ITS REPORT

Spain 2020

MINISTERIO DEL INTERIOR

DGT
Dirección General de Tráfico

1 Content

ILLUSTRATIONS

TABLES

ACRONYMS

ACC	Autorizaciones Complementarias de Circulación - Complementary Traffic Authorization Application
ACOTRAM	Asistente para el Cálculo de Costes del Transporte de Mercancías por Carretera - Assistant for the Calculation of Road Freight Transport Costs
ADAS	Advanced Driver Assistance Systems
ADIF	Administrador de Infraestructuras Ferroviarias - Railway Infrastructure Administrator
ADT	Average Daily Traffic
AI	Artificial Intelligence
AID	Automatic Incident Detection
AEMET	Agencia Estatal de Meteorología - Spanish Meteorological Agency
ANFAC	Asociación Nacional de Fabricantes de Automóviles y Camiones - National Association of Manufacturers of Vehicles and Trucks
API	Application Programming Interface
APP	Application
ASFA	Association of French Motorway Companies
ATM	Autoridades de Transporte Metropolitano - Metropolitan Transport Authorities
AVI	Automatic Vehicle Identification
AVE	Alta Velocidad Española – Spanish High Speed
BOE	Boletín Oficial del Estado - Official State Bulletin
CAE	Controlador de Acceso a la Estación - Station Access Controller
CAM	Content Aggregation Model
CCAM	Connected, Cooperative and Automated Mobility
CCTV	Closed Circuit Television
CEDR	Conference of European Directors of Road
CEF	Connecting Europe Facility
CITRAM	Centro de Innovación y Gestión de la Movilidad del Consorcio Regional de Transportes de Madrid - Center for Innovation and Mobility Management of the Regional Transport Consortium of Madrid
C-ITS	Cooperative Intelligent Transport Systems

CIVICAT	Centro de Información Vial de Cataluña - Catalonia’s Road Information Centre
CONCORDA	Connected Corridors Driving Automation
COPSV	Centro de Operaciones y Seguridad Vial - Road Safety and Operations Center
CRTM	Consorcio Regional de Transportes de Madrid - Madrid’s Regional Transport Consortium
CTAG	Centro Tecnológico de Automoción de Galicia - Technological Automotive Centre of Galicia
CSV	Comma Separated Values
CVT	Controlador de Velocidad en Travesías - Crossing Speed Controller
DAS	Distributed Acustic Sensor
DGC	Dirección General de Roads - General Directorate of Roads
DGT	Dirección General de Tráfico - General Directorate for Traffic
DGTT	Dirección General de Transporte Terrestre - General Directorate of Land Transport
DPC	Data Processing Center
DSRC	Dedicated Short Range Communications
DT	Departamento de Tráfico y Seguridad del País Vasco - Traffic and Security Department of the Basque Country
DUM	Distribución Urbana de Mercancías - Urban Distribution of Goods
DVIT	Digital Vision Touch
EATA	European Automotive Telecom Alliance
EC	European Commission
EDM	Encuesta Domiciliaria de Movilidad – Household Survey on Mobility
EETS	European Electronic Toll Service
EFC	Electronic Fee Collection
EMT	Empresa Municipal de Transportes - Town Hall´s Transport Company
EMV	Europay Mastercard Visa
EN	European Norm
ERTICO	European Road Transport Telematics Implementation Coordination Organisation
ESP	Elektronisches Stabilitäts-Programm

ESS	Exploitation Support Systems
ETC	Electronic Toll Collection
EU	European Union
EU EIP	EU European ITS Platform
FCD	Floating Car Data
GDPR	General Data Protection Regulation
GEIS	Gestor de Incidencias en la Explotación – Operational Incident Manager
GIS	Global Positioning System
GPS	Global Positioning System
GTFS	General Transit Feed Specification
HD	High Definition
HMI	Human Machine Interface
HSM	Hardware Security Module
HOV	High Occupancy Vehicle
I2V	Infrastructure to Vehicle
IDE	Integrated Development Environment
IDS	Intrusion Detection System
IOS	iPhone Operative System
IoT	Internet of Things
IRS	Interest Rate Swap
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
IP	Information Point
JSON	JavaScript Object Notation
JU	Joint Undertaking
KML	Keyhole Markup Language
KP	Kilometer Point
KPI	Key Performance Indicators

LDM	Local Dynamic Map
LINCE	Localizador de Incidencias en las Carreteras de España - Incident Locator on Spanish Roads
LOD	Linked Open Data
LOPD	Ley Orgánica de Protección de Datos - Spanish Data Protection Law
LOS	Levels Of Service
LPR	License Plate Recognition
LTE	Long Term Evolution
MAC	Message Authentication Code
MaaS	Mobility as a Service
MAM	Maximum Authorized Mass
MEAT	Máquina Expendedora Automática de Títulos - Ticket Vending Machine
MITMA	Ministerio de Transportes, Movilidad y Agenda Urbana - Ministry of Transport, Mobility and Urban Agenda
ML1	Metro Ligero 1 – Light Rail 1
MLO	Metro Ligero Oeste – West Light Rail
MMTIS	Multi Modal Travel Information Services
MNO	Mobile Network Operators
MNT	Modelo Nacional de Transportes – National Transport Model
MOT	Ministry of Transport Test (MOT) – Inspección Técnica de Vehículos (ITV)
NAP	National Access Point
NFC	Near Field Communication
NNTT	New Technologies
OBE	On Board Equipment
OCR	Optical Character Recognition
ODS	Objetivos de Desarrollo Sostenible - Sustainable Development Goals
ONCE	Organización Nacional Ciego Españoles - Spanish National Blind Organisation
OPE	Operación Paso del Estrecho - Paso del Estrecho Special Operation
OTLE	Observatorio del Transporte y la Logística en España - Transport and Logistics Observatory of Spain

O/D	Origin-Destination
PAM	Predictive Analytics Module
PITVI	Plan de Infraestructuras, Transporte y Vivienda 2012 - 2024 - Infrastructure, Transport and dwelling national plan 2012 – 2024
PoC	Points of Control
PPP	Public Private Partnership
PSA	Support Action Programme
PSAPs	Public Safety Answering Points
PTV	Passenger Transport Vehicle
QR	Quick Response
RA	Rest Area
RaaS	Renfe as a Service
RACC	Royal Automobile Club of Catalonia
RDS	Radio Data System
RENO	Ratificación de Expedientes de Obra - Ratification of Work Expeditions
RGB	Red Green Blue
RIMP	Red de Itinerarios para Mercancías Peligrosas - Itineraries Network for Dangerous Goods
RNE	Radio Nacional de España - Spanish National Radio
RSU	Road Side Unit
RTTI	Real Time Traffic Information
RUN	Ronda Urbana Norte - North Urban Ring
R & D	Research and Development
SAM	Secure Access Module
SAGB	Sistema de Administración y Gestión Barik - Barik Administration and Management System
SCADA	Supervisory Control And Data Acquisition
SCT	Servei Català de Tránsit - Catalan Transit Service
SDCTU	Sistema Distribuido de Control de Tráfico Urbano - Distributed Urban Traffic Control System

SHP	Shapefile
SEITT	Sociedad Estatal de Infraestructuras de Transporte Terrestre - State Society for Land Transport Infrastructure
SGIP	Servicio de Información al Pasajero – Passengers Information System
SGRAF	Supervisor Gráfico – Graphic supervisor
SIF	Sistema de Información de Frontera - Borderline Information System
SIM	Subscriber Identity Module
SIRDE	Sistema de Información para Registro de Datos de Expediciones - Management Information System for Recording Data of Dispatches
SISCOGA	Sistemas Cooperativos Galicia - Cooperative Systems Galicia
SIT	Sistema de Información del Transporte - Transport Information System
SMS	Short Messaging Service
SRTI	Safety Related Traffic Information
SSNN	Social Networks
STT	Servicios Territoriales - Territorial Services
TCA	Tramos de Concentración de Accidentes - Accident Concentration Sections
TEN-T	Trans-European Transport Network
TMC	Traffic Management Centre
TRAZA	Tramitación de Autorizaciones - Processed Authorizations
TTP	Tarjeta de Transporte Público – Public Transport Card
UAM	Universidad Autónoma de Madrid
UAV	Unmanned Aerial Vehicle
UC	Use Cases
UITP	Unión Internacional de Transporte Público - International Union of Public Transport
UN	United Nations
UNE	Una Norma Española – A Spanish Regulation
V2C	Voice to Control
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle

VEOS	Visualizador Geolocalizado de Sucesos - Events Geolocated Display
VMS	Variable Message Signs
WRD	Winter Road Dashboard
XML	Extensible Markup Language

1 Introduction

The objective of this document is to develop the National Report on the progress in the deployment of Intelligent Transport Systems (ITS) in Spain in accordance with the European Directive 2010/40/EU[1].

Considering the aforementioned Directive 2010/40/EU and, in particular, the third paragraph of Article 17, each Member State must report on the progress made in implementing the priority actions, referred to in the first paragraph of Article 17, every three (3) years.

In accordance with Royal Decree 662/2012[2] and in compliance with the ITS Directive, the Central Traffic Authority is established as the authorised entity responsible for reporting to the European Commission (EC) on the progress made in ITS activities and projects related to the priority actions.

In August 2011, Spain will report on the state of progress in the implementation of technological applications for traffic and transport. In August 2012 it also reported to the European Commission on national ITS ambitions, plans and projects for the next five (5) years. Following these reports, in 2014, Spain issued its first three-year report and later, in 2017, a second report was sent, updated with the progress made in that period of time. Now, in August 2020, this third report shows the progress made since 2017.

This document aims to gather and organise existing information on Spain's progress in the context of intelligent transport systems in a comprehensive manner.

Illustration 1. 2+1 Road. Source: Own Elaboration

[1] DIRECTIVE 2010/40/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 July 2010 laying down the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other transport modes-

[2] ROYAL DECREE 662/2012 of 13 April, establishing the framework for the deployment of Intelligent Transport Systems (ITS) in the road transport sector and for interfaces with other transport modes.

1.1 Structure of the document

In line with the guidelines issued by the European Commission services, the document is structured in three main blocks, a section mentioning those whom contributed to make this report possible, a reference section and an annex with contact information as shown in the diagram below:

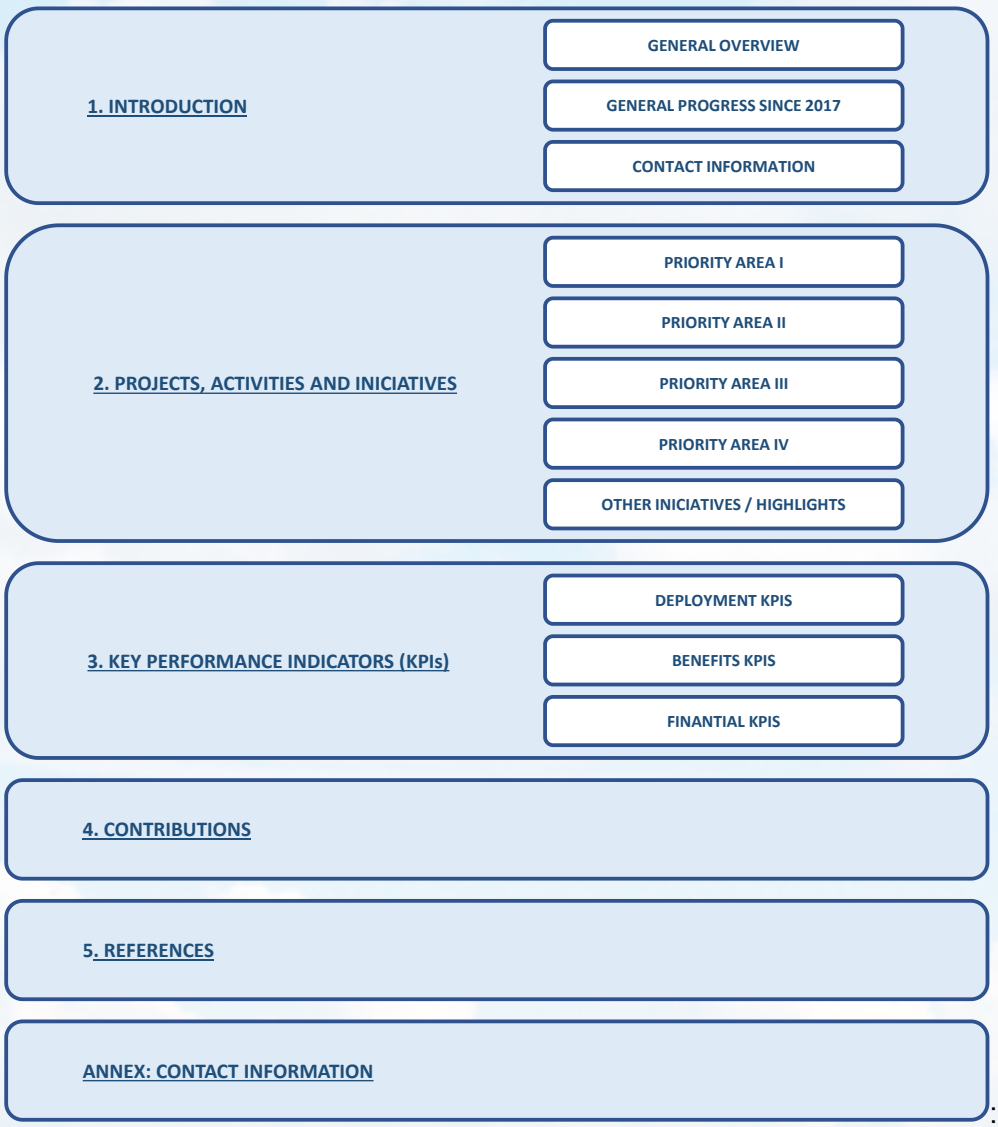

Illustration 2. Structure of the document. Source: Own Elaboration

The first block consists of a brief introduction of the main national activities and projects in which Spain participates, as well as their progress since 2017.

With the activities and progress already introduced, they are classified according to Annex I: Priority areas and Actions of Directive 2010/40/EU and are included in the second block with a more detailed description of each of them.

The third block of the document focuses on the calculation of the efficiency indicators (KPIs) related to ITS, explaining the methodology used for their calculation and the results obtained for each classification of the road network in Spain.

1.2 Overview of national activities and projects

The deployment of intelligent transport systems has been very significant in Spain for decades, as well as the deployment of applications and services that accompany citizens on their journeys. There are four main objectives of this deployment: to provide safety, to reduce delays in order to predict travel times more accurately, to improve the quality of road transport and to enhance the road experience for users.

The figures reflect the magnitude of the services provided by the applications and systems; for example, in 2019 more than 427 million long-distance trips were monitored on 15,770 km of the Spanish road network with ITS equipment. In total, 165,624 km of roads are managed at the state level.

In the last three (3) years, different trends have been observed that affect the daily movements of citizens and the transport of goods. The digitalization, irruption and improvement of technologies such as the Internet of Things (IoT), automation, Big Data, the exponential increase of people connected as a result of the evolution of telephones, smartwatches and other intelligent devices, vehicle connectivity and the improvement of mobile communications (4G, 4.5G, 5G), are being fundamental and decisive elements in the restructuring of activities and approaches, among which we can highlight the deployment of priority actions established in the ITS Directive.

For the preparation of this report, the entities participating in Working Group 56 of the Council on Traffic, Road Safety and Sustainable Mobility were consulted. The contributions received strengthen the content of the report.

