithm uses real time information to give multiple route alternatives during travel. App uses load balancing (different users from the same location are advised different routes). Back office system is like the function of Super-Route<br>Highlights:<br>• Open platform<br>• Advice for participants<br>• Receives floating car data from participants<br>• Uses information of road authorities |
| Main objective | Less congestion and more reliable trip information (efficiency) |
| Innovation phase | TRL 7 |
| Type of ITS | ATMS Parking management |
| Technology used | 3g/4g cellular network |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Service/app users<br>• Road authority<br>• Municipality<br>• Research institutes<br>• Service providers/app developer |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources: |
| Transferability | Event based solution. Actual information for the Amsterdam area. Scalable but not profitable in its current form. The system in general could be used for events in other cities or at other large events. |

| Sensit Nedap parking | |
|---|---|
| Description | |
| Status | Applied at multiple places. Kortrijk (BE) and Zoetermeer(NL) for example. Introduced in 2006. Also applied in Moscow, |
| Country | Netherlands |
| Description of service | Wireless ground sensors that measure if parking spots are available. This is communicated towards a central station. This information is then communicated towards drivers. The sensors also measure times, which is used to inform authorities if parking times are exceeded. This product is developed by a private company NEDAP and the service is called Sensit. |
| Main objective | Less time finding a parking spot. Which is good for comfort and reduces fuel use. |
| Innovation phase | 9 |
| Type of ITS | ATMS. Parking management |
| Technology used | • Sensor<br>• Earth magnetic field<br>• Infra red<br>• 900 MHz to communicate with sensor station |
| Geographical scale | Urban parking places |
| Type of transport | Aimed at cars and inner city trucks |
| Type of stakeholders | Private company |
| Institutional arrangements | Developed and commercialized by a private company |
| Transferability | Transferable to other cities and Countries |

| Traffic Information System Romania | |
|---|---|
| Description | |
| Status | Finished (12/2011 – 2/2013) and in operation |
| Country | Romania:  all national routes, motorways and Bucharest's main thoroughfares |
| Description of service | TrafficGuide - Real-time Traffic Information System for Romania has been a project developed by Electronic Solutions SRL and co-funded by European Union with European Fund for Regional Development.<br>The project aim has been to develop a real-time traffic information system for Romanian Motorways, National Roads and Bucharest Area, monitoring a total of around 80,000 kilometres of road.<br>The data gathered is compared, validated, harmonised and merged. The data sources are dynamically weighted during the harmonisation process to facilitate adaptation to local circumstances. Thanks to these solutions, it is possible to provide traffic managers with a comprehensive picture of speed, traffic densities and congestion across their traffic network. |
| Main objective | • Efficiency<br>• Comfort<br>• Safety<br>• Environment |
| Innovation phase | TRL9 |
| Type of ITS | Discuss the type of ITS to which the application belongs: Advanced Traffic Management System (ATMS)<br><br>Elaborate on the type of station(s) used: FCD, ANPR |
| Technology used | • Satellite<br>• Radio |
| Geographical scale | National level |
| Type of transport | Freight or passenger transport<br>Transport mode: passenger car, truck<br>Transport type/motive: long distance, commuter travel, leisure travel etc. |
| Type of stakeholders | • ELSON (coordinator, an engineering and consulting firm which specialises in ITS solutions and is working together with ITS Romania to implement intelligent traffic systems in Romania)<br>• PTV (software provider)<br>• Motorways operators<br>• National road operators<br>• Bucharest Traffic Management<br>• Road operators |
| Institutional arrangements | TrafficGuide - Real-time Traffic Information System for Romania - is a project developed by Electronic Solutions and co-funded by European Union from European Fund for Regional Development. |
| Transferability | Totally transferrable |

| Urban Traffic Control (UTC) London | |
|---|---|
| Description | |
| Status | Finished and in operation |
| Country | England |
| Description of service | London has one of the largest integrated traffic signal systems in the world. There are 4.800 sets of traffic signals and all are owned and operated by Transport for London. Of these, 2,800 are controlled centrally directly by the UTC system, allowing the signal phasing timings to be controlled directly by the London Traffic Control Center and by Transport for London traffic signal engineers.<br>Some 1300 sets of traffic signals are controlled by central computers systems that use a dynamic, real time demand responsive management systems. This adjust the operation of the traffic signals on a second by second basis. Vehicles detectors buried under the road surface, monitor the volume of traffic and levels of congestion and change the signal timings to optimise the road capacity. The systems use the SCOOT algorithm developed by the Transport Research Laboratory. The dynamic SCOOT approach provides significant improvement over the alternative “Fixed Time” approach and there is a continuing programme to extend SCOOT use.<br><br>500 sets of traffic signals are on fixed time and the relevant timing plans can be implemented remotely using computer control systems. These plans are derived7 through traffic modelling techniques. They vary according to the time of day and day of week and are designed to take in account of “expected” traffic conditions. Plans can be altered by the London Traffic Control Center operation staff, usually drawing on a growing library of pre-defined plans developed to meet a range of operational scenario. When significant incidents take place, or there are preparations for major events, traffic signal control engineers will develop new plans to meet the specific circumstances. |
| Main objective | • Safety<br>• Efficiency<br>• Environment |
| Innovation phase | TRL9 |
| Type of ITS | Advanced Traffic Management Systems / Demand and Access Management<br><br>Via ITS stations: traffic lights, traffic management centre |
| Technology used | Adaptive control |
| Geographical scale | Urban |
| Type of transport | Freight or passenger transport<br>Transport mode: passenger car, truck, |
| Type of stakeholders | • Municipality of London<br>• Transport for London<br>• Transport Research Laboratory |
| Institutional arrangements | Public |
| Transferability | Totally transferrable |

| Congestion Charge London | |
|---|---|
| Description | |
| Status | In operation since February 2003 |
| Country | United Kingdom |
| Description of service | The Congestion Charge is an £11.50 daily charge for driving a vehicle within a specified area of central London during the week (between 07:00 and 18:00 from Monday to Friday).<br>It was introduced by Transport for London (TfL) in February 2003 after an extensive public and stakeholder consultation. It was extended westward in February 2007, but the extension was then removed in December 2010.<br>Paying the Congestion Charge enables motorists to drive in the charging area, leave and re-enter it as many times as required during the day.<br>The drivers have to pay to register their Vehicle Registration Number (VRN) on a database. Cameras read the vehicle's number plates in the charging zone and check these against the database. Once a VRN has been matched, the photographic images of the vehicle are automatically deleted from the database.<br>The daily charge can be paid before or on the day of travel by telephone, text message, online and by post. The payment can also be made via Congestion Charging Auto Pay, an automated payment system that gives a discounted daily charge rate.<br>The drivers who have not paid the charge by midnight on the next charging day after they travel in the zone are issued with a Penalty Charge Notice. Exemptions and discounts are also available to certain categories of vehicles and individuals.<br>By law, net revenue from the Congestion Charge must be spent on further improvements to transport across London. |
| Main objective | As London suffers from the worst traffic congestion in the UK and one of the worst in Europe, the Congestion Charge is designed to reduce congestion and encourage motorists to use other modes of transport, like public transport, walking and cycling (efficiency and environment). |
| Innovation phase | 9 |
| Type of ITS | The type of ITS is ATPS congestion charging. The types of stations used are cameras and computer. |
| Technology used | The type of technology used is mainly the automatic number plate recognition technology. |
| Geographical scale | It applies to central London only. |
| Type of transport | It applies to vehicles, but there are some exceptions, like for example London licensed taxis and private hire vehicles, motorcycles, bicycles, vehicles with nine or more seats licensed with the DVLA as buses. |
| Type of stakeholders | The main stakeholders are Transport for London (TfL) and passengers. |
| Institutional arrangements | No information. |
| Transferability | The service can be transferred potentially to other cities. |

| Maut | |
|---|---|
| Description | |
| Status | Ongoing |
| Country | Germany and Austria |
| Description of service | Toll system for heavy duty vehicles on German and Austrian Highways and main national roads. The amount of the toll depends on the total distance that is driven by the trucks. On-board registration units capture the total distance driven and the amount of toll. This is collected automatically.<br>Toll amount depends on:<br>• Axles<br>• Euro emission class<br><br>The plan is to extend the toll for all road vehicles in 2018. |
| Main objective | • Efficiency (reducing congestion)<br>• Environmental (polluter pays more) |
| Innovation phase | TRL9. Operational |
| Type of ITS | Advanced pricing systems. Vehicle miles travelled systems. |
| Technology used | OBU |
| Geographical scale | Germany and Austria |
| Type of transport | Heavy duty freight |
| Type of stakeholders | • Government<br>• Service provider |
| Institutional arrangements | Public |
| Transferability | Potentially high |

| Milano Area C: Low Emission Zone & Charging Scheme | |
|---|---|
| Description | |
| Status | In operation |
| Country | Italy |
| Description of service | This is a combined Low Emission Zone and urban road charging scheme. The “Area C” is the historical Centre of Milan bounded by the Cerchia dei Bastioni and it is a restricted traffic zone from Monday to Friday from 7.30 to 19.30 (18 on Thursday). This is the only scheme of its kind in Italy.<br>The access points to the area are 43, including 7 for exclusive use of public transport, and are monitored by cameras. The surveillance cameras detect the entering vehicle and transmit the data collected to a computer which recognizes it and the corresponding due charge.<br>To access the area is necessary to buy a ticket (the standard price is €5, but several types of tickets, discounts and exemptions are available); this can be purchased at parking meters, newsagents, tobacconists, ATM points (Milan Transport Company), Intesa Sanpaolo ATMs, online or by phone. In case of non-payment, a penalty is issued. |
| Main objective | The main aim is to improve the life conditions of those who live, work, study and visit the city. Its objectives are:<br>• decreasing road traffic in the designated area<br>• improving public transport networks<br>• raising funds for soft mobility infrastructures : cycle lanes, pedestrian zones, 30kph zones<br>• improving the quality of life by reducing the number of accidents, uncontrolled parking, noise and air pollution.<br>These objectives belong to the categories of efficiency and environment. |
| Innovation phase | 9 |
| Type of ITS | The types of ITS involved is ATPS congestion charging. The stations used are cameras and computer. |
| Technology used | I suppose that the type of technology used is mainly the automatic number plate recognition. |
| Geographical scale | It applies to the historical Centre of Milan bounded by the Cerchia dei Bastioni. |
| Type of transport | The vehicles allowed need to comply with certain requirements (i. e. “Euro 0” petrol vehicles and “Euro 0, 1, 2, 3” diesel vehicles with a length of more than 7.5 meters are forbidden), including foreign ones.<br>Public transport is allowed and some categories of vehicles are exempted from payment (i. e. motorcycles and scooters, electric vehicles, hybrid vehicles, natural gas, LPG and bi-fuel vehicles, vehicles transporting people with disabilities, subjected to life-saving treatments or for those who must go the first aid). |
| Type of stakeholders | The main stakeholders are the Comune di Milano (government actor), the ATM Azienda Trasporti Milanesi (Milan Transport Company), the people and operators driving in the designated area. |
| Institutional arrangements | The people who want to access the area have to pay. |
| Transferability | The service can be easily transferred to other regions. |

| Sanef UK Liber-t Automated Toll Payment Service | |
|---|---|
| Description | |
| Status | In operation |
| Country | France |
| Description of service | Sanef, the French motorway operator, has extended its Liber-t automatic toll payment service to UK motorists. Liber-t is the French national télépéage scheme for light vehicles operated by the members of ASFA, the association of French motorway operators on behalf of the French government. It works on the entire French toll road network and can also be used to pay for parking in some car parks.<br>To use the service, drivers have to register on the dedicated UK website and will receive a small electronic transponder (tag) to attach to the windscreen of the car, just behind the rear-view mirror.<br>When approaching the barriers, a device by the barrier will read the transponder (tag), extract the unique reference of that user and then automatically open the barrier. The barrier has to be approached at walking pace and, when the transaction has been completed, the tag will "beep", the traffic light changes to green and the barrier opens (on certain lanes it is possible to drive through at up to 30 km/h).<br>Therefore, the user will not need to stop and manually pay the toll. They will receive an invoice and about 15 days later, the payment (in GBP) will be automatically collected from their bank account in the UK via Direct Debit. |
| Main objective | The main aim is to speed up travel for UK drivers and holiday makers in France. These lanes save time because they avoid both queuing and having to keep Euro cash handy to pay tolls (efficiency). |
| Innovation phase | 9 |
| Type of ITS | APS. Electronic toll collection |
| Technology used | Electronic transponder technology. |
| Geographical scale | The service includes all the toll motorways in France (excluding the Mont Blanc and Fréjus tunnels). Sanef runs the toll roads in northern France, but this new tag will work with every toll road across France. |
| Type of transport | The Liber-t scheme is for light and intermediate vehicles and motorcycles only (i.e. vehicle classes 1, 2 and 5); and it is for consumers, not businesses. |
| Type of stakeholders | Sanef Tolling is a trading name of Emovis Tag UK Ltd, a wholly owned subsidiary of Abertis SA, the ultimate majority owners of Sanef SA (a French motorway company who operates toll roads in France and other toll systems around the world). This is the main stakeholder, together with the UK motorists who use the service. |
| Institutional arrangements | The motorists who use the service have to pay the toll. |
| Transferability | The application is transferable to other regions. |

| Stockholm Congestion Pricing | |
|---|---|
| Description | |
| Status | Finished:<br>Full operational since 2007 |
| Country | Sweden |
| Description of service | In 2006, the county of Stockholm had nearly 2,000,000 residents, of which almost half a million lived in the inner city. Of the approximately 320,000 people employed in the inner city, more than 210,000 of them commuted from outside the inner city. Prior to the congestion charges, the cordon around the inner city (see below picture)was crossed by 530,000 vehicles and 800,000 transit passengers each day.<br><br>Between March 2003 and February 2004, the Swedish Road Administration, researched, designed and planned an access management system based upon the concept of charging. They tested multiple traffic forecasting models to determine how such charges would impact, among other things, public transit, traffic congestion and air quality. Most models predicted a traffic decrease of about 16%.<br>There was no room on any of the city's bridges to build toll booths, so the idea of individual vehicle transponders linked directly to bank accounts was proposed. Eighteen unmanned electronic control points were established at all entrances into the cordon and the tax was applied on both the entry and exit of the area.<br>For vehicles without a transponder, license plates were photographed using automatic number plate recognition (ANPR) technology and cross-referenced with Sweden's National Vehicle Registry to record the charge.<br>Figure below represent the process of the vehicles identification. |
| Main objective | The primary objectives of the system were to reduce congestion, increase accessibility and improve the environment. |
| Innovation phase | The technology readiness level (TRL) of the application is at the top being operative for 10 years and continuously optimized |
| Type of ITS | Advanced transport pricing systems. Congestion charging.<br><br>Elaborate on the type of station(s) used: I2V carrying an on board unit linked to road side beacon. |
| Technology used | Briefly discuss the technologies and message standards used.<br>DSRC |
| Geographical scale | Urban level, limited to the inner part of the city of Stockholm |
| Type of transport | :<br>Freight and passenger transport<br>Transport mode passenger car, truck,<br>Transport type/motive:, commuter travel. |
| Type of stakeholders | Stakeholders that are involved in the project (and their role). Possible stakeholders are:<br>• Stockholm County Council regional planning and traffic unit<br>• Stockholm Transport<br>• Emergency services<br>• Travellers/passengers association |
| Institutional arrangements | Fully public including financing sources for the project |
| Transferability | Fully transferable provided careful planning and deep citizens involvement. |

| TELEPASS | |
|---|---|
| Description | |
| Status | Ongoing application (1989 -) |
| Country | Italy, interoperability with specific motorway networks in France, Spain, Portugal and Belgium (Liefkenshoek Tunnel) |
| Description of the application | Automatically road tolls at motorway toll gates through a device called Telepass.<br><br>The automatic toll collection system Telepass uses DSRC technologies which consists of the microwave transmission of data between an in-vehicle device and roadside tolling infrastructure, mainly comprising DSRC gantries installed along the tolled road. The technology can be applied on motorways with open and closed toll systems. Each Telepass gate, whether entering or exiting, is equipped with DSRC technologies that automatically manage transits, maintain the dialogue with the on-board unit device and the connection with the information systems to charge for the transit, according to the logical steps illustrated in the following picture. |
| Main objective | The main objectives of the service concern with comfort for the user, e.g. avoiding queues and easing the payment, and environmental reasons, e.g. saving fuels and travel time at charging points. Thus, a more general efficiency of the travel is also pursued through the application. |
| Innovation phase | Technology readiness level 9. The service is fully operational. |
| Type of ITS | ATPS electronic toll collection. DSRC technologies for communication between the on-board device (OBU) and the roadside equipment, the on-board unit with registered user's tolling account which can then be used to charge the user either pre-pay or post-pay. The OBU can also store some vehicle-specific data, including licence plate details and vehicle category, which can be used to calculate the toll to be paid. |
| Technology used | The following technologies are used:<br>• microwave DSRC (Dedicated Short Range Communication) technology at a frequency of 5.8 GHz<br>• Automatic Number Plate Recognition (ANPR) for reading license plates<br>• The Telepass technology is aligned with the European interoperability standards (European Standard ETSI ES 200674-1). |
| Geographical scale | Urban level (e.g. parking, access to historical centre) National and European level, along specific segments of the European motorway toll network. |
| Type of transport | Passenger and freight vehicles, long and short distance trips. |
| Type of stakeholders | • Italian and European motorways infrastructure managers: management and development<br>• Municipalities<br>• Nodes (e.g. airports) and infrastructure, e.g. parking |
| Institutional arrangements | Telepass is owned by Autostrade per l'Italia S.p.a (96,15%) and by Autostrade Tech (3.85%) |
| Transferability | This service is currently interoperable with the Via-T Spanish service, TIS PL and the French electronic tag Telepass SAT, along 33,000 kilometers of European highways, and it is in development the project that will allow transit through the Liefkenshoek tunnel in Belgium. Furthermore, through the Telepass Pyng service, payments of services dedicated to mobility are now allowed in several Italian cities through the download of an app via smartphone.  Payments include the access to the Milan historical centre and the Rome Fiumicino Airport parking fees, |