All the initiatives and projects included in this report are developed under the vision, scope and activities or strategic plans at national, regional and local levels, highlighting

- Strategic Plan for Road Safety 2011 - 2020 (Ministry of the Interior - DGT)
- Infrastructure, Transport and Housing Plan 2012 - 2024 (Ministry of Transport, Mobility and Urban Agenda)
- Innovation Plan for Transport and Infrastructures 2018 - 2020 (Ministry of Transport, Mobility and Urban Agenda)
- National Air Quality Plan 2017 - 2019 (Ministry of Agriculture, Food and Environment)
- Strategic Road Safety Plan of the SCT 2010-2020
- National Pact for Safe and Sustainable Mobility (Government of Catalonia's agreement to face the challenges of mobility, in line with the EU, objective of zero vision and the fight against climate change)
- Safe, Sustainable and Connected Mobility Strategy 2030 (Ministry of Transport, Mobility and Urban Agenda): among the activities carried out by the Ministry of Transport, Mobility and the Urban Agenda, the development of the Safe, Sustainable and Connected Mobility Strategy 2030 stands out. The Mobility Strategy is a roadmap which will allow Spanish society and economy to move towards the new mobility paradigm, facing the recent challenges in the sector, related to the massive introduction of technology in transport, the need to decarbonise the economy and the increasing concentration of population in urban and peri-urban areas, with the consequent challenges of congestion and depopulation for the rural world and medium-sized cities. The Mobility Strategy is a long-term framework document, with a 2030 horizon, which

will be implemented in the short and medium term. To this end, the Mobility Strategy is structured in 9 sections with more than 40 lines of action and more than 150 specific measures. One of its main objectives is Intelligent Mobility, to which one of the nine strategic lines of action is dedicated. This part mainly deals with the use of technology to support mobility policies, facilitating mobility as a service (MaaS) through the publication of open data, the commitment to the intelligent management of infrastructures, terminals and stations, to the automation of transport and logistics, to the promotion of connected and autonomous vehicles (cars, but also boats or trains), to the use of the GALILEO system in mobility, to the use of drones and to the promotion of entrepreneurship and R&D+i in mobility. However, digitisation is one of the key themes of the Strategy, and other parts of the Strategy, such as those related to Safe Mobility and intelligent Intermodal Logistics Chains which also contain measures that refer to intelligent transport systems. The Mobility Strategy began to be developed in 2019 and the first document is expected to be published in September 2020, giving way to a process of public participation and open debate with society. In addition, the regulatory development of some of the measures contained in the Mobility Strategy, work is underway on the Preliminary Draft Law on Sustainable Mobility and Transport Financing, for which prior public consultation began in July 2020. The future law is expected to include issues such as the digitalisation and automation of transport, and innovation and research in transport and mobility.

Illustration 3. Strategic plans at national, regional and local level. Source: Own elaboration based on documentation mentioned above

A complete list of reference documents is included in the final section "References".

The following table shows the main reference projects that have consolidated the activities of the National Progress Report.

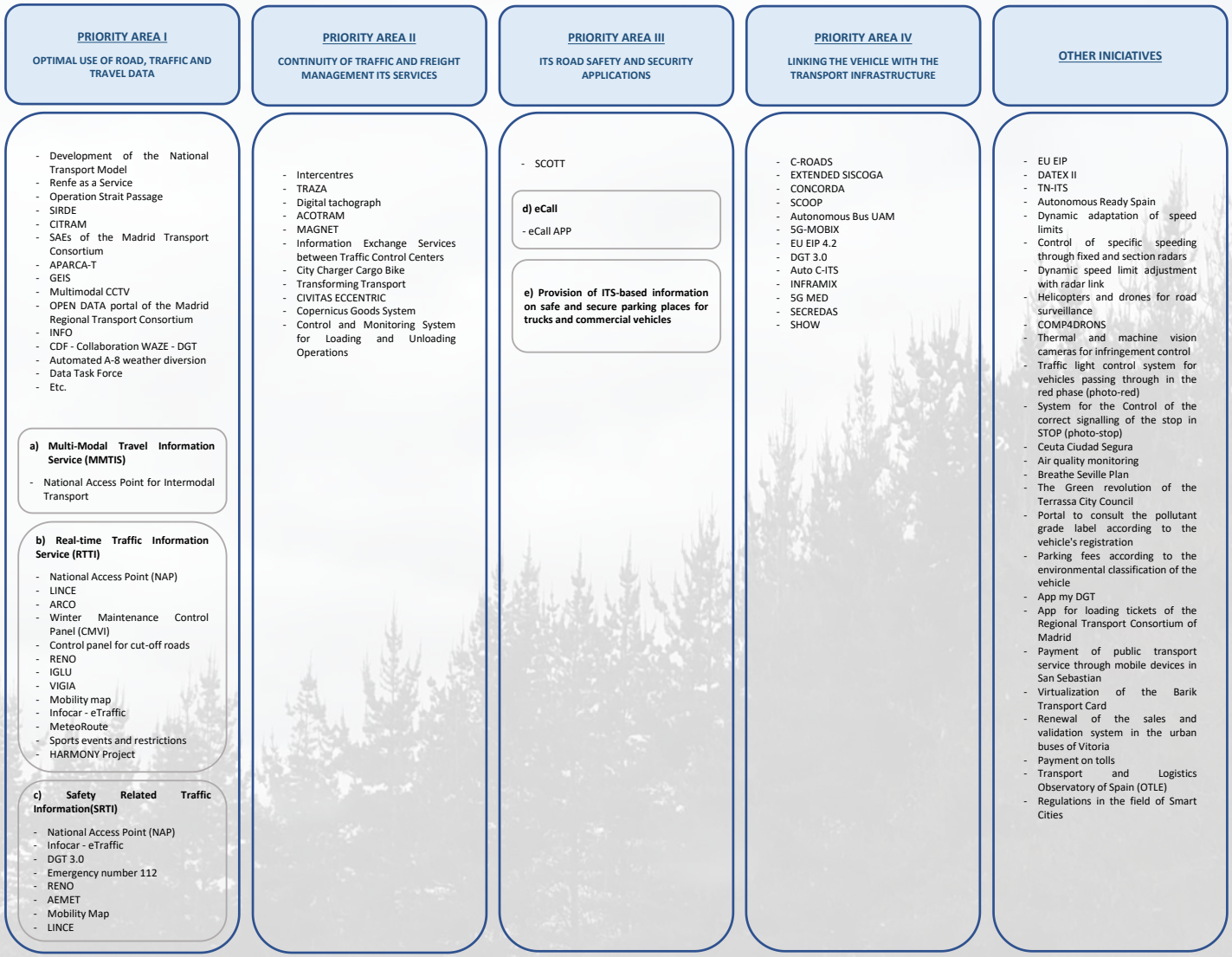

Illustration 4 General structure. Source: Own Elaboration

1.3 General Progress since 2017

The information on the ITS progress in Spain since 2017, and in accordance with the priority actions of the ITS Directive, has been structured in such a way as to maintain the format used for the 2014 and 2017 Reports and thus allows the information to be compared between years and shows the evolution of the services which existed in the past and in the new ones included in the current document.

Table 1. Functional areas and ITS services analysed in overall progress since 2017. Source: Own Elaboration

FUNCTIONAL AREA	ITS SERVICE
Traffic information	Traffic events and incidents
	Traffic flow (Levels of Service - LOS)
	Travel times
	Information of speed limits
	Driving restrictions
	Images or video distribution
	Weather related information
	Itinerary planning
	Information exchange
Traffic and mobility management	Dynamic speed management
	Prohibition of truck take-over
	Implementation of reversible lanes
	Hard shoulder use
	Management of high occupancy lanes
	Ramp metering
	Dynamic management of driving restrictions in mass movements and adverse weather conditions
	Tunnel management
	Traffic management plans
	Dynamic management of urban traffic plans
	Traffic light priority systems for public transport
	On demand public transport
	Public bicycle service management
	Car pooling and car sharing
	*Weight control**
Security and emergency management	eCall or incident management
	*ADAS**
	*Remote diagnostics**
	*Vulnerable users**
Monitoring (compliance)	Speed control
	Red light control
	Access control
	*Digital tachograph**
	Video surveillance system in public transport

FUNCTIONAL AREA	ITS SERVICE
Telematic payment and electronic toll collection (ETC)	*EFC (Electronic Fee Collection) and road pricing**
	ETC compliance
	ETC infringements
	Mobile phone payments and card verification on public transport
	*ETC application**
	*Shadow toll**
Freight and fleet	Information and reservation services on safe and secure truck parking places
	Dangerous Goods Traffic Management
	Dangerous Goods Monitoring
	Special transport management
	Urban and interurban logistics
	Lean and green logistics
Transport facilities	*ITS deployment and demand studies (ITS Electronic Product Supply Catalogue, ITS Action Plan)**
	Exploitation Support Systems (ESS)
	Travel planning (including door-to-door planner)
	Intermodal transport management
	E-ticketing
	Transfer
	Integration of data and information in a single architecture
	Traveller information

**NOTE: Additional ITS services with respect to the 2017 Report in italics*

The following sections include a series of tables, disaggregated and linked to each of the functional areas and ITS services, which indicate the current situation of each service in Spain. The colour-scale shown on the table below has been used to represent 3 levels of deployment and maturity.

Table 2. ITS level of deployment colour scale. Source: Own Elaboration

	Test level, pilot projects, research projects or preliminary studies
	Service implemented in certain corridors or specific cities
	Service implemented in a large part of the territory or area where it is necessary

The information collected in the following tables is the result of a massive consultation launched to all service providers (both public and private), boroughs with more than 50,000 inhabitants, concessionaires, bodies, entities and associations at a national level related to the subject. The aim is to reflect the true state and evolution of the ITS field in Spain since 2017 in the most realistic way possible.

1.3.1 Traffic information

1.3.1.1 Traffic events and incidents

Table 3. General progress on traffic events and incidents. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
	Web servers	The entire interurban network				
	Information phone numbers (011), SMS, 012, …	The entire urban and interurban road network				
	Interactive digital televisions	The entire interurban network				
	NAP	The entire interurban and part of the urban road network				
DGT	Radio (via RNE)	The entire interurban network				
Big Cities (Madrid, Castellón, Sevilla, Bilbao, Vitoria, León, …)	VMS, social networks, Servers web, APPs. NAP (Madrid City Council)	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Gijón, Sant Boi de Llobregat, Terrassa, …)	VMS, CCTVs, APPs, Web servers	Urban road network				
Public and private ITS service providers	Mobile APPs NAP (TomTom)	The entire interurban and part of the urban road network				
Toll operators (e.g. motorways)	Pharos, VMS, web, APP, DATEX II	High capacity network				
Renfe Services	APP and mobility platform	Railway and multimodal transport network of other public and private transport modes				

1.3.1.2 Traffic flow (Levels of Service - LOS)

Table 4. General progress on Traffic flow (Levels of Service - LOS). Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	NAP, Servers web, APPs, Social Networks	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
Big Cities (Madrid, Castellón, Sevilla, Bilbao, Vitoria, León, …)	VMS, social networks, Servers web, APPs. NAP (city council Madrid)	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Gijón, Sant Boi de Llobregat, Terrassa, …)	Loops, PMVs and Web Servers	Urban road network				
Public and private ITS service providers	Google, INRIX, etc.	The entire urban and interurban road network				
Toll operators (e.g. motorways)	VMS, web, APP, DATEX II	High capacity network				

1.3.1.3 Travel times

Table 5. General progress on Travel times. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
	NAP	The entire interurban and part of the urban road network				
DGT	Web servers	Access and ring roads of big cities.				
Big Cities (Madrid, Castellón, Sevilla, Bilbao, Vitoria, León, …)	VMS, SSNN, Web servers, APPs.	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Gijón, Sant Boi de Llobregat, Terrassa, …)	VMS, LPRs, Web servers	Urban road network				

WHO	HOW	WHERE	2011	2014	2017	2020
Public and private ITS service providers	Mobile APPs and Big Data Platforms (e.g. Indra-TomTom)	The entire interurban and part of the urban road network				
Toll operators (e.g. Motorways, SEITT, National Delegation of Toll Roads)	VMS, web, APP	High capacity network				
Renfe Services	APP and mobility platform	Railway and multimodal transport network of other public and private transport modes				

1.3.1.4 Information of speed limits

Table 6. General progress on Information of speed limits. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
	Web servers	The entire interurban road network				
	NAP	The entire interurban and part of the urban road network				
Big Cities (Madrid, Castellón, Sevilla, Bilbao, Vitoria, León, …)	VMS, Informative pedagogical speed signals. NAP (City Council of. Madrid)	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Gijón, Sant Boi de Llobregat, Terrassa, …)	VMS, radars	Urban road network				
Public and private ITS service providers	Mobile APPs	The entire interurban and part of the urban road network				
Toll operators (e.g. motorways)	VMS, APP, web	High capacity network				

1.3.1.5 Driving restrictions

Table 7. General progress on driving restrictions. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS, Web servers and news channels	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
	NAP	The entire interurban and part of the urban road network				
Big Cities (Madrid, Castellón, Sevilla, Bilbao, Vitoria, León, …)	VMS, Social Networks, Web servers, APPs. NAP (Madrid City Council)	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Terrassa, …)	VMS, LPRs, Web servers	Urban road network				
Public and private ITS service providers	Mobile APPs	The entire interurban and part of the urban road network				
Toll operators (e.g. Motorways, SEITT, National Delegation of Toll Roads)	VMS, web, APP, DATEX II	Urban road network				
Renfe Services	APP and mobility platform	Railway and multimodal transport network of other public and private transport modes				

1.3.1.6 Images or video distribution

Table 8. General progress of image or video distribution. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	Web servers, Mobile APPs	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
	NAP	The entire interurban and part of the urban road network				
Big Cities (Madrid, Castellón, Sevilla, Bilbao, Vitoria, León, …)	CCTVs, Social networks, Web servers, APPs.	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Gijón, Terrassa, …)	CCTVs, Web servers, Local Police	Urban road network				

WHO	HOW	WHERE	2011	2014	2017	2020
Toll operators (e.g. Motorways, SEITT, National Delegation of Toll Roads)	Web servers through DGT	High capacity network				

1.3.1.7 Weather – related information

Table 9. General progress on weather-related information. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT, DGC	VMS, Web servers and Mobile APPs	Specific points of the interurban network				
Big Cities (e.g. Madrid)	VMS and Social networks with information from AEMET	High capacity network				
Some municipalities with more than 50,000 inhabitants (Albacete, Terrassa, …)	VMS	Urban road network				
Public and private ITS service providers	Mobile APPs	The entire interurban and part of the urban road network				
Toll operators (e.g. Motorways, MITMA, SEITT, National Delegation of Toll Roads)	Web, APP.	High capacity network				
Renfe Services	APP and mobility platform	Railway and multimodal transport network of other public and private transport modes				

1.3.1.8 Itinerary planning

Table 10. General progress on Itinerary Planning. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	Web servers and Mobile APPs	The entire interurban road network				
Big Cities (e.g. Madrid)	EMT MaaS Madrid	The entire road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Terrassa, …)	VMS and TMC software	Urban road network				
Public and private ITS service providers	Mobile APPs	The entire interurban and part of the urban road network				
Toll operators	Web, APP.	High capacity network				

WHO	HOW	WHERE	2011	2014	2017	2020
Renfe Services	APP and mobility platform	Railway and multimodal transport network of other public and private transport modes				

1.3.1.9 Information Exchange

Table 11. General progress on Information Exchange. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT, DGC	DATEX II, XML and text files	The entire interurban road network				
Big Cities (Madrid, Castellón, Sevilla, Bilbao, Vitoria, León, …)	APIs, Open Data Systems, XML, Cloud IDE	The entire road network				
Public and private ITS service providers	Mobile APPs	The entire interurban and part of the urban road network				
Toll operators (e.g. Motorways, MITMA, SEITT, National Delegation of Toll Roads)	DATEX II	High capacity network				

1.3.2 Traffic and Mobility management

1.3.2.1 Dynamic speed management

Table 12. General progress on dynamic speed management. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT	VMS, Web servers	Specific sections of the interurban and peri-urban network				
Big Cities (e.g. Madrid)	VMS, Web servers	High capacity network				
Toll operators	VMS, Web servers	Specific sections of the peri-urban network				

1.3.2.2 Prohibition of truck take-over

Table 13. General progress on the Prohibition of truck take-over. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, DT	VMS, Web servers, New channels	Specific sections of the interurban network				
Toll operators	VMS, Web servers, New channels	Specific sections of the interurban network				

1.3.2.3 Implementation of Reversible lanes

Table 14. General progress on the Implementation of Reversible Lanes. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS, Web servers, New channels	Specific sections of the interurban network				

1.3.2.4 Hard shoulder use

Table 15. General progress on the hard shoulder use. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS	Specific sections of the interurban network				

1.3.2.5 Management of high-occupancy lanes

Table 16. General progress on the Management of high-occupancy lanes. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	VMS, Web servers, New channels	20 km section in Madrid on the A-6 HOV lane				
SCT	VMS, Web servers, New channels	High Occupancy Vehicle Lane project on C-58 completed (October 2012: HOV+3; March 2013 HOV+2; September 2014 HOV +2 (1+1 route)				

1.3.2.6 Ramp metering

Table 17. General progress on Ramp metering. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	VMS, Web servers, New channels	A-5 and A-1 peri-urban motorways in Madrid M-40 evaluation				
Big cities (e.g. access to Seville)	Traffic Management System SIT 3	Urban road network				
Integrators, installers and maintainers (e.g. Kapsch)	Services V2X	AP-7 (C-Roads)				

1.3.2.7 Dynamic management of driving restrictions in mass movements and adverse weather conditions.

Table 18. General progress on Dynamic management of driving restrictions in mass movements and adverse weather conditions. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS, Web servers, New channels NAP	Interurban network and ring roads in the metropolitan areas of big cities: Madrid and Barcelona				
Big cities (e.g. Madrid and Barcelona)	VMS, Web servers, New channels NAP	The entire road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Aranjuez, Terrassa, ...)	VMS	Low Emission Zone in pollution episodes				

1.3.2.8 Tunnel Management

Table 19. General progress on Tunnel management. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGC	VMS, Web servers, New channels	Tunnels of the urban and interurban network				
Big cities (e.g. Madrid and Barcelona)	VMS, Web servers, New channels	Tunnels of the urban and interurban network				
Toll operators	HORUS	High capacity network				

1.3.2.9 Traffic management plans

Table 20. General progress on Traffic management plans. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	LOS algorithms, traffic conditions, AID and travel times. VMS, Web servers, New channels and mobile APPs	In all the Traffic Management Centres, the interurban road network in Spain				
Big cities (Madrid, Sevilla, San Sebastián, Vitoria, Lleida, ...)	Management systems SDCTU, SIT3, Optimus, APPs, Web servers	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Aranjuez, Terrassa, ...)	Traffic management systems	Urban road network				
INECO	Transport model	The entire interurban network				

1.3.2.10 Dynamic management of urban traffic plans

Table 21. General progress on Dynamic management of urban traffic plans. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (Madrid, Sevilla, San Sebastián, Vitoria, Lleida, ...)	Management systems SDCTU, Optimus, Centralised crossings, Adaptive system ITACA	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Aranjuez, Terrassa, ...)	Control Centre Software Centralised crossings Modification of Traffic Light Work Plans	Urban road network				

1.3.2.11 Traffic light priority systems for public transport

Table 22.. General progress on Traffic light priority systems for public transport. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (Madrid, Sevilla, San Sebastián, Vitoria, Lleida, ...)	Control Centre Software Specific traffic lights for Public Transport	Urban road network				

WHO	HOW	WHERE	2011	2014	2017	2020
Some municipalities with more than 50,000 inhabitants (Albacete, Terrassa, ...)	Control Centre Software Specific traffic light intersections with BUS priority	Urban road network				

1.3.2.12 On request public transport

Table 23. General progress on On request public transport. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (Madrid, Sevilla, San Sebastián, Vitoria, Lleida, ...)	On-board equipment as operational aids, information screens, reservation centre, tools for making reservations (APP, web, SMS, telephone)	Urban public transport				
Some municipalities with more than 50,000 inhabitants (Albacete, El Ejido, Molina de Segura, ...)	Reservation service via APP and telephone	Urban public transport				

1.3.2.13 Public bicycles service management

Table 24. General progress on Public bicycles service management. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (Madrid, Castellón, León, San Sebastián, ...)	Equipped stations - bike racks - conventional and electric bikes; Contactless card; Intramodality with other modes of public transport; Web servers; News channels: web portals; APPs	Urban road network				
Some boroughs with more than 50,000 inhabitants (Albacete, Gijón, Molina de Segura, ...)	Web servers; News channels: web portals; APPs	Urban road network				

1.3.2.14 Car-pooling and car-sharing

Table 25. General progress on Car-pooling. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, DT	VMS, Web servers and mobile APPs	Specific sections of the interurban road network				
Private service providers with information provided by the Administration or other servers	Mobile APPs	The entire road network				

Table 26. General progress on Car-sharing. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (e.g. Madrid)	Web sites and mobile APPs	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Gijón, Molina de Segura, ...)	In study	Urban road network				
Private service providers with information provided by the Administration or other servers	Mobile APPs	The entire road network				

1.3.2.15 Weight control

Table 27. General progress on Weight Control. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT, DGC	Restriction control system for vehicles with MAM> 7,500 kg	The entire road network				
Big cities (e.g. Sevilla)	Unauthorized MAM, control system in RUN	Urban road network				

1.3.3 Security and emergency management

1.3.3.1 eCall or incident management

Table 28. General progress on eCall or incident management. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
112 PSAPs, DGT, MNO (Mobile Network Operators)	Mobile communication network, PSAP (Public Safety Answering Points) and information exchange protocols	The entire road network				
DGT, SCT, DT, DGC	NAP, VMS, CCTVs, Web servers, APPs, Social Networks	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
Big cities (e.g. Madrid, Vitoria, ...)	NAP, Web portals and mobile APPs	Urban road network				
Toll operators (e.g. motorways)	Web, APP.	High capacity network				
Renfe Services	APP and mobility platform	Railway and multimodal transport network of other public and private transport modes				

1.3.3.2 ADAS

Table 29. General progress on ADAS. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, Barcelona City Council	Pilot projects (e.g. Autonomous Ready)	Urban and interurban road network				
Toll operators (e.g. motorways)	Fleet vehicles	High capacity network				

1.3.3.3 Remote diagnostics

Table 30. General progress on Remote diagnostics. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	Alarm and communication failure management system	Access and ring roads of big cities. Some sections of the most representative interurban road network				
Big cities (e.g. Madrid)	Alarm and communication failure management system	Urban and interurban road network				

1.3.3.4 Vulnerable users

Table 31. General progress on Vulnerable users. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	Multiple projects focused on improving Road Safety for cyclists, motorcyclists and pedestrians (dynamic signage with presence detectors, devices to improve the visibility of vulnerable users, etc.)	Access and ring roads of big cities. Some sections of the most representative interurban road network.				
Big cities (e.g. Madrid, San Sebastián)	Parking card for people with reduced mobility. Fleet of accessible buses. Accessibility of metro and suburban stations.	Urban and interurban road network				
Renfe Services	Special vehicle service for people with functional diversity	Railway network				

1.3.4 Monitoring (compliance)

1.3.4.1 Speed control

Table 32. General progress on Speed Control. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	Speed control devices. Average speed controls.	Specific areas for safety reasons. Specific risk sections such as tunnels or viaducts.				
Big cities (e.g. Madrid, San Sebastián, Vitoria, Lleida, León …)	Multi-lane cinemometers, educational radars, software applications, En4sys	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Gijón, Ciudad Real, Sant Boi de Llobregat, Arganda del Rey, …)	Fixed cinemometers and mobile radars	Urban road network				

1.3.4.2 Red light control

Table 33. General progress on Red Light Control. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, DT	Camera, traffic and weather sensors and traffic light units	Interurban network with frequent adverse weather conditions				
Big cities (e.g. Madrid, Valladolid, Sevilla, Vitoria, Lleida, León …)	Photo-red systems, OCR/LPR, software applications, En4sys	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Ciudad Real, Terrassa, Sant Boi de Llobregat, Arganda del Rey, …)	Photo-red systems, OCR/LPR, software applications, En4sys	Urban road network				

1.3.4.3 Access control

Table 34. General progress on Access control. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	VMS and LPR	Zones set according to the pollution protocol - air quality protection. Restricted access in high occupancy areas. Traffic restrictions on certain roads.				
Big cities (e.g. Madrid, Barcelona, Málaga, Sevilla, Vitoria, San Sebastián, Ciudad Real, León …)	Photo-red systems, OCR, software applications, SACAP	Urban road network				
Some municipalities with more than 50,000 inhabitants (Albacete, Ciudad Real, Terrassa, Sant Boi de Llobregat, …)	OCR/LPR, Bollards with remote control	Urban road network				
Toll operators (e.g. motorways)	VMS y LPR	High capacity network				

1.3.4.4 Digital Tachograph

Table 35. General progress on Digital Tachograph. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT (Dirección General de Transporte Terrestre), DT	Digital tachograph	All vehicles weighing more than 3.5 tons or capable of carrying 9 or more persons (including the driver and subject to certain exceptions) and which are registered for the first time				

1.3.4.5 Video surveillance system in public transport

Table 36. General progress on the Video surveillance system in public transport. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (e.g. Madrid, Vitoria, San Sebastián, …)	On-board video surveillance cameras in the vehicles themselves, control centres, operation support systems	Urban and regional interurban public transport				

WHO	HOW	WHERE	2011	2014	2017	2020
Some boroughs with more than 50,000 inhabitants (p.ej. Albacete)	On-board video surveillance cameras in the vehicles	Urban public transport				

1.3.5 Telematic payment and Electronic Toll Collection (ETC)

1.3.5.1 EFC (Electronic Fee Collection) and road pricing

Table 37. General progress on EFC and road pricing. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT, National Delegation of Toll Roads, SEITT	LPR/OCR, EETS (European Electronic Toll Service)	All Spanish toll roads				
Toll operators (e.g. motorways)	LPR/OCR, EETS	High capacity network				

1.3.5.2 ETC Compliance

Table 38. General progress on ETC Compliance. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Toll operators (e.g. motorways)	DSRC antennas in tolls, EETS, on-board devices, CCTVs, LPRs	All Spanish toll roads				

1.3.5.3 ETC Infringements

Table 39. General progress on ETC Infringements. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT	Camera, Infringement Sensor, ETC, DVIT and Automatic Infringement Device Integration with the National Centre for the Management of Fines (ESTRADA Centre)	All Spanish toll roads				
Toll operators (e.g. motorways)						

1.3.5.4 Mobile phone payment and card verification on public transport

Table 40. General progress on Mobile phone payment and card verification in public transport. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (e.g. Madrid, San Sebastián, …)	EMV contactless bank card payment, mobile APPs, credit card payment	Urban and regional interurban public transport				
Toll operators (e.g. motorways)	AWAI	High capacity network				
Renfe Services	Mobile APP	Railway and multimodal transport network of other public and private transport modes				

1.3.5.5 ETC Application

Table 41. General progress on the ETC Application. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Toll operators (e.g. motorways)	EETS	All Spanish toll roads				

1.3.5.6 Shadow toll

Table 42. General progress on the Shadow Toll. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Toll operators (e.g. motorways), National Delegation of Toll Roads, SEITT, DGC	Gantry equipment, CCTVs, LPRs	All Spanish shadow toll roads				

1.3.6 Freight and fleet

1.3.6.1 Information and reservation services on safe and secure truck parking places

Table 43. General progress on Information and reservation services on safe and secure truck parking places. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Repsol Security Parkings, Logistics Areas, verified service areas, etc., DGC	Web and telephone reservation service	Parking lots defined in the National Platform for Safe and Secure Parking				
Toll operators (e.g. motorways)	VMS, Web and telephone reservation service	AP-7 Truck park Montseny – Porta Barcelona				

1.3.6.2 Dangerous Goods Traffic Management

Table 44. General progress on Dangerous Goods Traffic Management. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT, SCT, DT	VMS, LPRs, Web servers	Interurban road network				
Big cities (e.g. Madrid, Barcelona, …)	VMS, LPRs, Web servers (subject to permissions and payment of fees)	Urban and interurban road network				

1.3.6.3 Dangerous Goods Monitoring

Table 45. General progress on Dangerous Goods Monitoring. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT	VMS, Web servers	All tunnels in the national road network				

1.3.6.4 Special Transport Management

Table 46. General progress on Special Transport Management. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	Web application "TRAZA" for abnormal size/weight transport authorizations	The entire road network competence of DGT				
SCT	Web application "TRESA" for abnormal size/weight transport authorizations	The entire road network competence of SCT				
DT	Complementary Traffic Authorization Application (ACC)	The entire road network competence of DT				
Big cities (e.g. Madrid, Sevilla, …)	VMS, LPRs, Web servers (Subject to permissions and payment of fees)	Urban road network				
Toll operators (e.g. motorways)	GETE	High capacity network				

1.3.6.5 Urban and interurban logistics

Table 47. General progress on Urban and interurban logistics. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT	Technical Department	National road network				
Big cities (e.g. San Sebastián, Sevilla, …)	City Changer Cargo Bike Project. DUM public/private	Urban road network				

1.3.6.6 Lean and Green logistics

Table 48. General progress on Lean and Green logistics. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT	Creation of a logistics platform	National road network				
Big cities (e.g. Madrid, San Sebastián, Sevilla, …)	Sustainable Mobility Ordinance	Urban road network				

1.3.7 Transport facilities

1.3.7.1 ITS deployment and demand studies (ITS Electronic Product Supply Catalogue, ITS Action Plan)

Table 49. General progress on ITS Deployment and demand studies. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	ITS Plan	The entire interurban road network				
Big cities (e.g. Madrid)	Urbanisation and planning projects	The entire road network				

1.3.7.2 Exploitation Support Systems (ESS)

Table 50. General progress on Exploitation Support Systems (ESS). Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (e.g. Madrid, Vitoria, San Sebastián, Sevilla, León, …)	Monitoring and control of the fleet by means of geolocation (GPS) and wireless voice/data communication with mobile units. Control of boarding systems. Controller help interface. Operations control centre: communication and database servers, customer positions, geographic and synoptic information.	Urban and interurban public transport				
Some municipalities with more than 50,000 inhabitants (e.g. Albacete, El Ejido, Terrassa, …)	Web servers, GPS tracking and fleet control and wireless voice/data communication with mobile units. Stop prediction system	Urban public transport				
Integrators, installers, and maintainers (e.g. INDRA)	Proyecto HARMONY	Bus fleets in the North of Madrid				

1.3.7.3 Travel planning (including door-to-door planner)

Table 51. General progress on Travel planning (including door-to-door planner). Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT	SITRANBUS Site	National interurban public transport				

WHO	HOW	WHERE	2011	2014	2017	2020
DGT and other service providers (based on DGT sources)	Nationwide travel planning (including weather, incidents, restrictions and traffic LOS) through mobile APPs	The entire road network				
Big cities (e.g. Madrid, San Sebastián, Sevilla, León, …)	Web service and Mobile APPs	Urban and interurban public transport				
Some boroughs with more than 50,000 inhabitants (e.g. Albacete, El Ejido, Terrassa, …)	Mobile APP, Web portal, Integration of service information into Google Transit	Urban public transport				
Integrators, installers and maintainers (e.g. INDRA)	Mobile, APP or Web Site	Carried out within R&D projects in the Shift2Rail-IP4 program: Attracktive, Co-Active, Connective, Cohesive, MaaSive, of which Indra is a partner. Complemented by the Open Call Shift2MaaS project, with which Indra collaborates, in which the developments will be tested in real environments				
Toll operators (e.g. motorways)	Mobile APP or Web Site	High capacity network				
Renfe Services	APP and mobility platform	The RaaS project includes an intermodal planner with national coverage. In pilot phase urban areas of Madrid and Barcelona and HS train between both				

1.3.7.4 Intermodal transport management

Table 52. Progress in Intermodal transport management. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	Dissemination of long-range road trip information throughout the country to access ports (traffic levels, port occupancy, estimated departure times, rest areas en route, etc.)	Seasonal Road-Sea Intermodality				
Big cities (e.g. Madrid, León, …)	Introduction of a single transportation card. Systems for harmonising electronic tickets from different operators. Control and clearing centre for distribution among operators. APPs to manage and monitor intermodal transport (SGRAF, GEIS, SGIP Intermodal, etc.)	Urban and interurban public transport				
Some boroughs with more than 50,000 inhabitants (El Ejido)	Integration of Urban Transport in the Almeria Metropolitan Transport Consortium.	Urban public transport				

WHO	HOW	WHERE	2011	2014	2017	2020
Integrators, installers and maintainers (e.g. INDRA)	Mobile APP or Web Site	Carried out within R&D projects in the Shift2Rail-IP4 program: Attracktive, Co-Active, Connective, Cohesive, MaaSive, of which Indra is a partner. Complemented by the Open Call Shift2MaaS project, with which Indra collaborates, in which the developments will be tested in real environments				
Renfe Services	APP and mobility platform	The RaaS project includes an intermodal planner with national coverage. In the pilot phase, urban areas of Madrid and Barcelona and the HS train between the two.				

1.3.7.5 E-ticketing

Table 53. General progress on E-ticketing. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGTT	SIRDE	National interurban public transport				
Big cities (e.g. Madrid, San Sebastián, León, …)	Contactless technology. Sales system. Card use control system, control centre and electronic ticket management. Payment with QR codes (e.g. E-MOBASK)	Urban and regional interurban public transport				
Some boroughs with more than 50,000 inhabitants (e.g. El Ejido, Molina de Segura, Terrassa, …)	Cards with contactless technology	Urban public transport				

WHO	HOW	WHERE	2011	2014	2017	2020
Integrators, installers and maintainers (e.g. INDRA)	Mobile, APP or Web Site	Carried out within R&D projects in the Shift2Rail-IP4 program: Attracktive, Co-Active, Connective, Cohesive, MaaSive, of which Indra is a partner. Complemented by the Open Call Shift2MaaS project, with which Indra collaborates, in which the developments will be tested in real environments				
Renfe Services	APP and mobility platform	The RaaS project includes E-tickets for various modes of transport.				