| TEXpress | |
|---|---|
| Description | |
| Status | In operation |
| Country | Texas, USA |
| Description of service | TEXpress Lanes are unique toll lanes built within an existing highway. They add additional capacity to the highway to relieve congestion and allow traffic to flow freely. They are adjacent to the general highway lanes, but they have independent entrances and exits. The driver can choose to use the TEXpress lanes and pay the tolls or to drive in the adjacent non-tolled general highway lanes.<br>The price of the TEXepress lanes changes depending on the level of traffic in the corridor to maintain a minimum 50 mph speed of travel. This is different from the traditional toll roads that instead charge the same rate at all times and do not aim to ensure predictable travel times.<br>Roadside equipment monitors real-time traffic conditions and calculates real-time traffic-based rates every 5 minutes throughout the day based upon the average speed and number of drivers who want to use the TEXpress Lanes.<br>Prices may increase or decrease depending on the amount of traffic and the time of the day (prices are lower during non-peak times); the customers are notified of the price they would pay on the toll pricing signs prior to entering any segment of the lanes. The variable pricing aims to ensure a predictable, higher-speed commute.<br>The TEXpress Lanes are all-electronic and cashless. For customers with a Texas tag, toll fees are automatically deducted from their pre-paid account. For those who don’t have a tag, the video cameras will photograph the vehicle license plate and the North Texas Tollway Authority will send the bill to the registered vehicle owner. |
| Main objective | The main aim of the application is to offer more control over daily commute (efficiency). |
| Innovation phase | 9 |
| Type of ITS | APS. Fee-Based express lanes |
| Technology used | Technology for video cameras and toll pricing signs. |
| Geographical scale | Currently, TEXpress Lanes are open or under construction on seven major Dallas – Fort Worth corridors. Within the next years, other lanes will be designated on other highly-congested roadways throughout North Texas. |
| Type of transport | TEXpress Lanes can be used by anybody, including local drivers and commuters. They are open to all types of vehicles including passenger vehicles, SUVs, motorcycles, pickup trucks, large trucks and tractors with trailers. Special vehicles or vehicles transporting hazardous material may have certain restrictions on some routes. |
| Type of stakeholders | The stakeholders involved are mainly government organisations (North Texas Tollway Authority, NTTA; Texas Department of Transportation, North Central Texas Council of Governments, Regional Transportation Council, Harris County Toll Road Authority Organization) and drivers using the TEXpress Lanes. |
| Institutional arrangements | The drivers who want to use the TEXpress Lanes have to pay. The price fluctuates on the basis of traffic levels and demand for the lanes. |
| Transferability | The service is potentially transferable to other regions. Actually, similar managed lanes are already in operation in more than a dozen cities throughout the USA. |

| Automatic dependent surveillance- broadcast | |
|---|---|
| Description | |
| Status | Being deployed |
| Country | Global |
| Description of service | Technology to allow airplanes to broadcast their position, flight information and weather conditions. This information is sent to flight control centres as well as other airplanes. Mandatory in portions of Australian airspace, Required in US in 2020 for some planes. Mandatory in Europe from 2017 onwards. New satellite will allow full coverage and prevent planes 'getting lost'.<br>Technique shows:<br>Traffic: altitude, heading, speed and distance to other aircrafts.<br>Weather<br>Flight Information (restrictions for example) |
| Main objective | • Safety (continuous tracking of planes and weather updates)<br>• Efficiency (closer passing of aircrafts leads to more efficient use of space, furthermore the technique is cheaper as radar) |
| Innovation phase | Operational. TRL 9 |
| Type of ITS | ATIS IMSIS |
| Technology used | The following technologies are used:<br>• GPS navigation source<br>• ADS-B unit (1090 MHz & 978 MHz)<br>• Ground units and on board system |
| Geographical scale | Aviation |
| Type of transport | Airplanes |
| Type of stakeholders | • Airplane manufacturers<br>• Airports<br>• Traffic operators<br>• Service providers<br>• ADS-B manufacturers |
| Institutional arrangements | 60% of all passenger planes are equipped. Installations are done by private companies and differ per navigational unit. |
| Transferability | Not sure |

| Heavy vehicle platooning trial Australia | |
|---|---|
| Description | |
| Status | Running– C-ITS feasibility study testing autonomous heavy vehicle platooning government-backed initiative of industry and commercial partners<br>With Peloton Technology set to make its driver assistance truck platooning system commercially available in 2017 in the US, it may be fair to assume the trial will take place next year (press release in 10/2016). |
| Description of service | Heavy vehicle platooning, a group of 2 or more wirelessly-connected heavy vehicles that travel at highway speed in close proximity, nose-to-tail.<br>A lead vehicle is followed by a number of other vehicles that precisely match the lead vehicle's speed and manoeuvres (synchronization of speed, braking and positioning)<br>Under the technology, a lead truck assumes control of the convoy or platoon through V2V communication and the trailing vehicles fall into lock-step.<br>Other vehicles can wirelessly connect and seamlessly join or leave the platoon at any time |
| Main Objectives | Facilitate demonstrations of autonomous technology for heavy vehicle platooning<br>Gathering valuable data and experience in safe operation of new technology<br>Raise awareness of autonomous vehicles and explore the benefits of truck platooning in Australia.<br>Shape development of government policy + legislation for self-driving heavy vehicles |
| Innovation phase | 7 |
| Type of ITS | C-ITS V2V freight |
| Technologies used | Telstra's 4G and future 5G networks |
| Geographical scale | Western Australia<br>22 km non-public roads section of the Carina Haulroad: controlled environment |
| Type of transport | • Heavy vehicle<br>• Long distance |
| Type of stakeholders | • Main Roads Western Australia<br>• Australian Driverless Vehicle Initiative (ADVI), a cooperation of industry, government and academia<br>• Peloton Technology (US-based automation + connected vehicle technology company)<br>• Telstra (telecommunications company)<br>• Western Australian Road Transport Association (WARTA)<br>• Government of Western Australia. |
| Institutional arrangements | run by Western Australia, Department of Main Roads |
| Transferability | This service is transferable |

| CACC - Cooperative Adaptive Cruise Control in Real Traffic Situations | |
|---|---|
| Description | |
| Status | Finished – Joint demonstration study (UC Berkeley / Nissan Co. Ltd) - 2014 |
| Country | USA |
| Description of service | Adaptive cruise control (ACC) systems can gain enhanced performance by adding vehicle-vehicle wireless communication to provide additional information to augment range sensor data, leading to cooperative ACC (CACC).<br>CACC was designed, developed, implemented in production cars and tested in real-traffic scenarios (to compare to existing ACC systems). |
| Main objective | Reduction of traffic accidents (road safety) – previous focus<br>Improving traffic flow, Reducing congestions on highways (efficiency, environment) – focus of this study<br>A system able to reduce disturbances propagated from leading vehicle to rest of the vehicle platoon<br>Tighter control of vehicle spacing + shortened time-gap settings (efficiency, drivers' comfort) in any traffic circumstance, with smoothness + accuracy |
| Innovation phase | TRL 5(-6) = Design, development, implementation + testing of a CACC system |
| Type of ITS | C-ITS V2V Safety |
| Technology used | V2V - Cooperative adaptive cruise control (ACC)<br>• Factory installed ACC controller<br>• 5.9-GHz Dedicated Short-range communication (DSRC) with GPS in wireless safety unit (WSU) supplied by DENSO (wireless communication)<br>• LiDAR providing data on immediately preceding vehicle<br>• On-board vehicle sensors providing data on own speed, acceleration, yaw rate |
| Geographical scale | National level highways / public roads<br>4 equipped vehicles-scenario |
| Type of transport | V2V (wireless communication)<br>• Freight or passenger transport = different from ACC, a vehicle gets information not only from its preceding vehicle but also from vehicles in front of the preceding one<br>Transport mode<br>• Passenger cars, trucks<br>Transport type<br>• High speed, long distance |
| Type of stakeholders | • Automotive suppliers<br>• Road operators<br>• Traffic management operators<br>• Passenger/Drivers |
| Institutional arrangements | Joint Publication from<br>Center for Automation and Robotics (CAR, UPM-CSIC, Madrid/ES)<br>California Partners for Advanced Transit and Highways (PATH) Program of the Institute of Transportation Studies, UC Berkeley, Richmond, CA/USA<br>ITS Advanced and Product Engineering Group, Nissan Motor Co. Ltd / JPN<br>Nissan Technical Center North America, MI/USA |
| Transferability | Yes, flex. in terms of vehicle type, scale, region etc.: |