1.3.7.6 Transfers

Table 54. General progress on Transfers. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (e.g. San Sebastián, Vitoria, León, …)	Line and zone defined Transfers, APPs and multimodal information servers and contactless card to allow free transfers within a given time	Urban public transport				
Some boroughs with more than 50,000 inhabitants (e.g. Ciudad Real, Albacete, El Ejido, Molina de Segura, Terrassa, …)	Transfers defined by lines and zones. and contactless card to allow free transfers within a given time	Urban public transport				

WHO	HOW	WHERE	2011	2014	2017	2020
Integrators, installers and maintainers (e.g. INDRA)	Mobile, APP or Web Site	Carried out within R&D projects in the Shift2Rail-IP4 program: Attracktive, Co-Active, Connective, Cohesive, MaaSive, of which Indra is a partner. Complemented by the Open Call Shift2MaaS project, with which Indra collaborates, in which the developments will be tested in real environments				
Renfe Services	APP and mobility platform	The RaaS project includes an intermodal planner with national coverage.				

1.3.7.7 Integration of data and information in a single architecture

Table 55. General progress on the Integration of data and Information in a single architecture. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
DGT	INTERCENTROS and DATEX II	The entire road network				
Big cities (e.g. Madrid)	Real-time consolidated databases, Open Data Portal, Web portal for developers based on Open Source software technologies and Open Standards	The entire road network				
Some boroughs with more than 50,000 inhabitants (e.g. El Ejido, Molina de Segura, Terrassa, …)	Web servers and data export in international standard format	Urban public transport				

WHO	HOW	WHERE	2011	2014	2017	2020
Integrators, installers and maintainers (e.g. INDRA)	Mobile, APP or Web Site	Carried out within R&D projects in the Shift2Rail-IP4 program: Attracktive, Co-Active, Connective, Cohesive, MaaSive, of which Indra is a partner. Complemented by the Open Call Shift2MaaS project, with which Indra collaborates, in which the developments will be tested in real environments				
Renfe Services	APP and mobility platform	The RaaS project integrates intermodal information with national coverage.				

1.3.7.8 Traveller information

Table 56. General progress on Traveller information. Source: Own Elaboration

WHO	HOW	WHERE	2011	2014	2017	2020
Big cities (e.g. Madrid, Sevilla, San Sebastián, Vitoria, León, …)	System for visually impaired people inside the bus. Wireless communication between the control centre (ESS) and the information screens in real time. Applications and websites for the dissemination of information to users	Urban and regional interurban public transport				
Some boroughs with more than 50,000 inhabitants (e.g. Ciudad Real, Albacete, El Ejido, Molina de Segura, Terrassa, …)	ESS, Web server, mobile APPs, etc	Urban public transport				
Toll operators (e.g. motorways)	Mobile, APP or Web Site	High capacity network				

WHO	HOW	WHERE	2011	2014	2017	2020
Integrators, installers and maintainers (e.g. INDRA)	Mobile, APP or Web Site	Carried out within R&D projects in the Shift2Rail-IP4 program: Attracktive, Co-Active, Connective, Cohesive, MaaSive, of which Indra is a partner. Complemented by the Open Call Shift2MaaS project, with which Indra collaborates, in which the developments will be tested in real environments				
Renfe Services	APP and mobility platform	The RaaS project includes an intermodal planner with national coverage. In the pilot phase, urban areas of Madrid and Barcelona and the HS train between the two.				

Illustration 5. Pedestrian Safety. Source: DGT Magazine

1.4 Contact information

1.4.1 Delegated Regulation (EU) 2017/1926 with regard to the provision of multimodal travel information services throughout the European Union (priority action a)

National Access Point contact details

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1.4.2 Delegated Regulation (EU) 2015/962 with regard to the provision of real-time traffic information services throughout the European Union (priority action b)

National Access Point contact details

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1.4.3 Delegated Regulation (EU) 886/2013 concerning data and procedures to provide, where possible, minimum universal traffic information relating to road safety, free of charge to the user (priority action c)

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1.4.4 Delegated Regulation (EU) 885/2013 with regard to the provision of information services on safe and secure parking areas for trucks and commercial vehicles (priority action e)

National Access Point contact details

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2 Projects, activities and initiatives

In the following sections, the most significant initiatives and progress are described and classified in the various priority areas as shown in the image below.

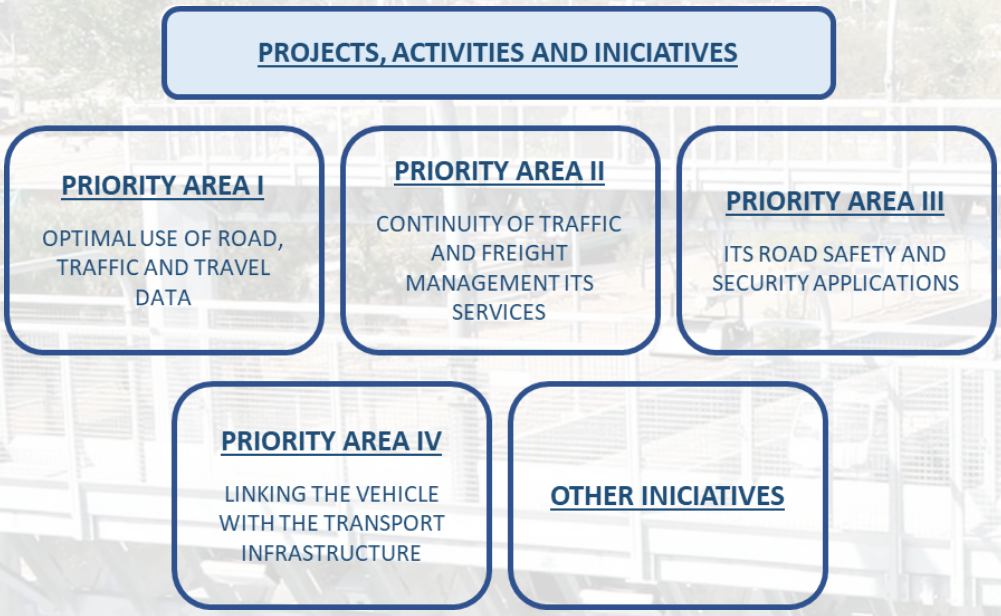

Illustration 6. Projects, activities and initiatives. Source: Own Elaboration

Depending on the subject matter of the activities, they are classified in relation to the priority actions according to the priority areas and in compliance with Directive 2010/40/EU.

2.1 Priority Area I. Optimal use of road, traffic and travel data

The objective of the projects in this priority area is mainly focused on improving the provision of traffic and travel information services in order to provide more accurate and reliable pre-trip and on-trip traffic information that can be delivered to users' smartphones, navigation devices or on-board units in cars and trucks.

This information includes planned roadworks, sports events, estimated time of arrival and warnings about adverse weather or particular conditions along the route.

2.1.1 Description of national activities and projects

Optimal use of traffic, road and travel data has a great impact on ITS projects. These projects can be divided into three (3) different priority actions:

- Priority Action (a): Multi-modal Travel Information Services
- Priority Action (b): Real-time Traffic Information Services.
- Priority action (c): Universal Traffic Information in relation to Road Safety.

On the other hand, there are other activities and initiatives associated with these issues that do not fall within any of these priority actions.

Illustration 7. Priority Area I. Projects, activities and initiatives. Source: Own Elaboration

2.1.2 Progress since 2017

2.1.2.1 Development of the National Transport Model

In 2019, MITMA began the development of the National Transport Model (MNT), a planning tool at national level, through the assignment made to INECO. This tool is based on a model, for passengers and freight, which will allow the identification of bottlenecks and necessary connections, selection of actions, prospective traffic analysis and the collection of data necessary for cost-benefit analysis.

The MNT is conceived as a 4-stage model focused on interprovincial mobility, both for passengers and freight. The modelling takes 2017 as the base year for calibration. In the case of passengers, the following modes of transport which will be modelled are: private vehicle, rail, bus, sea and air. For freight, the transport modes modelled will be: road, rail, sea and air.

2.1.2.2 Renfe as a Service

The RaaS (Renfe as a Service) Pilot Project is Renfe's Mobility as a Service platform offering a door-to-door intermodal service. The aim of this project is to integrate the railway (long-distance, medium-distance and suburban), and multiple modes of public and private transport, such as taxis, PTV, car-sharing, car-pooling, shared bicycle, rented scooters, bus, tube, parking service for private vehicles, park and ride, etc.

It allows, in a single APP, to plan the route, to reserve means of transport, to acquire transport tickets, to make the payment, and to access the services. It also provides information to the traveller and has a customer service interface.

Illustration 8. Renfe as a Service: Source: Renfe press room

In the first phase, a pilot test of the service is being carried out, integrating the Madrid-Barcelona high-speed train and urban transport services in both cities with an investment of 230.000 euros.

The commercial phase will integrate more modes of transport than those mentioned and will progressively acquire greater coverage with the objective of providing nationwide mobility solutions.

In 2019 the Proof of Concept Phase was launched and is progressing as planned. The users participating in the test (500) were selected and invited. The APP and the platform are serving users from 15th November, 2019. Work is underway to improve the APP and to integrate new modes of transport and services into the platform, extending the deadline and number of participating users to 3000.

In addition, work continues on the development of the commercial platform.

2.1.2.3 *"Paso del Estrecho" Special Traffic Operation*

The General Directorate for Traffic (DGT) provides information and assistance to users on their trips through the main routes in Spain to the ports of departure to North Africa. This operation involves more than 760.000 vehicles crossing the border between France and Spain (Irún and La Jonquera) and using these corridors to reach their destination.

This special traffic operation comprises rest areas, information points, emergency areas and variable sign posts located in the two main national corridors: the Central Corridor and the Mediterranean Corridor.

Illustration 9. Localisation of LPRs and CCTVs for OPE monitoring. Source: DGT

The traffic information and management system are based on the monitoring of the main borders of Spain with France through Variable Sign posts which provide, among other things, information on the occupancy rate and waiting times from the ports of departure. In addition, the system has more than fifty (50) LPRs and other means at the main boarding ports to North Africa, which provide updated information on movements and a prognosis of the entry of traffic to the ports. Additionally, the system provides recommendations on the purchase of boarding tickets.

In emergency situations, the panels are also used to give warnings and recommendations to the users.

In order to know precisely the number of vehicles crossing the borders of Irún and La Jonquera, the system has a Borderline Information System (SIF - Sistema de Información de Frontera) for the integration of as much data as necessary to calculate the estimated mass movement.

This system allows reading and identifying the place of origin of the vehicles at the border crossings, automatically obtaining the vehicle capacity. The data provided by the SIF is collected by the hour and can be used to obtain time evolution at the borders.

In recent years, the General Directorate for Traffic has improved the quality of its equipment, thus having state-of-the-art devices to provide top-quality information to its users.

During the “OPE Campaign”, the DGT's website includes an information leaflet with advice, recommendations and indication of the location of rest areas and information points.

Illustration 10. Example of the main page of the triptych. Source: DGT

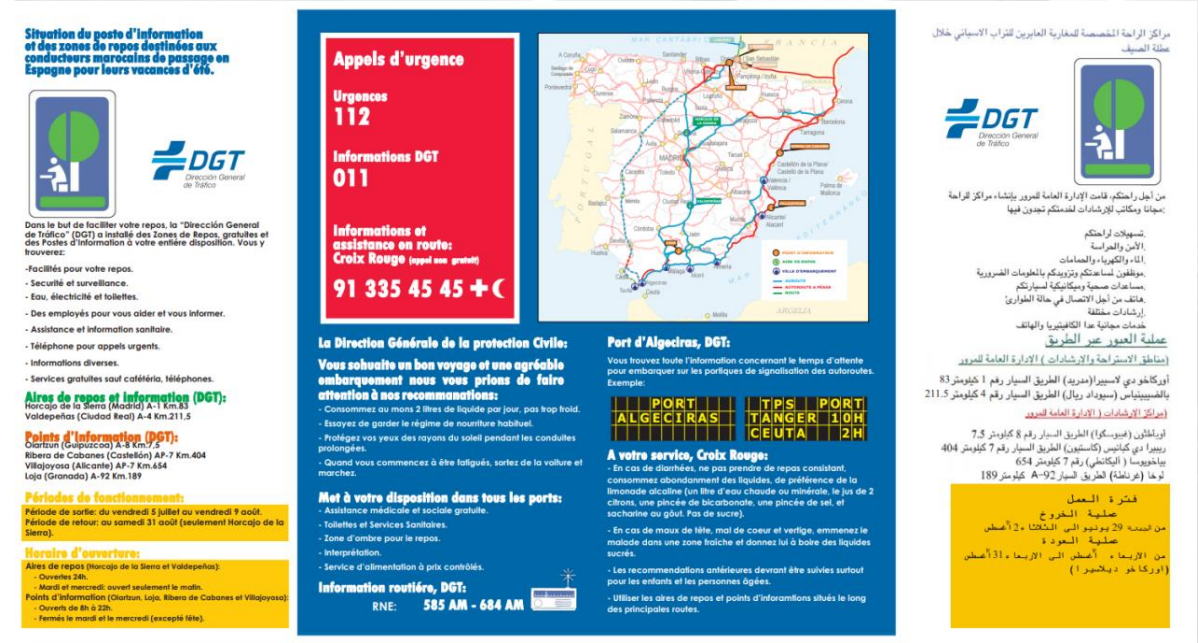

Illustration 11. Example of the back page of the triptych. Source: DGT

In addition to all this information, the DGT's website contains other information of interest such as emergency telephone numbers, information on accidents in previous years etc., all in of which can be provided in four languages: Spanish, English, French and Arabic.

2.1.2.4 SIRDE

In 2016, the Ministry of Transport, Mobility and Urban Agenda developed an application called "SIRDE" (Sistema de Información de Registro de Datos de Explotación – Management Information System for Recording Data of Dispatches) to improve the management of road passenger transport concessions, which is the responsibility of the General State Administration.

This application can be downloaded free of charge from a device located on the buses themselves. SIRDE collects the operating data of the concessions by reading a QR code printed on the tickets. At the same time, the positioning of the buses is recorded. All the data and travel routes of the passengers are sent in real time to a data warehouse pertaining to the Ministry of Transport, Mobility and Urban Agenda, where they are managed and analysed for the development of O/D (Origin and Destination) matrices.

For the approval of this system, the Ministry carried out numerous tests on some travel routes, with the collaboration of various concessionary companies. Currently, more than a third of the concessions under the Ministry have SIRDE installed.

2.1.2.5 CITRAM

The public transport management centre of the Madrid Regional Transport Consortium (CITRAM) monitors the public transport system of the Community of Madrid in real time. This was launched in August 2013, it monitors the public transport system of the entire region in real time. A project in which the 179 boroughs of the Community of Madrid and more than 40 companies collaborate to improve coordination and support decision-making. The information is presented in a unified way at the disposal of the 5 million public transport passengers. To manage it, the Madrid Regional Transport Consortium has developed "tailor-made" technological tools, which integrate the data of each mode of transport in the same platform, allowing to act with a global approach of the system. CITRAM's role becomes especially relevant in exceptional circumstances such as large events and incidents.

The creation of CITRAM has modified the concept of public transport authority from being mere observers to active agents in the management in real time. In this new framework, objectives such as a new approach to the passengers can be achieved by providing them with homogeneous, updated and quality information on the entire public transport system in order to optimise their journeys and by promoting the capacity to share resources between operators by optimising management. This also makes it possible to put in the hands of developers and other agents the information about the system that allows the creation of new services that give added value to the transport system.

Since 2017, the following progress has been made at CITRAM:

- Monitoring and management in real time and through the existing technological platforms of multimodal events.
- Integration of the onboard cameras of the interurban buses and the Madrid City Council within the existing CCTV application in CITRAM.