| CITI Australia | |
|---|---|
| Description | |
| Status | 2013 -2018 |
| Country | Australia |
| Description of service | Collision warning system test |
| Main objective | • Increase road safety<br>• Increase in "time horizon" = quality + reliability of information available to the drivers about their immediate environment, other vehicles and road users<br>• Improve network efficiency<br>• Improvement of traffic conditions for all road-users, if heavy vehicles do not need to accelerate/decelerate too often/much thanks to ITS<br>• Reduce greenhouse gases |
| Innovation phase | 7 (System prototype demonstration in operational environment) |
| Type of ITS | C-ITS V2V Safety |
| Technology used | • Dedicated Short Range Communication (DSRC): 5.9 GHz, 3G/4G mobile phone network – in vehicle, plus min. 1 signalised intersection |
| Geographical scale | Illawarra Region of NSW south of Sydney:<br>2300 km of NSW road network |
| Type of transport | • Heavy vehicle<br>• Buses<br>• Passenger vehicles<br>• Short- and long distance trips. |
| Type of stakeholders | • Heavy Transport Companies<br>• Suppliers of DSRC equipment<br>• Communications and Media Authority<br>• Scientific and Industrial Research Organisation<br>• Road safety researchers<br>• Hardware and software developers |
| Institutional arrangements | PPP |
| Transferability | In the future, automated vehicles may use V2I to interface with traffic lights, or V2V to detect vehicles not in line of sight. Experts believe that a **combination** of **connected and automated technology** is required to realise the largest potential improvements to congestion and safety. |

| C-ITS Corridor: Road Works Warning | |
|---|---|
| Description | |
| Status | Ongoing pilot project (2015-2018) |
| Country | The Netherlands |
| Description of service | The Road Works Warning service aims to inform drivers about road works ahead. The warnings are transmitted using a secure short-range ETSI G5 (WiFi-p) connection and the 3G/4G mobile telephone network. Roadside beacons send a warning message to the traffic information centre. This information is made available to service providers who offer related services to drivers over the mobile network (3G/4G). Road users using these services receive a message about 3 kilometres before they reach the road works, containing information about the exact location of the road works.<br>With help of WiFi-P technology information on the road works is sent directly to vehicles equipped with WiFi receivers and shown on their navigation screens. This may include information on the (adjusted) speed limits, lane availability, etc.<br><br>The service has been tested on a small scale (two test locations with a very limited number of passenger cars) on the national highway (A16 and A58) in the Netherlands. |
| Main objective | The main objective of this service is to improve traffic safety and reduce the number of incidents (safety), to reduce the number of traffic jams and improve the efficiency of road use (efficiency), and to ensure that traffic flows are smoother resulting in less $CO_2$-emission (environment). |
| Innovation phase | 7 |
| Type of ITS | C-ITS. V2I. Different C-ITS stations are used: road beacons, traffic centres, mobile phones, navigation systems. |
| Technology used | The following technologies are used:<br>• ETSI G5 WiFi beacons<br>• 3G/4G cellular network<br>• DENM Decentralized Environmental Notification Messages. ETSI/Cen standards used |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This C-ITS service is tested for passenger cars and is relevant for both short- and long distance trips. The service is useful for all type of interurban road users. |
| Type of stakeholders | • Road manager (Rijkswaterstaat): management and development<br>• Research institutes/consultancy agencies<br>• ITS companies<br>Province: financing |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources: Province Noord-Brabant, European Commission. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| C-ITS Corridor: Probe Vehicle Data | |
|---|---|
| Description | |
| Status | Ongoing pilot (2015-2018) |
| Country | Netherlands |
| Description of service | The probe vehicle data service aims to collect anonymous data from vehicles about road conditions and journey details at the stretch of road on the Dutch part of the ‘C-ITS Corridor’. Examples of data being measured are speed, position on the road, braking power and the current weather conditions. The goal of this information is to allow road operators to create a more accurate image of the road. This information than can be used for multiple purposes, a.o. providing real time traffic warnings, performing adequate road maintenance and better analysing traffic flows. This service has been tested on a small scale on two national highways with a limited number of passenger cars (2) in the Netherlands. |
| Main objective | The better information a road manager receives will be used to increase the efficiency of the road. This reduces congestion and emissions. A better maintained road is also beneficial for safety. |
| Type of ITS | C-ITS V2I |
| Innovation phase | TRL 7 |
| Technology used | • ETSI G5/ WiFi-P collect data from the passing cars<br>• On Board Units in cars collect and safe data about the road conditions. These are then sent to the road side units who collect the data and transmit it to the road operator. |
| Geographical scale | Regional level: on specific parts of national highways |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Road manager (Rijkswaterstaat): management and development<br>• Research institutes/consultancy agencies<br>• ITS companies<br>• Province: financing |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources: Province Noord-Brabant, European Commission. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| Companion truck platooning | |
|---|---|
| Description | |
| Status | Actively tested from 2013 – 2016 |
| Country | Sweden, Spain |
| Description of service | An on-board unit was installed inside Scania trucks. This ensured that trucks could communicate between each other and this allowed the forming of platoons. These platoons allow trucks to drive in close proximity which indulges a slipstream effect which reduces the fuel consumption of the follower truck. Furthermore, several aspects of the system have been tested:<br>• Merging<br>• Splitting<br>• Platoon formation<br>• Double lane change<br>• Varying speed<br>• Gap modification<br>• Emergency braking<br>• Cutting vehicles<br>On board drivers get information about main manoeuvres to secure the anxiety of driving in close proximity.<br>Platoons not only have to cooperate with each other but also must react to other (not) connected forms of transport, for example by allowing them to merge inside the platoon at a highway. |
| Main objective | Fuel saving and emissions reduction<br>Road Efficiency (longer term as more modes become connected) |
| Innovation phase | Technology readiness 7 |
| Type of ITS | C-ITS freight |
| Technology used | • Satellite<br>• On Board Unit<br>• WiFi-P |
| Geographical scale | Regional level: on specific parts of national highways in Spain and Sweden |
| Type of transport | This ITS service is tested for freight trucks covering long distances on highways |
| Type of stakeholders | • European Union<br>• Truck manufacturer<br>• Automotive research<br>• Research institutes<br>• Automotive suppliers |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources including 3.4 million from the 7th framework programme. The total costs of the project are 5.4 million. |
| Transferability | This service is transferable to other manufacturers but this requires standardisation. It is transferable to other vehicles but there is no business case yet. |

| Connected cruise control | |
|---|---|
| Description | |
| Status | Finished, active from 2009 until 2012 |
| Country | Netherlands |
| Description of service | A built-in route indicator that efficiently guides drivers through busy traffic, reducing congestion problems. Advised:<br>• Driving speed which takes congestion ahead into account<br>• Warnings for problems/incidents ahead |
| Main objective | • 30% reduction of congestion<br>• 10% reduction in fuel consumption |
| Innovation phase | Technology Readiness 6, tested on closed highway |
| Type of ITS | C-ITS V2V routing |
| Technology used | UMTS/HSDPA for collecting floating car data |
| Geographical scale | Tested on regional highways |
| Type of transport | Passenger cars |
| Type of stakeholders | • Universities<br>• Research institutes<br>• Road operators<br>• Technological companies |
| Institutional arrangements | Eu FP7 funded project. 4 Million € budget. Three types of partners<br>4 cities<br>3 fleet operators<br>5 technology suppliers |
| Transferability | Transferable to other types of vehicles and roads. . |