- Development of a public access point pilot for downloading static and real-time GTFS files from public transport in the Community of Madrid. During the pilot, concurrent access tests of 100 users per second were successfully carried out.
- Improvement of CITRAM's operational applications to optimise the daily operation of venue operators. These include developments related to improving the SGIP (passenger information service), vehicle location in the SGRAF (graphic supervisor) or updating the pollutants tool to adapt it to the new scenario activation rules approved by the Council in Madrid.
- Development of a platform of open data services for demand, a consolidated real-time database with supply and occupation data for all modes of transport in the community of Madrid
- During the second half of 2019, the contract was awarded for the implementation of a new CRTM control centre at the Avenida de América Interchange (CITRAM's Support Centre) with the aim of having an exact duplicate of the centre so that in the event of serious incidents/accidents at the current locations, the centre will continue to operate with the same characteristics as the main one, thus guaranteeing the correct management of the public transport system of the community of Madrid in real time.

2.1.2.6 Madrid Transport Consortium ESSs

This application, integrated in the Public Transport Management Centre of the Community of Madrid (CITRAM), displays real-time information on vehicles in circulation. It is displayed in the form of thermometers, showing the actual position of all vehicles in operation at that time.

This application, in addition to the location of the vehicles, provides a wide range of information about the vehicles in operation. There are different models of ESS, depending on the mode of transport, which offers different information depending on the type of vehicle.

- Light Rail ESS (ML1, MLO)
  - Position. Displays vehicle position information.
  - Schedule. Indicates the time offset of the vehicle, actual time with respect to its theoretical time.
  - Interval. Indicates the interval between vehicles, i.e. the time with respect to the previous and subsequent vehicles.
  - Identification. Provides data on the number plate of the vehicle, the service being performed and the driver who is performing the service.
- Interurban ESSs (INDRA, GMV, ETRALUX)
  - Position. Displays vehicle position information.
  - Schedule. Indicates the time offset of the vehicle, actual time with respect to its theoretical time.
  - Frequency range. Indicates the interval between vehicles, i.e. the time with respect to front and rear vehicles.
  - Identification. It provides data in relation to the bus number, the line that is running, the registration number and the driver who is running the service.
  - CCTV. It allows to access to the footage of the cameras inside the buses.
  - Reports. It provides different types of reports, having a history, being able to obtain daily, monthly, by bus number, by line, by operator... Some reports show the total number of journeys carried out, occupation, time of the journey...

- Emergencies. It monitors the alarms activated by the drivers.
- It also allows the tracking of specific buses, with the maps that the application itself includes.

2.1.2.7 APARCA-T

Hand in hand with the Madrid Transport Consortium, the APARCA-T Plan is going to create a network of dissuasive car parks in the surroundings of suburban train stations and interchanges of the community of Madrid to promote the use of public transport, boosting the modal interchange and relieving the pressure of private traffic in the accesses to the capital.

Illustration 12. Aparca-T Parking. Source: Community of Madrid

In January 2020 the first pilot test of the deterrent parking plan was launched, making the first 1.470 parking spaces available to public transport users in the car park next to the suburban train station in the municipality of Colmenar Viejo. The results of this pilot will be used to finish defining the definitive configuration of the regional network of park and ride facilities.

All the data obtained will be dumped into an integration technological platform that will enable the integrated management of the different car parks, consisting of a user APP that will allow to consult the list of car parks, their location, how to get to them and their occupation in real time. The application will enable user registration, including the transport card identifier, the data of the vehicles to be used and establish a payment method.

The platform will send the occupation in real time to the community of Madrid's Transport Management Centre (CITRAM) which will disseminate it through various channels (information panels, websites, etc.).

2.1.2.8 GEIS

GEIS (Gestión de Incidencias en la Explotación - Incident Management in the Operation), is an application for recording all types of incidents that occur in the transport system of the community of Madrid, integrated within the Public Transport Management Centre of the community of Madrid (CITRAM). In this way, it contemplates the incidents that have occurred and those that are expected to be generated, such as in the case of programmed cuts.

This application includes all the elements and modes of transport that are contemplated in the transport system of the community of Madrid, such as the city buses of the different boroughs of the community, interurban buses, the tube, light rails, suburban trains, interchanges and bus stops. In this way, more than 40 public transport operators in the community of Madrid have access to the same platform where they can register the status of their network. Each one of them has access only to the visualisation and registration of incidents/accidents related to their company and all this information is received globally in CITRAM (as part of the public transport authority of the community of Madrid) so that within the same application the global status of the public transport system of the region is known in real time.

In 2019, nearly 19.000 incidents/accidents and 48.000 conditions were recorded in the application for the entire public transport system of the community of Madrid.

2.1.2.9 CCTV Multimodal

Application to visualise the cameras of the different modes integrated in CITRAM, which are part of the transport system of the community of Madrid.

It is a multimodal application stemming from the same application and it is possible to visualise the cameras of the different interchanges, of the tube, the light rails, the main roads of Madrid (DGT), cameras of the city council of Madrid, cameras on board interurban buses, on board cameras on buses of the EMT, centralising the access to the different existing cameras in the different modes of transport.

Different visualisation formats can be structured, being able to see one camera (1x1), four (2x2), nine (3x3) and up to 17 cameras in a special format. The application allows the creation of combinations with the desired cameras, and it is possible to choose to see one camera or one combination in each of the boxes enabled for this purpose.

It is a very useful tool to manage an incident/accident, since it allows us to visualise, using the same application the state of the transport modes that transit through the area affected by the incident/accident, to help in the decision making process and to recommend the user the most suitable transport mode.

Other camera trees from external sources external to the public transport system of the community of Madrid can be displayed as well.

In total, the system has more than 10.500 cameras integrated (capacity for 15.000) within the same application that allows a global vision of the transport system of the community of Madrid.

2.1.2.10 SGIP Multimodal

This development has two different access points or consultation environments:

1. The web page that offers the integration of the SGIP of the different interurban transport operators of the community of Madrid. It integrates both real time information on the status of the passenger information panels and its historical status.

   It has four menu options:

   - Failed panels: list of panels that are failing at the time of consultation, with data on them, as well as the number of days they have not communicated.

- Panels: consult the list of panels with the possibility of filtering by borough or by company.
- Operation report: panel status report by company, with the number and percentage of panels in operation, identifying those which don´t work and those which are pending connection.
- Status history: consultation of the history of the status of the panels with the possibility of filtering by a borough, by a company and by start and end date.

2. The user information application: This application sends information of interest to the user via the different panels distributed throughout the transport network of the community of Madrid and to the interior panels of the interurban buses.

This application gives the user the opportunity to be informed about the next services and the next stops, as well as being able to advise in real time about any conditions that are occurring at any point of the transport system of the community of Madrid, offering the traveller the possibility to choose the optimal mode of transport to reach their required destination, even before starting the trip.

Integrated in CITRAM, through it, it's possible to access more than 6.000 information panels in the public transport system of the community of Madrid.

2.1.2.11 Travel planner of the Community of Madrid

In May 2019, the Regional Transport Consortium published the pilot of the Multimodal Planner for Public Transport within the scope of the entire community of Madrid. Among other functions, it allows travellers to plan their trips by calculating personalised itineraries, according to their preferences, available modes of transport, date and time.

The route calculations are made by including all the existing modes of public transport in the community of Madrid: tube, light rail and Parla tram, Madrid city buses (EMT) and those of other boroughs, interurban buses and Renfe Cercanías. Users can customise their search by selecting the mode of transport they are most interested in using, and the date and time of their trip. The system is especially useful for non-traditional journeys and for tourists visiting the region.

Additionally, the application has been reduced to the maximum number of steps required to access information, an attractive and easy-to-understand environment has been designed, and tools have been incorporated for map navigation (zoom, scroll, etc.) and selection of different cartographic backgrounds to facilitate access and understanding.

The system also allows the user to access other information of interest, such as the route of existing lines in each mode of transport. The search by street map has also been completed with the search of stops and stations of the different modes of transport, which allows the user to customise the search according to their required criteria.

This pilot project has been designed in several phases. In the first phase, the application of the multimodal planner was limited to a certain number of users, but this was later increased, and the performance of the system was evaluated. This first phase included a web version and a version for Android mobile devices. The iOS mobile version was released in early 2020. Throughout the duration of this pilot project, improvements and new functionalities have been incorporated.

2.1.2.12 OPEN DATA Portal of the Madrid Regional Transport Consortium

In 2016 the Madrid Regional Transport Consortium launched https://datos.crtm.es, its new Open Data portal. With this new Open Data portal of the Integrated Public Transport System of the community of Madrid, the CRTM has faced a great challenge that also involves the more than 40 public and private transport operators in the region. In this way, the CRTM has managed to integrate all the available information, making it homogeneous, reusable and standardised to facilitate its use and dissemination.

Illustration 13. Open data CRTM. Source: [Open Data Portal CRTM]

Amoungst the contents that can be found in the CRTM Open Data Portal there are:

- Public Transport Network
  - Metro network: lines, stations, accesses, platforms and halls. Planned timetables.
  - Urban bus network for the area of Madrid (EMT): bus lines and stops. Planned timetables.
  - Madrid city bus network, bus lines and stops. Planned timetables.
  - Interurban bus network of the community of Madrid: bus lines and stops. Planned timetables.
  - Light rail / tram network: lines, stations, accesses, platforms and halls. Planned timetables.
  - Suburban network: lines, stations, accesses, platforms and lobbies. Planned timetables.
- Public Transport Card
  - Management offices - Public Transport Card.
  - Charging network: locations of ATMs, tobacconists and other key authorised points of sale of public interest.
- Mobility
  - Deterrent car parks.
  - Green Routes.
  - Consultation of EDM2018 results.
  - All public bicycle systems in the community of Madrid.
  - Network of bicycle parking spaces in Tube and suburban stations and in bus shelters or interurban bus stations within the boroughs of the community.

All this data is available for download in various formats: GTFS, SHP or KML for GIS applications, CSV for tables and spreadsheets, as well as APIs: GeoJSON and Geoservices.

2.1.2.13 3 Stars Open Data Portal of the Regional Transport Consortium of Madrid

The CRTM 3 Stars Open Data Portal will provide an Open Data platform of developers, which will guarantee a secure access point to the static and dynamic data of the public transport system of the community of Madrid.

The following objectives will be achieved with the forthcoming publication of this portal:

- Facilitate the consumption of public transport system information, planned and real time, that is hosted and/or provided by the different current CRTM systems and tools, to developer users from a single secure access point.
- To show the different static and dynamic data catalogues in a visual, descriptive and structured way, including the methods to make online queries about different available web services and the downloading of data in non-proprietary structured formats. The Open Data Portal contains information on the public transport network of the community of Madrid in GTFS format. This format has become a de facto standard for the publication of open transport data and is divided into a static component containing timetable and transport network information, and a real-time component containing stop times and service warnings.
- Describing the steps to be taken and providing documentation to be able to obtain the different public data sets from external or third-party applications, ensuring up-to-date information on a secure and scalable environment.
- To have a suitable management solution for the design and publication of APIs (API Management System) from an Open API definition, in a controlled and secure way, so that the information can be consumed from different channels establishing availability policies, traffic monitoring and service consumption.
- To implement a solution based on Open Source software technologies and Open Standards, with the double objective of being aligned with the philosophy and culture of the Open Data concept, on the one hand, where accessible, reusable data is provided without technological restrictions to promote openness, and on the other hand, to encourage the participation and collaboration of the community as an engine of innovation and socio-economic growth.
- To have a platform prepared for future evolution towards a four and five star Open Data model, which is also capable of integrating other external Open Data information services from other organisations linked to Public Transport in the Region of Madrid.

2.1.2.14 Services for Obtaining and Processing Real Mobility Data in the City of Madrid

This service, developed by Kapsch, allows one to know the real mobility that takes place in the city, as well as to carry out its later treatment and elaboration of reports derived from the movements that are generated.

Traffic data can be obtained thanks to different devices and sources:

- Permanent vehicle, pedestrian and bicycle measure points
- Portable counters for specific measurements
- Open data catalogue of the municipal website such as parking lots, public transport, even social networks
- Police reports
- Travel time data from Inrix or third parties

This service consists of the following functionalities:

- Integrated visualisation of the information from the EcoTrafiX console, both the information and service level in real time, as well as profiles and historical data. It allows one to visualise in real time, in a geo-positioned way from the map itself, the information associated to the status of the traffic service level in the network, traffic data from a measuring point or traffic data from a stretch of road.
- Merging different data sources, it consolidates the information in a navigable traffic network, which will be that of the Madrid city council, and with an automatic calculation and display system of traffic profiles.
- Short-term prediction, based on the real-time traffic trend and the calculated traffic profile for the day, and mechanisms for long-term prediction, based on the calculated traffic profiles.

In addition, it is allowing the use of the latest sensor technologies for the detection of vehicles, pedestrians and bicycles.

2.1.2.15 Madrid City Council Mobility Website

With regards to road traffic, the Madrid city council informs citizens through its website:

- Major events in the city and the mobility plans defined for this purpose.
- Projects with an impact on mobility (urban remodelling, building, alterations to the public transport network, etc.). According to the pollution protocol, information is provided on speed restrictions and the prohibition of driving according to the vehicle's logo. The pollution protocol is applied based on the values resulting from air quality monitoring, an activity described in detail in section 2.5.2.12.

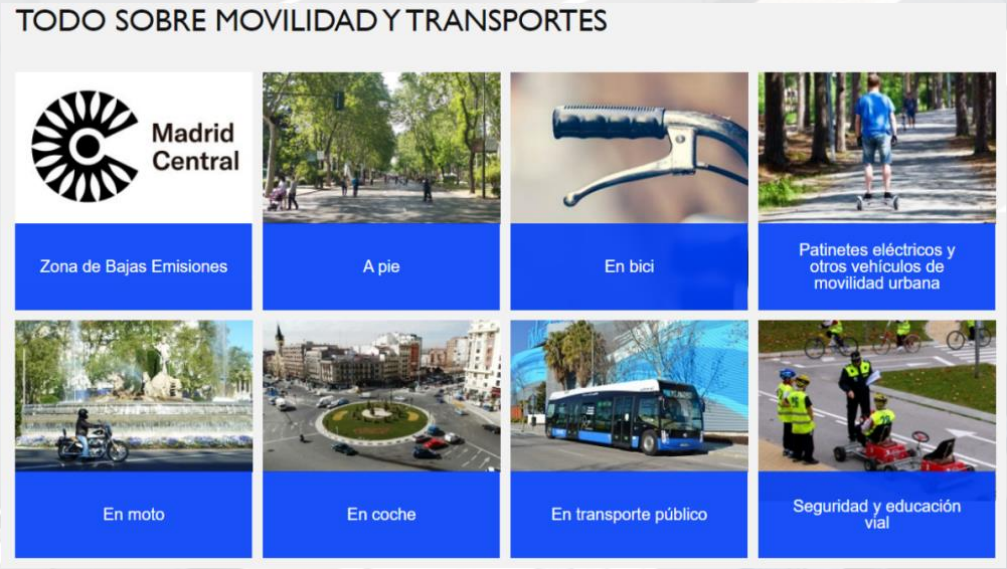

Illustration 14. Everything about mobility and transport. Madrid Central. Source: Madrid City Council

2.1.2.16 Integral System of Mobility in the City Council of Valladolid

In the city of Valladolid, an Integral Mobility System has been implemented, which allows the different agents involved in urban mobility to intercommunicate while at the same time becoming a single point of information for users on timetables, incidents and intermodality.

The aim of this project developed by Kapsch, is to promote the interaction of a traffic control system, with public parking management, regulated parking and public transport, so that citizens only have to communicate with a single agent, the same platform, from which they get all the reliable information on transport in their city. Passengers will have the relevant information on the variable road signs that the Valladolid city council has installed for this purpose. Based on the Kapsch EcoTrafiX software, this system allows users to plan their trips in a more rational and efficient way by accessing, through the boroughs website, updated and reliable information about the traffic in the city, analysing the information and the status of the different public transport methods in order to propose effective solutions and reorganise the scenario in real time and, thus, give them an alternative way to move. Optimise the mobility conditions of public transport, reducing traffic congestion in the city centre.

The solution allows one to centralise both the multimodal information and the operation of the mobility of the city. It includes event and incident/accident management, asset management, data analysis, report generation, as well as the layout of the data on the borough's website.

2.1.2.17 INFORMO

The Madrid city council has the Informo system (informo.madrid.es), a web-based citizen information system with a geographic system that integrates the following information:

- Levels of service
- Traffic flow (vehicles/hour)
- Infrastructure information (traffic lights, photo-red systems, acoustic warning devices, etc.)
- Accident information
- Road works in the city
- Information on environmental labels and the possibility of accessing the centre of Madrid depending on the license plates.