| DANTE - Development and Application of New Technologies for integrated improvement of road safety and intersection design | |
|---|---|
| Description | |
| Status | Finished (2009-2011) |
| Country | Spain |
| Description of service | DANTE aims to develop an innovative system to improve road safety at T-junctions and crossroads on conventional two-lane motorways, where most fatal accidents occur (e.g. the risks of front/side collisions, running into cars pulling out slowly in front for the vehicle on the main road, and the vehicle on the secondary road approaching the intersection too fast and failing to comply with the STOP sign).<br><br>Stereoscopic cameras detect the trajectory and speed of the vehicle on the main road when it is 80–250 m. from the intersection.<br>A Lidar system detects any other vehicles within 80 m of the intersection, while a Stop-control system detects the speed and trajectory of the vehicle on the secondary road, determining whether it is going to stop.<br>These integrated systems detect what is happening at the intersection by means of a centralized system that analyses data and, if a possible conflict is detected, triggers an alarm to warn the drivers involved.<br>There are two ways of communicating with road users: with variable messages and beacons of different types on the road itself, plus an I2V system on the vehicle, presenting the information on a PDA device. |
| Main objective | To improve road safety |
| Innovation phase | 6 |
| Type of ITS | C-ITS V2I |
| Technology used | • Camera<br>• Lidar<br>• Beacon<br>• PDA |
| Geographical scale | Motorways, urban |
| Type of transport | Freight or passenger transport |
| Type of stakeholders | • Research institutes<br>• Universities<br>• ITS/ICT solutions provider<br>• Geotechnical company |
| Institutional arrangements | Public-private partnership. National R&D Plan and FEDER, Public-Private Transport and Infrastructure Cooperation Projects Programme |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| EcoMove 6.3 Improve Lane Usage | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Vehicles broadcast information about their position, speed, heading, etc. while they approach an (controlled) intersection, ramp metering installation or toll gate. Based on the actual queues, the control scheme and the approaching vehicles, the best distribution of vehicles over the available lanes is calculated.<br>Next, individual vehicles are allocated to specific lanes and vehicle drivers are informed whether they should continue the same lane or not. |
| Main objective | Make best use of available road capacity at intersections, onramps and toll gates and so reduce congestion, unnecessary waiting time, number of stops, and so smoother traffic flows. |
| Innovation phase | 7 |
| Type of ITS | C-ITS. Vehicles report their location to the infrastructure (V2I). Infrastructure could inform advice back towards vehicles (I2V) if an on-board unit is equipped. Otherwise matrix signs are a necessity. |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Roads with Toll boots, traffic lights, ramp metering installations or similar infrastructure. |
| Type of transport | All type of vehicles approaching a ramp, traffic light, toll gate or other infrastructure. |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users<br>• Toll collectors<br>• Road operators |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and countries |

| EcoMove 6.2 coordinate traffic controllers | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | While approaching a sequence of traffic light, vehicles periodically broadcast information about their position and speed. Together with detector and traffic light data from traffic light controllers a roadside unit processes the information and forwards it to a traffic control centre. The traffic control centre computes green wave control parameters and distributes them to traffic light controllers to enable coordination between controllers. Next, the road side unit computes speed advices based on the current traffic light control and sends the advices to the drivers. When following the speed advice, the vehicle drives smoothly through the green wave section. |
| Main objective | • Minimize fuel consumption and CO2-emission for a road section of subsequent urban intersections by maintaining acceptable circumstances for all road users.<br>• Use (microscopic) vehicle generated data to get a more detailed picture of the traffic situation (e.g. the concrete shape of vehicle platoons and their evolution in time).<br>• Enable new dynamic green wave control procedures that -besides waiting times and number of stops - explicitly considering fuel minimising objective functions.<br>• Use short range communication to inform and instruct approaching drivers about green wave coordination speed in order to shape vehicle platoons and to harmonise vehicle speeds with the current green wave strategy. |
| Innovation phase | 7 |
| Type of ITS | C-ITS. Vehicles report their location to the infrastructure (V2I). Infrastructure could inform advice back towards vehicles (I2V) if an on-board unit is equipped. Otherwise matrix signs are a necessity. |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Inner city roads with a sequence of traffic lights |
| Type of transport | All type of vehicles |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and countries |

| EcoMove 6.3.1 Improve intersection control | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Vehicles report to the intersection how they approach the intersection such that the intersection can determine when they enter or exit conflict zones on the intersection, when they pass the stop line, etc. Based on these the controller determines an optimal distribution of green times and tighter, less conservative green, yellow and red times. Information with respect to the estimated time at which vehicles will be able to pass the stop line is sent to the vehicles. |
| Main objective | Improve the efficiency of an intersection through use of information that can be retrieved from both vehicles and intersections. |
| Innovation phase | 7 |
| Type of ITS | C-ITS. V2I |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Busy intersections |
| Type of transport | All type of vehicles |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and Countries |

| EcoMove 6.3 Balance intersection control objectives | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Vehicles report to the intersection controller about their approach of the intersection such that the intersection can build a detailed representation of demand. Starting from a basic intersection control plan (see use cases Improve intersection control), the controller now integrates priority schemes for specific vehicles and platoons and allows flexible sequences for traffic light control to find a best balance between changing demands. As suggested by other use cases, vehicles approaching the controlled intersection will be informed with speed and time related information. |
| Main objective | Provide a more CO2 efficient traffic intersection controller that is considered acceptable given the prevailing traffic conditions. |
| Innovation phase | 7 |
| Type of ITS | C-ITS. Vehicles report their location to the infrastructure (V2I). Infrastructure could inform advice back towards vehicles (I2V) if an on-board unit is equipped. Otherwise matrix signs are a necessity. |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Busy intersections |
| Type of transport | All type of vehicles |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and Countries |

| EcoMove 6.3 Improve Ramp control | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Vehicle report to the ramp controller about their approach of the ramp metering installation such that the ramp controller can build a detailed representation of the traffic demand on the on-ramp. The conditions on the mainstream (i.e. motorway) and upstream urban controlled intersections are monitored through infrastructure sensors and other roadside units. Near saturation on the mainstream and based on the mainstream, onramp and upstream conditions, the ramp controller determines a strategy that best fits the design of the on-ramp and balances the current demands and overall objectives. This may affect the control scheme, the queuing process as well as the driving behaviour of approaching vehicles. The latter is strongly related to information provisioning to drivers as discussed in other use cases. |
| Main objective | Widen the scope and extend the horizon of ramp control to better anticipate to changes in the traffic situation and traffic demand, and so reduce fuel waste. |
| Innovation phase | 7 |
| Type of ITS | C-ITS. Vehicles report their location to the infrastructure (V2I). Infrastructure could inform advice back towards vehicles (I2V) if an on-board unit is equipped. Otherwise matrix signs are a necessity. |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Ramp control |
| Type of transport | Mixed traffic |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and Countries |

| eCoMove Support merging | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | By using roadside sensors and collecting ecoFVD (floating vehicle data) an infrastructure system monitors traffic flows at merging points on their traffic volumes, density, relative speeds of vehicles and following distances. Using vehicle trajectory data the number of lane changes at merging sections is estimated. First the overall traffic flow performance in terms of flow, speed and density is optimised which results in general speed and headway advices while approaching the merging point. In this process, the importance of the different traffic flows is carefully weighted. Next, near the merging point advices will be adapted to the number of mergers at that time, while the mergers themselves receive individualised recommendations for their speed and merging instant. Right after the merging point drivers will receive an advice that stimulates them to accelerate in order to best use the available road capacity |
| Main objective | Increase driver anticipation at merging points and smoothen traffic behaviour to improve traffic performance and reduce fuel waste. |
| Innovation phase | 7 |
| Type of ITS | C-ITS V2V |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Roads with merging points |
| Type of transport | Both freight and passenger. Unscheduled. |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and Countries |

| EcoMove 6.3.5 Improve approach velocity | |
|---|---|
| Description | |
| Status | Finished, run from 2010-2013 |
| Country | European project |
| Description of service | Vehicles broadcast information about their position, speed, heading, etc. while they approach an (controlled) intersection, ramp metering installation or toll gate. Based on the actual queues, the control scheme and the approaching vehicles, the best distribution of vehicles over the available lanes is calculated. Next, individual vehicles are allocated to specific lanes and vehicle drivers are informed whether they should continue on the same lane or not. In the figure below this use case is illustrated for a vehicle that approaches an intersection. The green vehicle is directed to the best lane for it to follow, given its destination, the queue length and the expected speed of outflow for each lane |
| Main objective | Make best use of available road capacity at intersections, on ramps and toll gates and so reduce congestion, unnecessary waiting time, number of stops, and so smoother traffic flows. |
| Innovation phase | 7 |
| Type of ITS | C-ITS. Vehicles report their location to the infrastructure (V2I). Infrastructure could inform advice back towards vehicles (I2V) if an on-board unit is equipped. Otherwise matrix signs are a necessity. |
| Technology used | • On-board units<br>• Roadside units |
| Geographical scale | Busy intersections |
| Type of transport | All type of vehicles approaching a ramp, traffic light, toll gate or other infrastructure. |
| Type of stakeholders | • Road users<br>• Service providers<br>• Traffic managers<br>• Vehicle users<br>• Toll gates |
| Institutional arrangements | EU fp7 program |
| Transferability | Transferable to other cities and Countries |

| eSEÑAL - Smart System for Traffic Signposting and Information | |
|---|---|
| Description | |
| Status | Finished (2007-2010) |
| Country | Spain |
| Description of service | eSEÑAL is a subproject of CABINTEC that aims to prevent accidents through the development of an intelligent signalling system.<br>The OBU collects both static and dynamic data from the infrastructure<br>Intelligently processes the data.<br>Gives drivers information in advance about traffic signals, traffic congestion, road conditions as well as possible accidents, road work or delays via the OBU installed in the vehicle.<br><br>The service has been tested in a lorry cab using a simulator. |
| Main objective | To improve road safety by enhancing driver-vehicle-environment system perception. |
| Innovation phase | 7 |
| Type of ITS | C-ITS, I2V |
| Technology used | • Radio beacon<br>• OBU<br>• WSN (Wireless Sensor Network)<br>• RFID |
| Geographical scale | Urban, motorways |
| Type of transport | Freight transport |
| Type of stakeholders | • Universities<br>• Research institutes<br>• ITS and ICT solution providers<br>• Automotive testing company |
| Institutional arrangements | Public-private partnership. The project is funded by the Spanish Ministry of Science and Innovation. |
| Transferability | This application is easily transferable to other road vehicles and to other types of roads. |

| FlowPatrol : cooperative traffic information mobile app | |
|---|---|
| Description | |
| Status | Testing in real environment. Active since 2013 |
| Country | Netherlands |
| Description of service | FlowPatrol is a mobile application installed on smartphones that advices users about speed and traffic warnings. Data is collected from (existing) road infrastructure (loops), and through the application itself speed and location of the vehicle are detected. This collecting is done either through 3g/4g or through FlowRadar: an on board installed ITS station that sends and receives data through WiFi-P. Flowradar is installed with a sucker inside the car, and uses one 12v hole. It then connects with mobile phones via Bluetooth to send messages. Data collection is thus possible via two methods:<br>3g/4g via mobile phone<br>Via the on-board unit and WiFi-p<br>The service offered to app users is the same. The on-board unit might have better location services, and thus more accurate travel advice. |
| Main objective | The main goal is to provide traffic information that is beneficial for efficiency and safety. Additionally, this could reduce congestion and thus emissions. |
| Innovation phase | 8 |
| Type of ITS | C-ITS traffic management V2I |
| Technology used | • 3g/4g cellular network<br>• ETSI G5 WiFi beacons<br>• Bluetooth is used inside the car |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS service is tested for passenger cars and is relevant for both short- and long distance trips. |
| Type of stakeholders | • Road manager (Rijkswaterstaat): management and development<br>• Research institutes/consultancy agencies<br>• ITS companies<br>• Province: financing<br>• Service users |
| Institutional arrangements | It is a public private partnership. The funding has been received from several sources: Province Noord-Brabant, European Commission. |
| Transferability | This service is easily transferable to other road vehicles and to other types of roads. |

| FOTsis 5 - Special Vehicle Tracking | |
|---|---|
| Description | |
| Status | Finished (2011-2015) |
| Country | 1 highway in Portugal, 1 highway in Spain |
| Description of service | Monitoring and detecting vehicle considered special: Dangerous goods, heavy vehicle for example. How effective the combination of in-vehicle information and information provided by the infrastructure (pre-trip, traffic and weather conditions) can be at minimizing the impact of special vehicles. Instead of continuously locating these vehicles, the goal is to combine this with historical and real time data. The service thus:<br>• Detects the entering/leaving of special vehicles on highway<br>• Monitors special vehicles on highway<br>• Warning informing other vehicles/infrastructure<br><br>Process: Transport operator asks for permission to use a road providing details about its vehicle and route. This is taken into account and access to a certain route is granted. Than other actions are taken to ensure a successful trip. Special vehicles are equipped with an on-board unit to inform traffic centres about its position. Road side beacons are used to receive and send information towards the special vehicle. |
| Main objective | Increase Efficiency and improving safety. Additionally, comfort and sustainability increase. |
| Innovation phase | 7 |
| Type of ITS | V2I C-ITS |
| Technology used | The following technologies are used:<br>• WiFi-P<br>• On Board unit<br>• Human Interface Machine (smartphone/navigation/etc.)<br>• Sensors on the vehicle<br>• Highway detection infrastructure: loops, cameras, etc. |
| Geographical scale | Regional level: on specific parts of national highways. |
| Type of transport | This ITS application is tested for special vehicles. It is possible to apply to other roads but not to other types of transport. |
| Type of stakeholders | • Road managers: management and development<br>• Research institutes<br>• ITS companies<br>• Drivers of special vehicles<br>• Other road users<br>• Policy makers<br>• traffic associations<br>• infrastructure companies |
| Institutional arrangements | Partly EU funded under FP7. Consortium with 25 Partners from 9 European Countries. Partners include Road operators, universities, telecom operators, maps providers, technology integrators, research centres, users' association, and industry associations. |
| Transferability | Useable for other types of roads. Not logical for other types of transport |

| Freilot. Truck priority at intersections | |
|---|---|
| Description | |
| Status | Successfully finished: active from 2009 until 2012 |
| Country | EU FP 7 project tested in: France, Netherlands, Poland, Spain |
| Description of service | Freilot aims to reduce congestion and emissions in cities. Four measures have been designed and implemented. Traffic light priority is highlighted here:<br>Energy efficiency optimised intersections (trucks and emergency vehicles get priority from traffic controllers at intersections to increase fuel efficiency)<br>In total 177 vehicles have been equipped divided over 4 cities. |
| Main objective | • Reduction of 25% fuel consumption/emissions after using Freilot services<br>• Ensure Freilot services after project life<br>• Expand Freilot services<br>• Safety reasons for emergency vehicles |
| Innovation phase | TRL 7 |
| Type of ITS | C-ITS V2I Freight |
| Technology used | Briefly discuss the technologies and message standards used. E.g.:<br>GPS for evaluation<br>Android based on board unit<br>GPRS |
| Geographical scale | In city at intersections/urban roads. As well on interurban roads. |
| Type of transport | Aimed towards freight transport as possible gains are the largest. During the test emergency services (fire trucks, ambulance) have joined as well. |
| Type of stakeholders | • Emergency services<br>• Fleet operators<br>• Cities<br>• Service users/drivers<br>• Other road users |
| Institutional arrangements | EU FP7 funded project. 4 Million € budget. Three types of partners<br>4 cities<br>3 fleet operators<br>5 technology suppliers |
| Transferability | Transferable to other fleet owners, vehicles and other roads. Certain limitations to the maximum number of participants as you can not prioritize everyone. |

| INTELVIA | |
|---|---|
| Description | |
| Status | Finished (2009-2012) |
| Country | Spain |
| Description of service | INTELVIA is a system of control, signalling and communication to intelligently manage road traffic through C-ITS systems and computer vision.<br>The computer vision solution increases intelligence in traffic management and in decision making from the control centre, allowing the automatic analysis of information and a faster detection of incidents and the management of the road network.<br>Signalling information is stored in electronic road side units (RSU) distributed along the road network. Vehicles interact with these nodes deployed along the roadside. The electronic devices will transmit the signpost information to the nearby vehicles via wireless, to be displayed on the OBU.<br>Different types of information could be transmitted: information about traffic parameters (speed limit and other road signs), route tracking, incidents, tolls, and weather alerts or warnings of approaching emergency vehicles. |
| Main objective | To improve road safety and mobility by reducing the number of accidents caused by low or no visibility of the signposts due to heavy rain, fog among others, and the reduction of driver distraction by presenting the information directly to the driver in the vehicle. |
| Innovation phase | 7 |
| Type of ITS | V2I C-ITS traffic |
| Technology used | • Wireless sensors/actuators<br>• Control centre<br>• Surveillance cameras<br>• Electronic roadside communication nodes<br>• GPRS/Wi-MAX<br>• ITS G5<br>• BUS CAN<br>• OBU |
| Geographical scale | Motorways |
| Type of transport | Road – Freight, and passenger cars |
| Type of stakeholders | • ITS solutions providers<br>• Road/Traffic authorities<br>• Research institutes<br>• Universities<br>• Wireless solutions provider<br>• Infrastructure and service operator<br>• Logistics and mobility association<br>• Automotive companies/testers<br>• ICT solutions provider |
| Institutional arrangements | Public-private partnership. The project is co-funded by the Ministry of Industry, Tourism and Commerce and the European Regional Development Fund ERDF. |
| Transferability | This application is easily transferable to other types of roads. |