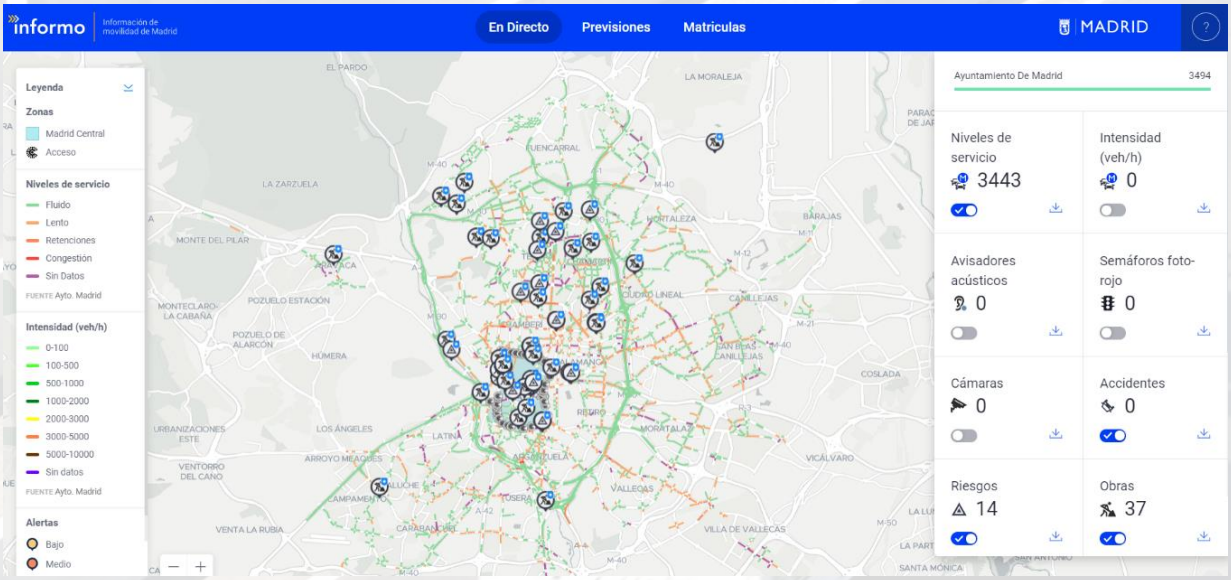

Illustration 15. INFORMO Madrid main interface. Source: [INFORMO Madrid]

2.1.2.18 Alicante Se Mueve: Being Smart

The main objective of the initiative "Alicante Se Mueve: Being Smart", by the Alicante city council, is to design and implement a global system in the city that will provide strategic information on all aspects related to mobility.

This platform will allow the extraction of sectorial indicators to be used by third parties and which will focus mainly on the achievement of direct benefits for the urban environment. It will also be a powerful tool for all the sectors that use it.

Illustration 16. Alicante Se Mueve Logo. Source: Alicante City Council

The project includes two major actions. The first will consist of the creation of a traffic and video system that will be composed, in turn, of three subsystems:

- A closed-circuit television system (CCTV subsystem) consisting of a camera system, a recording and management system and an operating system.
- An analysis and sensor system applied to license plates, as well as to roads and their uses.
- A traffic analysis subsystem to be integrated with existing cameras.

The second action will have the objective of installing a video wall system from which to control and monitor the platform, as well as to represent the events and information generated by the rest of the subsystems graphically in a geolocalised way on planimetry.

2.1.2.19 FCD – Collaboration WAZE – DGT

Since the beginning of 2017, the Directorate General General foror Traffic has joined Waze's "Connected Citizens Program", just as traffic authorities from all over the world have already done, such as Transport for London, ASFA (Association of French Motorway Companies), the cities of New York, Boston, Los Angeles, and in Spain the Barcelona City Council, and the Servei Català de Trànsit.

The initiative consists of the free exchange of traffic data between Waze and the DGT to improve traffic management and road safety. The Waze application currently facilitates the private vehicle travel by providing real-time information on traffic conditions, weather incidents, road network incidents, and other hazards.

The DGT, in its firm commitment to move towards advanced traffic management models with high added value, incorporates this new source of anonymised data from users in real time that enriches the available traffic data. Thanks to these new data sources, a more intelligent management is possible from the Traffic Management Centres both in the detection and transmission of incidents to improve traffic flow and safety.

Illustration 17. WAZE - DGT information exchange Source: DGT Magazine

2.1.2.20 Geotraffic

It consists of a traffic status information system based mainly on data obtained by means of the floating vehicle technique. Speeds, speed distribution and travel times are displayed in real time and updated every minute throughout the main road network. Incidents on the road and the status of passing by mountains is also shown. Lost time on roadblocks and associated costs can be calculated. Daily heat maps of the different corridors that make up the road network are shown, where and when roadblocks begin and end, as well as the evolution of their length.

Illustration 18. Starting the use of probe vehicle data for traffic management. Source: Arc Atlantique

2.1.2.21 Smart routing - Travel times

This is a service that is provided at various points throughout the country. It is carried out on the basis of theoretical calculations given by predefined rules inserted in the system, so that the system checks whether the time criteria is met and automatically sends a message to the VMS assigned for this purpose.

An example of this is the methodology followed at the Southeast Traffic Management Centre for the calculation of sections along the A-7 and AP-7.

The following table shows the criteria used to establish the automatic launch of the signalling in the decreasing direction of traffic:

Table 57. Travel times A-7 and AP-7. Source: DGT

	Time travelled for complete section by A-7 (min)	Half speed of complete section by A-7 (km/h)	Time travelled for complete section by AP-7 (min)	Half speed of complete section per AP-7 (km/h)	Difference A-7 and AP-7
Service level "A" **Service level "E"**	22:50 **25:03**	83,46 76,12	15:48 15:48	106,45 106,45	07:02 09:15

The parameter considered to launch the signalling automatically is given when a level of service "E" is reached on the A-7, that is, when the travel time direction to Marbella is over 25 minutes, in that moment, the time difference between A-7 and AP-7 is 9,15 minutes with a difference of 37% in travel time between the two routes.

In the following illustration, a capture of a VMS designated to be activated automatically in the decreasing direction is shown, the corresponding message is generated according to the calculations made by the system.

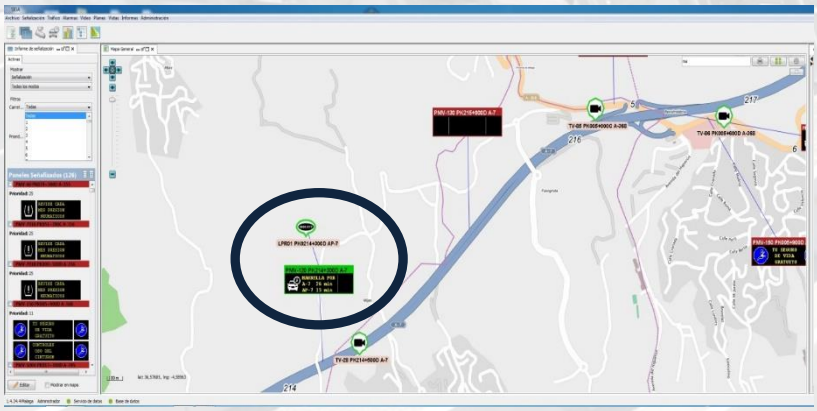

Illustration 19. VMS indicating travel times in the decreasing direction. Source: DGT

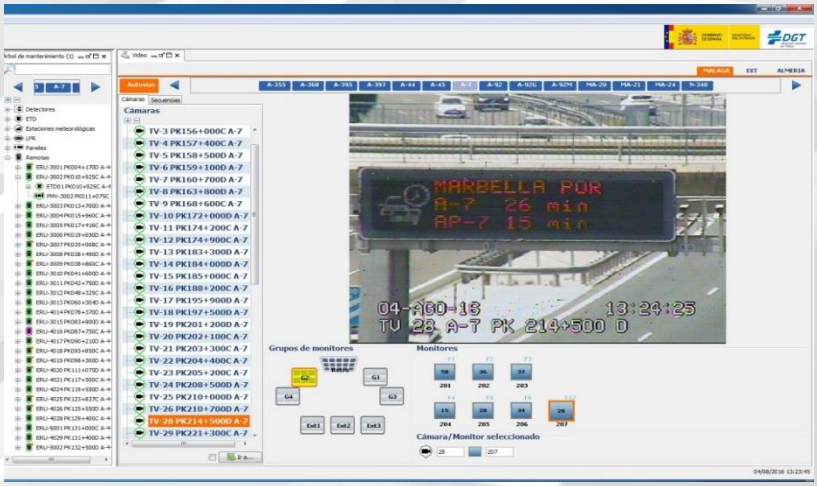

Illustration 20. Signalling automatically generated in the decreasing direction. Source: DGT

This methodology is applied in both directions (increasing and decreasing) with different values depending on the travel times and points of deviation. Below is a diagram of the complete system, detailing both the road connections and the VMS that provide information on the service in question.

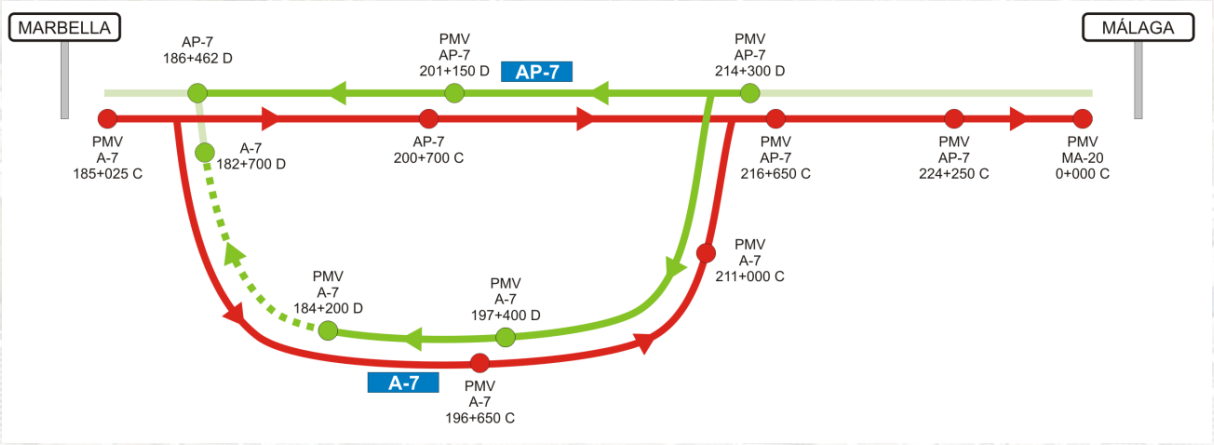

Illustration 21. Diagram of automatic signalling system of travel times of the Southeast TMC. Source: DGT.

2.1.2.22 Traffic light priority system

Although it is not a nationally extended system, there are some projects in the testing and calibration phase, as is the case of some urban public transport lines in Zaragoza.

The system works as follows: the vehicle transmits its position to the receiver before reaching the traffic lights, so that it sends its position based on GPS parameters and a distance measurement device installed on the road (an odometer). All this allows to fine-tune the moment of the bus arrival at the traffic light. The position of the buses, in turn, is based on the study that the system makes every day by collecting data that the buses themselves make over time and that are reconfigured every day in the depots. Thus, the vehicles collect the data and, the next day, the system recalculates their new approach curves.

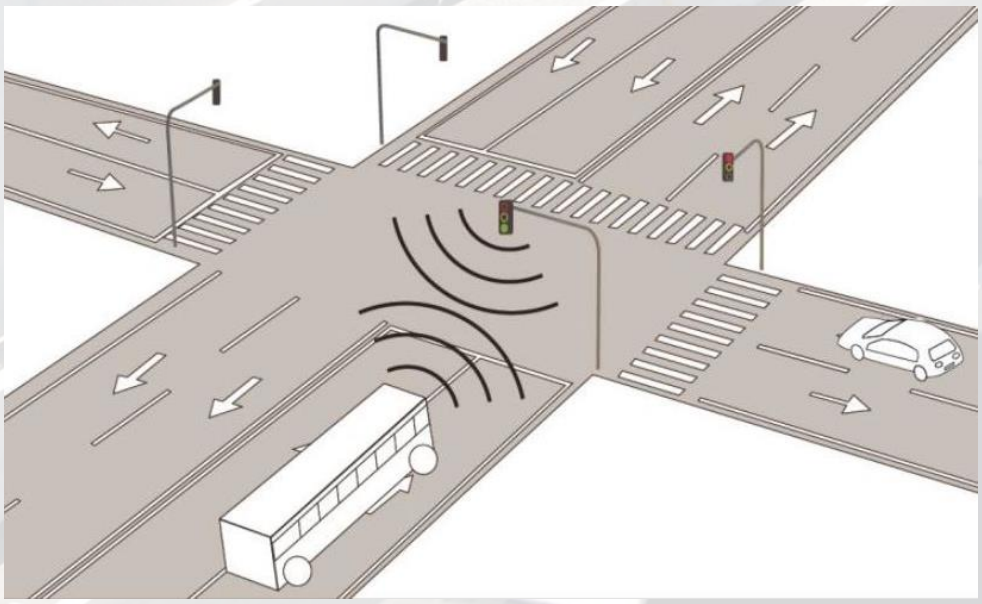

Illustration 22. Traffic light priority system. Source: DGT

Similarly, there are projects at national level to be implemented which constitute a variant of the previous example in which the traffic light priority is linked to heavy vehicles regardless of type of usage. For this purpose, the technology used also differs, using in this case a latest generation laser system that detects the volume and type of each vehicle by sending an order to the opposite traffic light to turn red when it verifies that there is a danger of an obstruction on the section it is travelling in. The main objective of the system is to prioritise the safety and comfort of users.

2.1.2.23 Tramway priority at intersections

On the occasion of the extension of the Vitoria-Gasteiz tramway to the University, the route of this extension has been equipped with all the necessary traffic light elements that ensure the sharing of the roadway between the vehicles and the tram.

Similarly, in León, in order to integrate the tram into the current infrastructure and guarantee correct operation with the rest of the modes of transport, the necessary equipment has been provided for the infrastructure along the entire route.

In this sense, the work carried out by Kapsch in both cities ensures that the tram is given priority at all the crossings it passes through the route of this extension by means of the following functions:

- Priority of passage for the tramway over the rest of the vehicles at each of the intersections it crosses, minimising the effect on traffic.
- Reliability in the event of failure, so that if one of the road signalling detectors fails and is not activated when the tram passes, the system has the necessary logic to trigger the priority of the tram at the crossing with the minimum possible delay.
- Monitoring of the tramway priority, being able to visualise in real time the situation of the detectors and regulators associated to the tramway crossing. This application allows the creation of reports and statistics for the control and improvement of the operation.

2.1.2.24 HOV-Bus Lanes

The aim of this type of lanes is to reduce traffic congestion at access points and exits from big cities. In fact, HOV-Bus lanes are usually physically separated from the rest of the lanes, with permanent barriers, and are usually reversible, in order to decongest traffic in the direction of the exit from the city, or at the access, as required..

As a general rule, and as is currently being implemented at national level, they will be able to run on one HOV-Bus lane:

- Vehicles with two or more occupants, including the driver.
- Two or three-wheeled motorcycles, cars, mixed vehicles (vans) and buses with more than 3.500 kg of MAM and articulated buses.
- These same vehicles only occupied by the driver when they carry the V-15 reduced mobility sign, are holders of a driving licence with some accredited physical limitation, two or three-wheel motorcycles, buses with more than 3.500 kg of MAM, vehicles with ZERO emissions label from the DGT, taxis and carsharing vehicles. The latter vehicles must carry the sign, which identifies them as car sharing, stuck on the upper left corner of the windshield.

- Vehicles with ECO, C and B labels when expressly indicated on the variable lane access signs. In this case they must be clearly identified by the sticker on the lower right-hand corner of the windshield or, if there is no sticker, in a visible place.
- Vehicles intended for public services such as police, fire brigade, civil protection, rescue teams, emergency health assistance and road maintenance employees.

At present, the DGC has BUS-VAO lanes on the central roadway of the A-6 road (kms. 6 to 20), in Madrid, which also functions as a reversible lane; on the left lanes in both directions of the GR-3211 road (kms. 0.115 to 1.410, increasing direction and 0.105 to 1.530, decreasing direction), in Granada. However, in the case of Madrid, the Ministry of Transport, Mobility and Urban Agenda is studying the possibility of implementing a new Bus-VAO lane on the A-5 and has definitively approved the projects for the implementation of this system on the A-2. The main characteristics of the Bus-VAO lane on the A-2 are that it seeks to provide the motorway with the necessary infrastructure to allow the exclusive use of the left lane for this purpose, through intelligent road management based on ITS systems.