| Roadart (Research On Alternative Diversity Aspects foR Trucks) | |
|---|---|
| Description | |
| Status | Ongoing (2015 - 2018) |
| Country | 4 partners from 3 countries: Germany, The Netherlands, Greece |
| Description of the project | The ROADART project aims to demonstrate especially the road safety applications for T2T and T2I systems under critical conditions in a real environment, like tunnels and platooning of several trucks driving close behind each other. |
| Main objective | The main objective of ROADART is to investigate and optimise the integration of ITS communication units into trucks. The ROADART project aims to demonstrate especially the road safety applications for T2T and T2I systems under critical conditions in a real environment, like tunnels and platooning of several trucks driving close behind each other. Besides that, traffic flow optimization and therefore reducing Greenhouse Gas emissions are positive outcomes of the use cases demonstrated in this project. |
| Innovation phase | Not applicable yet |
| Type of ITS | C-ITS freight. V2V and V2I systems specified from the C2C Communication Consortium are focussing on road safety applications. |
| Technology used | Perform measurements for Truck-to-Truck, Truck-to-Infrastructure mobile radio channel conditions. |
| Geographical scale | Urban and extra-urban scale |
| Type of transport | Freight transport |
| Type of stakeholders | • SMEs<br>• Research institutes<br>• Vehicle manufacturers |
| Institutional arrangements | The project has received public funding from the European Union‘s Horizon 2020 FP7-ICT - Information and Communication Technologies |
| Transferability | This service is transferable |

| SAFECROSS - Smart Pedestrian Crossing for People with Reduced Mobility | |
|---|---|
| Description | |
| Status | Ongoing (XXXX-2016) |
| Country | Spain (Madrid, Alcalá de Henares) |
| Description of service | SAFECROSS aims to develop an intelligent crossing designed for people with reduced mobility, as it provides real-time monitoring of pedestrians' movement.<br><br>If the traffic controller detects anyone still using the crossing when it is reaching the end of the pedestrians' green phase, the 'green' time is extended until the pedestrian has crossed to the other side. If the crossing is empty when the time is running out, vehicle traffic can proceed, thereby contributing towards streamlining traffic flow.<br><br>Also, it incorporates the activation of green light demand from the pedestrians' smartphones (Bluetooth) via two Android Apps allowing pedestrians and drivers interact through the deployment of cooperative services I2VRU and I2V.<br><br>A C-ITS station provides the communication channel WiFi Mobile (802.11p) to vehicles, alerting vehicle drivers of the presence of pedestrians on the crosswalk. |
| Main objective | To improve road safety of crossing pedestrians that require more than average time to cross the road thereby reducing the number of accidents of vulnerable users |
| Innovation phase | 7 |
| Type of ITS | C-ITS V2I |
| Technology used | • Artificial vision camera<br>• Bluetooth beacons<br>• Smart phone<br>• 3G communication<br>• Mobile WiFi<br>• OBU<br>• Radio beacons<br>• ITS-G5 |
| Geographical scale | Urban |
| Type of transport | Road |
| Type of stakeholders | • ITS solutions provider<br>• City administration<br>• Local city council<br>• Spanish Ministry of Industry, Energy and Tourism (Funding) |
| Institutional arrangements | Private, then Public-private partnership.<br>Initially started with the private funding of an ITS solutions provider but was later financed by the Spanish Ministry of Industry, Energy and Tourism. |
| Transferability | The infrastructure is easily transferable to other road vehicles and to other types of roads. |

| Satre (safe road trains) project | |
|---|---|
| Description | |
| Status | Finished (9/2009 – 11/2012) |
| Country | Intra-European. Consortium with partners from UK, Germany, Sweden and Spain |
| Description of service | Road train with truck as leading vehicle, followed by 1 truck and 3 different types of cars.<br>Goal: develop strategies and technologies to allow vehicle platoons.<br>The lead vehicle is driven by a professional driver; several vehicles follow are driven fully automatically by the system with little distance between the vehicles in the road train. An off-board system allowed Sartre drivers to locate a suitable platoon and navigate towards it. The project has analysed the following aspects: safety, fuel consumption, demonstration on different roads, commercial viability and policy advice. |
| Main objective | • Environmental -> 2.8 ton C02eq reduction for trucks per year possible<br>• Safety<br>• Comfort as drivers can (in the future) perform other tasks while driving<br>• Reduced congestion |
| Innovation phase | Tested on test sites and on operational highway. TRL level 7 |
| Type of ITS | C-ITS freight V2V. ITS stations are installed in vehicles which allows them to communicate between each other. |
| Technology used | The following technologies are used:<br>• GPS<br>• GSM/UMTS.<br>• On board units |
| Geographical scale | Regional level: on specific parts of national highways and local test facilities. |
| Type of transport | Briefly discuss the type of transport for which the application is used. This includes:<br>• Freight to reduce fuel cost<br>• Passenger cars could reduce fuel costs<br>• Transport type/motive: long distance, commuter travel, leisure travel etc. |
| Type of stakeholders | • Service providers<br>• Research institutes<br>• OEMS<br>• Automotive suppliers<br>• Road operators |
| Institutional arrangements | EU FP7 funded project with a consortium of Public and private parties. Total EU funding: 3.8 million Euros. |
| Transferability | Most suitable for long distance highway transport. Scalable to other highways and countries. |

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| UK Autodrive | |
|---|---|
| Description | |
| Status | 2013 -2018 |
| Country | United Kingdom |
| Description of service | Automated driving project with special focus on cooperative driving. Platooning test |
| Main objective | • Integrate autonomous and connected vehicles into real-world urban environments;<br>• Show how autonomous and connected vehicles could solve everyday challenges such as congestion;<br>• Demonstrate the commercial operation of electric-powered self-driving "pods" at a city scale;<br>• Provide insight for key stakeholders and decision-makers, including legislators, insurers and investors;<br>• Examine the potential benefits (in terms of safety, traffic flow and the environment) of having cars that can "talk to each other |
| Innovation phase | 7 |
| Type of ITS | C-ITS V2V |
| Technology used | • V2V communication<br>• LIDAR<br>• sensors |
| Geographical scale | The roads and footpaths will be a mix of grid-based streets (in Milton Keynes) and more traditional urban road layouts (in both Milton Keynes and Coventry). |
| Type of transport | • Cars |
| Type of stakeholders | • Industry<br>• Service providers<br>• Universities<br>• OEMs<br>• Insurance company |
| Institutional arrangements | PPP |
| Transferability | Could be transferred |

## Appendix 6 Mapping of services

Mapping of 94 services (short list) to Market by Type segmentation and to associated subcategory.