Illustration 23. HOV-Bus lane in A-6 access. Source: DGT

To this end, no physical separation is foreseen between the reserved lane and the rest of the lanes of the road, but rather a user information system is planned using variable light signals, supported by fixed horizontal and vertical signs in advance, with the aim of indicating the status and situation of the reserved lane and its use with maximum coverage.

Along the central and left lane separation line, there will also be embedded luminous beacons flush with the road surface, which will indicate, in red, the sections in which it is not possible to access the reserved lane, and in green, the sections enabled for this purpose.

In addition, in order to alleviate possible traffic disruptions caused by the implementation of the Bus-VAO lane, the projects include specific actions to improve the existing infrastructure.

Finally, it must be mentioned that the traffic management of these Bus-VAO lanes is carried out by the DGT in coordination with the DGC. It should also be noted that the SCT has a lane of these characteristics on the C-58 between Cerdanyola and Meridiana in Barcelona.

2.1.2.25 Reversible lanes

Thanks to ITS equipment, a more efficient use of the particular scenarios regarding the direction of traffic and the use of roads, lanes and hard shoulders can be made in order to optimise the capacity of the road and improve the traffic flow. Some examples:

- HOV-Bus lanes (described in the previous section, which in turn can function as reversible).

- Reversible lanes: this is a version of the lanes in the opposite direction to the original one, but more oriented towards access to cities or completely urban areas. These lanes have the characteristic that they are enabled in one or the other direction according to the traffic needs. This is indicated by means of traffic lights or arrow panels on the lanes, the reversible lane and adjacent lanes, which inform drivers of the direction in which the traffic is moving. At ground level, the lane is distinguished by its characteristic road markings: a double dashed line on each side of the lane and the two-pointed arrows.

In Spain, in addition to the HOV-Bus lane on the A-6, which as indicated in the previous section also functions as a reversible lane, the following lanes stand out as well:

- The reversible lane of the V Centenario Bridge in Sevilla.
  In order to decide in which direction to open the reversible lane, the Traffic Management Centre Operators have telematic tools in which, every minute, they receive the traffic flow data - vehicles that want to cross the bridge in each direction, as well as their average traffic speed and the percentage difference in intensity per direction.

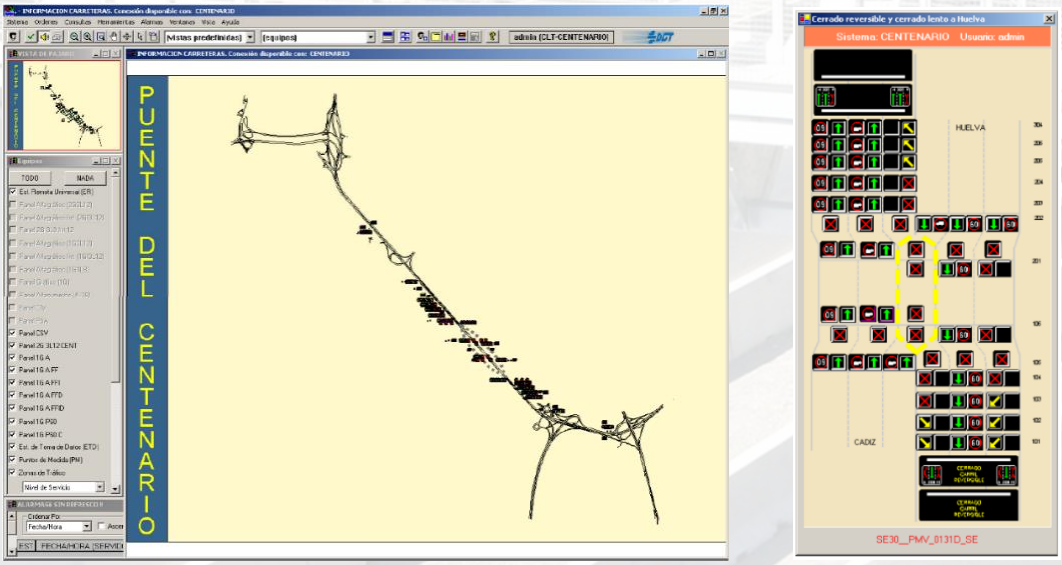

Illustration 24. Software used to manage the reversible lane on Sevilla's V Centenario Bridge. Source: DGT

However, in addition to the demand for passage over the V Centenario Bridge, the state of the traffic in the adjacent areas must be evaluated at all times, because for example, it would not be an appropriate management strategy to open the reversible lane in the direction of Huelva, even if there is more demand for passage in that direction, if 800 metres further on in the area of the Reina Sofía Bridge there is a traffic jam, as more vehicles would be brought into an area with traffic already stopped, increasing the length and severity of that traffic jam, with the consequent increase in the time taken for it to dissipate. Therefore, when operating the reversible lane, the situation on the bridge itself and on the rest of the SE-30 ring road must be considered.

It also means that at no time can a retention queue reach the reversible lane, so that vehicles stopped in the reversible lane, do not have the possibility of operating on it , so that for example, no vehicles can give way to ambulances or other emergency service vehicles if necessary, etc.

The change of direction of the reversible lane is made in approximately 100 seconds, which allows the configuration of the bridge to be quickly adapted to the needs of the traffic.

The main elements that make up the signalling system are:

- 96 Lane Signals: two signals per lane distributed in seven single gantries (covering the lanes in one direction), and four double gantries (covering the lanes in both directions).
- 244 Beacons: delimit the lane according to the direction of traffic.
- 7 Data Collection Stations: providing information on vehicles on the roads.
- 10 Universal Remote Stations: which manage the rest of the equipment.

Illustration 25. Reversible lane V Centenario Bridge. Source: DGT

- The reversible lane on the José León de Carranza Bridge in Cádiz.

The José León de Carranza Bridge is one of the main access points to the city of Cádiz, through the N-443 national road, and is also the direct access from the AP-4 motorway, which connects Cádiz with Sevilla.

This bridge was built in 1969 and until 2007, the roadway was made up of two lanes, one for each direction of traffic, which resulted in continuous retentions as a result of the low capacity offered by this route.

To alleviate this lack of infrastructure capacity during the hours of greatest traffic demand, an additional circumstantial lane with cones was installed on working days, which improved access but posed problems due to the time taken to install and collect the cones and because it was not possible to change the direction in which the additional circumstantial lane was installed quickly.

In July 2007, in coordination with the owner of the road, the Ministry of Transport, Mobility and Urban Agenda, a 1.450-metre long reversible lane was opened to traffic, operated from the Southwest Traffic Management Centre, with the aim of:

- Reducing traffic jams.
- To decrease the length of traffic jams if they occur.
- To have a greater control of the access routes/points to Cádiz.
- To increase the capacity of the José León de Carranza Bridge.
- To improve traffic efficiency.
- To increase the security of the users of this access.
- Reducing the volume of pollution produced during the circulation and retention of vehicles.

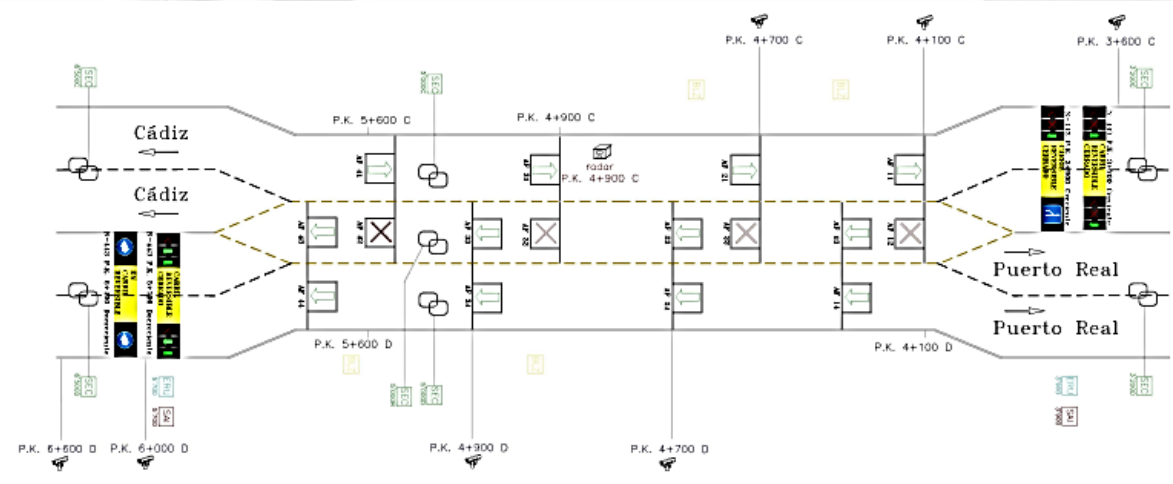

Illustration 26. Sketch of the equipment installed for the management of the reversible lane on the Carranza Bridge. Source: DGT

This reversible lane allows a more dynamic and flexible management of infrastructure capacity, adapted to the needs of traffic almost immediately, and is the result of the logical evolution of the infrastructure, whose capacity is optimised and used much more efficiently.
The main elements that make up the signalling system are

- 4 variable signposts (VMS): 2 in the direction of Cádiz and 2 in the direction of Puerto Real.
- 16 arrow-cross signs: 4 arrow-cross signs in the direction of Cádiz, 4 arrow-cross signs in the direction of Puerto Real and 8 in the reversible lane.
- 562 LED technology beacons embedded in the pavement forming two lines and divided into 4 circuits.
- 6 universal remote stations.
- 4 beacon control equipment.
- 6 television cameras on the bridge's gantries and three on the bridge's access points that allow the bridge's entrances to be monitored in both directions of traffic.
- 6 Aluminium gantries, which can be visited.
- 2 Aluminium banners, also accessible.
- 2 Data Collection Stations in the reversible lane.

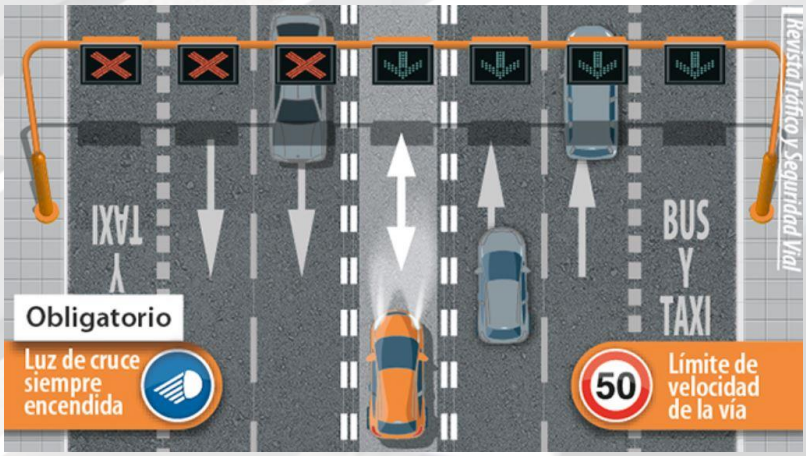

Illustration 27. Operation of a reversible lane. Source: DGT Magazine

2.1.2.26 Access management in the Covadonga Lakes

The General Directorate for Traffic, at the request of the Department of Infrastructure, Land Management and Environment of the Government of the Principality of Asturias and with the collaboration of the Picos de Europa National Park and the City Council of Cangas de Onís, has implemented a management and control system for access to the Covadonga Lakes.

With the measures adopted and the execution of the project, it is intended to avoid situations of collapse and road risk in the National Park and its access roads, to improve the environmental quality of the Picos de Europa National Park, and to allow a better management of the natural areas and the tourist attractions of the surrounding area.

Road safety is improved, as the risk of being run over or having an accident on the access roads is reduced as motor vehicles and mopeds are not allowed to pass continuously. On 6th, 7th, 8th and 9th of December 2018 the automatic management system was tested. Access is limited by a barrier, which allows access to authorized vehicles. A web application has been developed by DGT so that the agents involved can register authorised number plates (similar to access management systems in historic city centres) and allows authorised vehicles access to the Covadonga Lakes.

The barrier is an automatic industrial lifting barrier, folding for the passage of vehicles. The barrier has a double red light and an acoustic alarm on the frame. It is located next to the access roundabout, so that it leaves enough space for a bus to wait for passage without interrupting traffic on the roundabout.

In the same way, so that the user who decides to visit the Lakes during these days has updated information on the regulation and the occupation of the parking lots, variable message signs have been arranged for information, both at the accesses to Cangas de Onís, as well as on the AS-114 from Benia de Onís and on the AS-262 road.

Operational control is carried out in the field by the Picos de Europa Park and authority agents, with telematic support from the DGT's North Traffic Management Centre, with the capacity to activate and display the signalling on the VMS. For this purpose, the system has 5 video surveillance cameras located in each of the parking lots enabled, as well as in the CO-4 access roundabout.

Illustration 28. Access management in the Covadonga Lakes. Sources: DGT and Fixalia

2.1.2.27 Geolocation of vertical and horizontal signs

The City Council of Sevilla has developed a project whose objective is to geolocate all the vertical and horizontal signalling elements of the city.

This not only facilitates inventory management and preventive maintenance of all the city's sign posts, but also helps with the creation of value-added applications that use this information to share it with vehicles in movement, both in real time and pre-trip, in addition to having the information on speed limits, turning bans, permitted directions, and everything related to the vertical signs of the city, it facilitates the location of vehicle spaces for people with reduced mobility, freight vehicle spaces, or regulated on-street parking areas.

2.1.2.28 Variable Message Signs Network

The installation of variable message signs begun its deployment in the city of Sevilla at the end of 2018 with the aim of presenting information on traffic incidents (congestion, accidents, blocked-off streets, etc.), information on parking space availability and information of interest to road users.

The network of signs is managed by a software developed ad hoc, integrated with the Traffic Information System SIT3 of the General Directorate of Mobility of the City of Sevilla.

The information published regarding the availability of rotating parking spaces is done automatically. On the other hand, traffic status information is published semi-automatically, once it has been submitted to the judgment of the Mobility Management Centre operator. Finally, the information on street closures and/or incidents/accidents on the road is published manually by the Mobility Management Centre.

Illustration 29. VMS in the urban environment of Sevilla. Source: Sevilla City Council

The panels are high luminosity LED (RGB) type with a resolution of 160x80 pixels (LxA), a viewing area of 1600x800 mm (LxA), and a viewing angle of 150º-200º.

Currently 36 units have been installed. By the end of 2020 there will be 47 panels in total.

2.1.2.29 Mobility applications

In order to provide real time information related to the occupation of the parking lots, as well as the transmission of the existing CCTV cameras in the urban environment of the city of Sevilla, the city council has implemented an App for the use of smartphones, both iOS and ANDROID operating systems, where the following information is available:

- Location of the parking lots.
- Occupancy levels, description and additional information about the car parks.
- Option to navigate to the selected parking garage.
- Location of all the CCTV city council cameras available.
- Selection and visualisation of the CCTV cameras.

Illustration 30. Application for the Level of Occupancy of Public Parking Lots and Traffic Status. Source: Sevilla City Council

On the other hand, the RACC has developed a mobile application called B2C Infotransit that provides the user with traffic information, car parks (location, capacity, timetable and rates), location of radars, cameras (real time update) and petrol stations (supplier and prices) for the whole territory of Spain.

Illustration 31. Infotransit-RACC. Source: RACC

Since 2017, Infotransit has incorporated the following services:

- Location and availability of park and ride spaces for the metropolitan areas of Madrid and Barcelona in order to facilitate a more sustainable intermodality.
- Wrong-way functionality by which the user is sonorously informed if he/she is near another driver (within a 10 km radius) driving in a prohibited direction on a motorway or expressway or if by mistake the user has entered a prohibited direction on a motorway or expressway. This is an integration of the Bosch Wrong Way Driver Warning Service. It works throughout Spain. Its aim is to increase road safety by reducing frontal crashes.

There is another RACC application whose area of application is the city of Barcelona, the C-MobILE project (Accelerating C-ITS Mobility Innovation and Deployment in Europe), co-financed by the European Union, whose objective is to improve the safety and efficiency of driving on the roads. All this, using each user's favourite navigation application (Google Maps, Waze, MAPS.ME, etc.). C-MobILE will display warnings above these applications only when necessary.

Illustration 32. C-MobILE project logo. Source: C-MobILE

At present, the C-ITS services deployed are the following:

- Congestion
- Bicycle/Motorcycle presence notification
- Accidents
- Emergency vehicles
- Status of reversible lanes
- Road works
- Traffic Panels

2.1.2.30 Traffic light control plans

A project is currently underway to share the traffic control information (cycle, distribution and lag) of the 527 intersections controlled from the Mobility Management Centre of the Sevilla city council. More than 5.000 movements allowed for vehicles and 1.500 pedestrian crossings are controlled from these junctions.