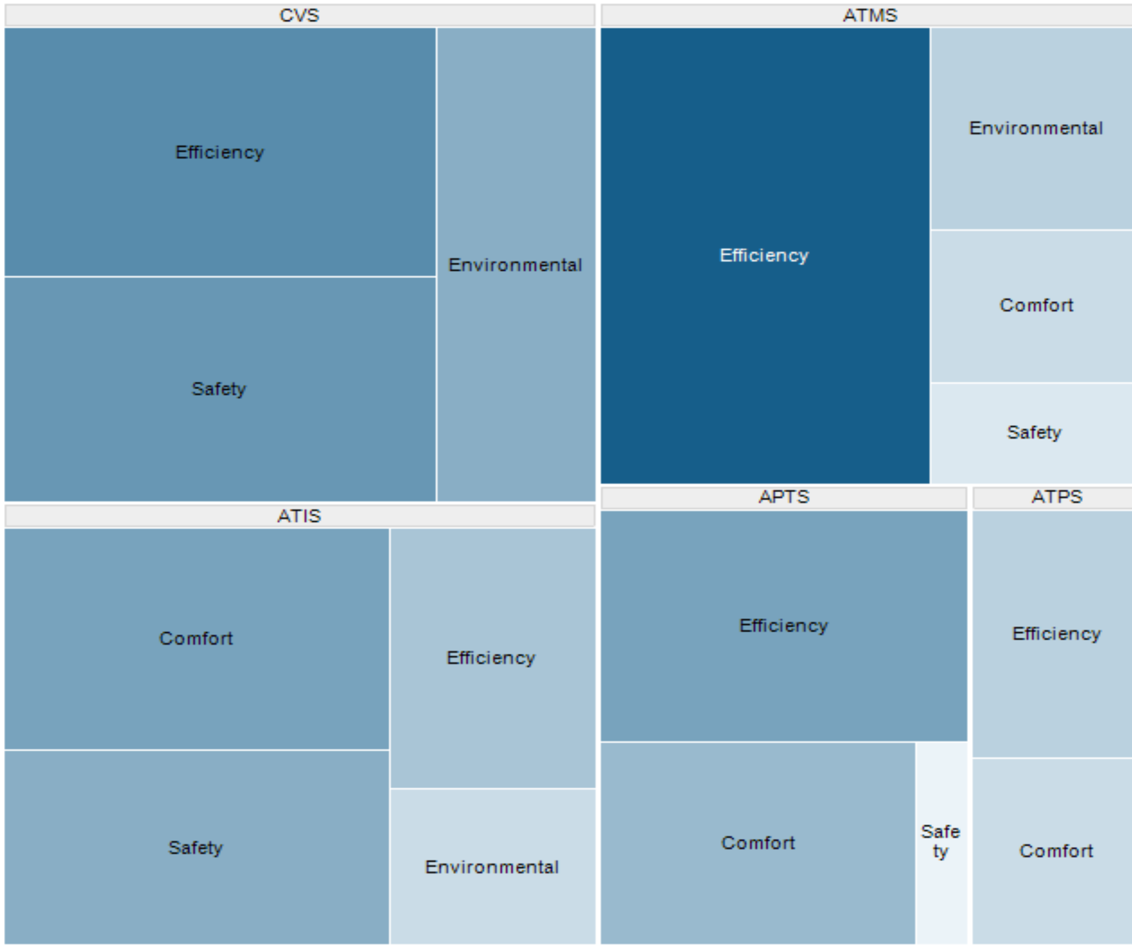
| Project | Service Acronym | Market by Type | Subcategory |
|---|---|---|---|
| Access control in Rome | ACPV | ATMS | Demand and access management / enforcement system |
| ADS-B | PCT | CVS | V2I/V2V |
| ASPI | HNMA | ATMS | Highway systems |
| Austroads heavy vehicle platooning | TP | CVS | V2V |
| Automatic passenger counting systems | CPA | ATMS | Fleet management optimization |
| Belfast rapid transit | NADPTB | APTS | Real time system status |
| C-ACC | CACCT | CVS | V2V |
| CBTC | CBTC | APTS | Real time system status information |
| CITI | CWS | CVS | V2V |
| C-ITS corridor Netherlands | VSD | CVS | V2I |
| C-ITS corridor Netherlands | VWRW | CVS | V2I |
| Co-Cities | ERTTI | APTS | Real time passenger information |
| Companion | TP | CVS | V2V |
| Congestion charge london | CSFTH | ATPS | Congestion pricing |
| Connected Boulevard Nice | MOCA | ATMS | Parking management |
| Connected cruise control | CCC | CVS | V2V |
| Dante | ICW | CVS | V2I |
| Departure planning information | RTDTA | ATMS | Traffic monitoring |
| eBrio+ (VIX) | ISBTSP | APTS | Multi & Smart ticketing |
| EcoGem | CRP | ATIS | IRANS |
| Ecomove | EDA | ATMS | Traffic monitoring |
| Ecomove | ERP | CVS | V2I |
| Ecomove | ICVAP | CVS | V2I |
| Ecomove | IIC | CVS | V2I |
| Ecomove | INU | CVS | V2I |
| Ecomove | IPG | CVS | V2I |
| Ecomove | LA | CVS | V2V |
| Ecomove | MS | CVS | V2I |
| Ecomove | RC | ATIS | In-vehicle signing information systems |
| Ecomove | RTRP | ATIS | In-vehicle routing and navigation systems |
| Ecomove | SALA | ATMS | Parking management |
| Ecomove | TLC | ATIS | IRANS |
| Enhanced wisetrip | MMIJPS | APTS | Multimodal journey planners |
| ERMTS | ETCT | APTS | Real time system status information |

| Project | Service Acronym | Market by Type | Subcategory |
|---|---|---|---|
| eSENAL | ISS | CVS | V2I |
| FAMS | DRTSIRT | APTS | Real time system status information and schedule optimization |
| FAMS | VAMS | APTS | All |
| Flitsmeister | RTTA | ATIS | In-vehicle motorist service information systems |
| Flowpatrol | CTIMA | CVS | V2I |
| Fotsis | ARASA | ATMS | Enforcement systems |
| Fotsis | DRP | ATMS | Demand and acces management |
| Fotsis | EE | ATMS | Highway systems |
| Fotsis | ETR | ATMS | Traffic monitoring |
| Fotsis | ICC | ATIS | In-vehicle safety and warning systems |
| Fotsis | SIM | ATIS | In-vehicle safety and warning systems |
| Fotsis | TIP | CVS | V2I |
| Fotsis | TOSV | CVS | V2I |
| Freilot | TPAI | CVS | V2I |
| GUIADE | PTIG | ATMS | Real time system status information/V2V |
| HeEro | EP | ATIS | In vehicle safety and warning sytems |
| HOGIA | STCBOT | ATMS | Traffic monitoring |
| I-5 smart truck parking | STPP | ATIS | CVO |
| IFM | IFMP | APTS | Multi & Smart ticketing |
| Intelvia | IETSS | CVS | V2I/V2V |
| In-Time | MRTTI | ATIS | IRANS/IMSIS |
| Lane management USA | LM | ATMS | Demand and acces management |
| Madrid smart parking | VPR | ATMS | Parking management |
| Maut | TSFF | ATPS | VMTS |
| Milano Area C | LEZCS | ATPS | Congestion pricing |
| Mobility 2.0 | VO | ATIS | IMSIS |
| Multi use lane Barcelona | VMS | ATMS | Demand and access |
| NY MiM | NATSCS | ATMS | Signal control |
| Octo U | MT | ATIS | CVO |
| On vehicle CCTV | OBCS | APTS | Mobile video surveillance |
| Onschedule and Ontime | POCAVA | APTS | Schedule optimization |
| Oyster Card | LS | APTS | Multi & Smart ticketing |
| Parckr | CTPA | ATIS | IMSIS |
| Piedmont regional traffic centre | TSC | ATMS | Traffic monitoring |
| Praktijkproef Amsterdam Adam | RTTA | ATIS | IRANS |
| Praktijkproef Amsterdam Eva | RTPA | ATMS | Parking management |

| Project | Service Acronym | Market by Type | Subcategory |
|---|---|---|---|
| Praktijkproef Amsterdam Superroute | RTTA | ATIS | IRANS |
| Praktijkproef Amsterdam Superroute P | RTPA | ATMS | Parking management |
| ProbeIT foresight vehicle | PTAALBA | ATIS | IRANS/IMSIS/ISIS/ISAWS |
| Q-Warn | QW | ATIS | IMSIS |
| Roadart | TPISS | CVS | V2V |
| RTPI | RTPII | APTS | passenger information systesm |
| Safecross | SPC | CVS | V2I |
| Sanef | ATUL | ATPS | ETC |
| Satre Road train | SRT | CVS | V2V |
| Scot Rail smartcard | SS | APTS | Multi & Smart ticketing |
| Sensit Nedap | APA | ATMS | Parking management |
| Smartfreight | UFMOBS | ATIS | CVO |
| SmarTrAC | IATCTD | ATIS | IRANS |
| Stockholm congestion pricing | CPAMIS | ATPS | Demand and access management/ congestion pricing |
| Telepass | ATR | ATPS | Electronic toll collection |
| TEXpress | TEL | ATPS | Fee-based express lanes |
| TIMON | ERTTA | APTS | Real time system status information |
| Traffic information system Romania | NRGS | ATMS | Highway systems |
| Uk Autodrive | AACCT | CVS | V2V |
| UTC london | UTLC | ATMS | Demand and acces management |
| VSC -A | DPP | ATIS | IVSAWS |
| Vx-TINFO | WRTIS | ATIS | IMSIS |
| Waze | RTTATA | ATIS | IMSIS |
| Zoof | CTIMA | ATIS | IMSIS |

# Appendix 7 Tree maps

**Appendix 7.1:** Tree map of services by market segment by primary benefits.



**Appendix 7.2:** Tree map of services by market segment by key enabling technology