The objective is to store in the cloud the current status of the colours presented at the traffic lights, so that any operator can develop value-added APPs to assist driving in the city of Sevilla. For example, countdown to know the estimated waiting time at a given traffic light or the estimated travel time in combination with traffic status information.

2.1.2.31 Deployment of the Spatial Data infrastructure for traffic information

The General Directorate for Mobility of the Sevilla city council has pioneered the intensive use of the Spatial Data Infrastructure of the Sevilla city council's Urban Planning Department. This platform is currently available:

- Map of geolocated information related to the traffic light installation of Sevilla: ducts, manholes, posts, vehicle traffic lights, pedestrian traffic lights, connections. This information, accessible via web, is available to all the technicians related to the Maintenance Contract of the traffic light network of Sevilla, municipal technicians or the company awarded the maintenance. Furthermore, this information is of vital importance when guaranteeing the integrity of the traffic control installation in view of the forecast of works on the road.
- Information map of traffic signal concealment, basically by tree line. This platform is shared with the Parks and Gardens Department and has become a basic element of information and coordination for pruning operations.
- Real-time traffic status maps and images from traffic cameras.
- Location map of free spaces in rotating car parks.
- Maps of the road hierarchy and other mobility studies.
- Map of location of acoustic traffic lights for blind people, in continuous monitoring with ONCE.
- Maps of preventive plans of the traffic light installation.

All the information is presented in web format, with all the functions related to the management of maps and the classic database consultation operations, facilitating the preparation of data analysis.

2.1.2.32 Control of Heavy Traffic on Seville's Ronda Urbana Norte

The Ronda Urbana Norte (RUN), registers the highest ADT of the urban road network of Sevilla with more than 70.000 vehicles per day. The road completes the SE-30 in the northern zone, although within the urban area, so the type of vehicle that runs on it is very varied, local or interprovincial, from cars to high-tonnage goods.

The proposed system seeks to detect the misuse of the RUN by units exceeding the Maximum Authorised Mass (MAM). The system combines two types of technology, both based on image processing.

The processing sequence is:

- Exclude light traffic by analysing the size of the vehicle by image processing.
- Once the screening is done, the license plates of vehicles of a certain length are recognised.
- Contrast the license plate with the data of the General Directorate for Traffic.
- If the vehicle is not allowed to pass through the RUN, automatically issue the proposal for a penalty if it exceeds the maximum authorised mass established.

The system consists of two components: intelligent cameras distributed along the Ronda Urbana Norte and an information processing unit located in the Mobility Management Centre.

2.1.2.33 Measurement of traffic quality in the urban area of Sevilla and traffic light coordination

The city council of Sevilla has developed an engineering support system, which allows the monitoring of the different green waves in the city.

The system allows:

- The modification in real time of the regulation and coordination parameters (cycle, distribution and lag) of the different green waves defined in the city's roads. This constitutes in itself a tool for traffic control.
- Knowing the green waves both at the present time, and for any time or type of day.
- Knowing the average speeds registered between crossings, which helps to determine slow stretches and thus a possible improvement in coordination.
- To know the location of the stops of the different routes made with a floating vehicle, and in this way to know the size of the queue on arrival at the traffic lights..
- To save in the traffic information system SIT3, the new revised green waves, with the idea that they become part of the daily traffic light regulation and coordination plans.

2.1.2.34 Exploitation Support Systems of the public transport company TUSSAM

The municipal transport company of Sevilla has had an ESS system for decades. In this last period the system has been renewed, improving the geolocation of its units thanks to the new potential of communication technologies.

This circumstance, in addition to helping to optimise the management of the bus fleet at its control centre, has enabled a substantial improvement in user information:

- Information screens installed in the bus shelters, indicating waiting times.

- Availability of a powerful APP with all the relevant information to help design the trip: position and travel time, route planning.
- Accurate and timely information on its web platform.

2.1.2.35 SITUAME

This is a comprehensive platform for urban mobility that allows users to access all the information needed to move around the borough of El Ejido by bus. Among the main characteristics of this project, it is possible to highlight the following:

- The computer application that allows the traveller, from his/her mobile device, to consult all the information of the urban transport service of buses of the borough, lines, stops, timetables, routes, etc., in a more comfortable and fast way and in real time. And even plan journeys, choose the stops that best suit their needs and receive and generate warnings about service incidents.
- The scope of action, which covers the entire municipality of El Ejido.
- The number of users of the application, which has been 642 daily consultations (COVID-19 pre-alarm) and 298 daily consultations (during the alarm) The number of active installations is 1.243.

The main functionalities of the platform are:

- To receive and generate real-time alerts on known incidents on each line, in chronological order.
- It allows to consult the schedules and order of stops by line.
- It provides a visual representation of the routes of each line and the stops closest to it, according to their location.
- It informs about the current situation of the bus online.
- It shows the approximate waiting time for the selected line and stop.
- The succeeding arrival times can be consulted.
- It shows the price list for each route and trip. Discounts and services, as well as the points where they can be acquired and the necessary documentation.
- Allows citizens to report incidents caused by delays in the bus transport service.

2.1.2.36 Transforming Transport

The objective of the Transforming Transport project (2017-2019), developed by Indra, is to apply Big Data and artificial intelligence technologies to improve transport efficiency. Among the pilots developed, Indra deployed a pilot in the AP7 - N340 corridor to predict the traffic condition at 15, 30, 60 and 120 minutes to improve the management of both roads. Data from the DGT, the concessionaire (AUSOL) and vehicle data (TomTom) were integrated and processed. The project was chosen as the best European success story and was awarded the Rafael del Pino Foundation and Paco Mundial prize for its contribution to the ODS. The project has a total budget of 18M euros. It is co-financed by the European Commission and includes 12 other similar pilots in other areas of Europe.

2.1.2.37 On-demand public transport

Several local councils in Spain have developed public transport services on demand to reach places where the population is widely dispersed.

The city council of Lleida has implemented this service provided by taxis in the area of La Huerta, since the cost of getting there with conventional public transport is high. Moreover, there are certain points in the area where it is not possible to get there by bus. A transport solution on demand has been devised with predefined stops and pre-established routes. The service is only activated in case of requests. To request this service, the interested user must make a phone call the day before the day he/she wants to travel. The payment method is done through an App. This service is carried out as a complementary activity through the company that provides the urban collective transport service with buses. The service is currently on a trial period.

On the other hand, some years ago San Sebastian city council started the Ulia Taxibus service, whose service must be booked at least 30 minutes and a maximum of 7 days in advance, by completing an application or booking form. The payment system is the same as for other Dbus services, who provides this service (MUGI card, San Sebastian Card, Basque Card, cash, etc.).

Additionally, this same city council implemented in 2018 a system of on-demand stops for women and people under 18 on a night line and in 2019 extended this system to all night lines in the network. The system can be requested on certain sections of the route between official stops.

2.1.2.38 Pide tu Bus -Order Your Bus-

"Pide tu Bus" is the first "Stop on Demand" bus service via smartphone in the Community of Madrid. It was launched in 2015 at a stop in the borough of Valdemorillo.

"Pide tu Bus" users inform the buses that they are waiting at the stop to be picked up. To do this, they can scan a QR code or send an SMS, which will alert the drivers of the vehicles of the need to stop at that point, and in turn the system informs users of the waiting time for the service to arrive.

In this way, to the 20 daily services on line 641 (Valdemorillo - Moncloa) that this stop has, another 25 dispatches should be considered additionally associated with line 642 (Colmenar de Arroyo -Madrid), significantly increasing the transport offer for users in this area.

2.1.2.39 Technological update of the City of Palencia

The project of technological update of the city of Palencia, endowed with Edusi funds, is based on the implantation of an integral system of management of the mobility (Ecotrafix of the company Kapsch) and incorporates the priority of buses to the urban traffic, extension of the system of CCTV and the implantation of an automatic system of control of the access of vehicles to the historical center of the city of Palencia based on automatic reading of license plates allowing to realise a suitable policy of management of the mobility.

2.1.2.40 Automatic vehicle access control system in Bilbao's Old Town

The automatic access control system allows the regulation of the traffic that accesses the controlled area by defining entrances and exits allowing an adequate policy of mobility management. To this end, control points are established to monitor access and apply different mobility policies depending on the user profiles identified.

The project includes the installation of 30 cameras in the perimeter of the Ribera, in addition to other access points such as Esperanza, Askao, Prim, Ronda or Iturribide. In addition, the Kapsch - Etra Norte joint venture will install 12 additional control points in the surroundings of Ledesma, Ercilla, Indautxu and Martzana streets. The system will detect not only the access and exit of vehicles but will also record the time spent in the area, as well as unauthorised journeys. In the event that any infringement is committed, it will be recorded in the system and reported to the Municipal Police for subsequent processing of the sanction.

Residents, shopkeepers and hoteliers will be authorised to pass through to facilitate loading and unloading, transporters, public services and hotels may request temporary authorisations for their guests. Users will have an APP to facilitate management.

On a software level, Kapsch will provide its solution for the Control Centre as well as the APP from which users will be able to communicate in an agile and simple way, with the operators of the system and with the city council itself.

2.1.2.41 Pilot project for the development of Bilbao O/D Matrices

The pilot project consists of drawing up the origin-destination matrix for vehicle trips in a certain area of the city of Bilbao based on information provided by municipal data sources.

The O/D matrices are matrices that show the number of trips that leave each origin and arrive at each destination. The origin/destination matrices have traditionally been the resource used to optimise the use of urban and interurban infrastructures.

Until now, obtaining the necessary information for the preparation of these O/D matrices has involved carrying out surveys directly with citizens, and subsequently carrying out costly statistical studies, which finally provided biased information, normally of an annual or biannual nature. With new sensor technologies, these matrices can now be calculated accurately and less expensively. Using them, O/D matrices can be made dynamically and adapted to the needs of each mobility manager. Obtaining O/D matrices on a daily basis and even by time slots is a real possibility that will allow an efficient management of mobility and public transport infrastructures with the aim of achieving an adequate and orderly urban planning.

Within the pilot project, Kapsch will carry out the following activities:

- Collect the AVI information available at the city council, guaranteeing privacy:
  - Preferably, Wifi access points.
  - In exceptional circumstances, and only if the Wifi information is not usable: additional sensors (like LPR already installed).
- Develop a module to process this information in order to calculate and visualise (in maps and tables) the historical demand (in the form of O/D matrices and scattering trails) between different origins and destinations (detectors or zones).
- Analyse the possibility of discriminating information by:
  - Pedestrians and vehicles.
  - Means of transport (private vehicles, public transport, cyclists, ...).
- Deploy and validate the developed system.
- Compare the results of the pilot and the O/D matrices previously calculated by the city council.

2.1.2.42 Passenger information systems

The company Dbus, in charge of managing urban public transport in the city of San Sebastian, launched a new version of its mobile application in 2017 and is currently working on a new update to provide users with all the necessary and high-quality information. With regard to the information panels located at street level, the number of these has increased over the years to 114 panels at present. In addition, in 2019 the first two solar-powered information panels were installed as part of the European E-MOBASK project. Within the framework of this same project, the next stop warning system inside the buses has been improved by including audio and image in English and French at the main stops of the Dbus network in order to improve the information offered to people visiting the city. Also, during these years, the improvement work on the website and social networks has continued.

On the other hand, the Sant Boi de Llobregat city council, through the M7 application, informs all citizens registered in the application about the street cuts scheduled in the borough. As an indicator, the number of readings of this information appears on the application.

2.1.2.43 DGTuit

One of the most widely used communication channels worldwide is the social network Twitter. This network provides information in a fast and concise way, so the DGT takes advantage of this channel to be able to alert and recommend users.

The DGT has organised the use of 2 accounts:

- @InformacionDGT: only with traffic information It has 312.000 followers.
- @DGTes: information of all kinds related to the world of the DGT. It has 138.000 followers.

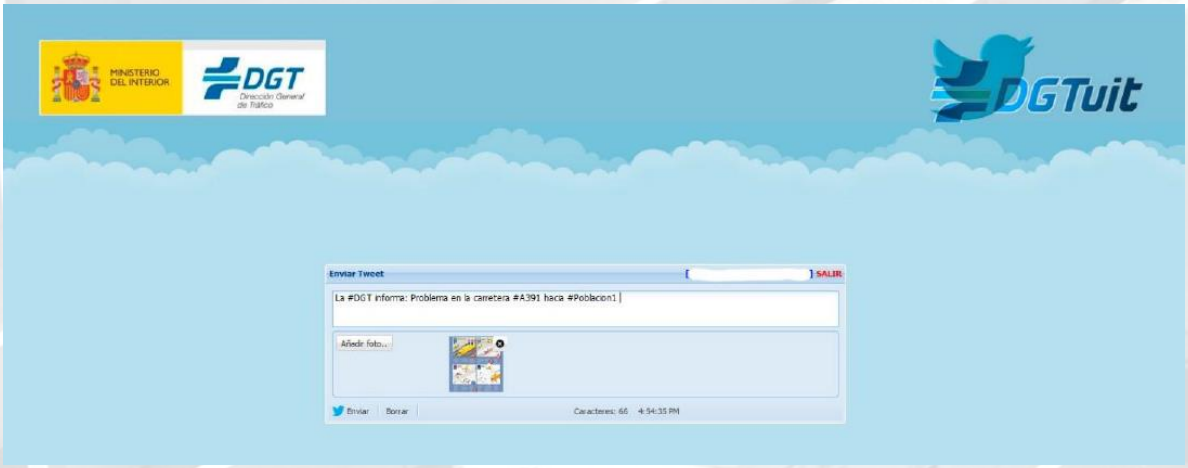

Illustration 33. Application DGTuit. Source: DGT

In order to keep both accounts updated in real time, the DGT has an automatic mechanism that generates a tweet for most of the traffic incidents on @InformacionDGT and only for those cases that are especially serious on @DGTes.

In addition to this automatic mechanism, traffic managers have the possibility of publishing tweets to inform in a more personalised way of any type of problem or recommendation that they wish to give to improve the traffic situation.

Illustration 34. Official profile of the General Directorate for Traffic on Twitter. Source: Twitter

2.1.2.44 Twitter of Trafikoa

Similarly, to the previous section, the Basque Government's Traffic Department also uses the social network Twitter to provide traffic and road safety information to users of the roads under its jurisdiction.

Illustration 35. Official profile of the Traffic Department. Eusko Jaurlaritza - Basque Government Source: Twitter

2.1.2.45 Twitter of the Servei Català de Trànsit

In line with the previous sections, the Servei Català de Trànsit has a generic Twitter account with over 220.000 followers as well as 35 automatic accounts corresponding to information on 35 main road axes.

Illustration 36 Official profile of the SCT in Twitter. Source: Twitter

2.1.2.46 System to help disseminate traffic information via Twitter

In 2018 and 2019, a system has been developed to assist in the dissemination of information that allows traffic status information to be integrated with the Twitter account @Trafico_Sevilla. Currently, this account is followed by more than 15.000 users, with an average rate of 1.000 tweets sent per month.

The system helps the operator of the Mobility Management Centre of the Sevilla city council to make traffic tweets, proposing text and images according to a pre-established calendar and schedule.

Illustration 37. Official channel specialised in traffic information of Sevilla in Twitter. Source: Twitter

In this last period, the Basque Government's Traffic Department has developed a mobile application that provides information related to traffic on the move, such as accidents, road works, incidents, traffic jams, winter road conditions in mountain passes, radars, webcams, traffic restrictions, etc.

Illustration 38. Mobile App of the Traffic Directorate- Basque Government. Source: Traffic Directorate- Basque Government

2.1.2.47 Predictive Analytics Module (PAM)

With a duration of one (1) year and having started in 2019, in Valladolid, two pilot projects have been implemented, one in the interurban area with the DGT and the other in the urban area with the Valladolid city council consisting of a traffic prediction system: ETX - Predictive Analytics Module (PAM).

These projects consist of the automatic generation of traffic models and patterns, as well as the real-time prediction of parameters based on time series of data. Using various Artificial Intelligence technologies, such as Machine Learning and Decision Trees, Kapsch has developed the Predictive Analytics module which allows traffic to be modelled on the basis of processed historical data and to generate patterns that enable predictions to be made, in the long and short term, of the evolution of certain parameters.

The module also allows the automatic generation of alarms based on both data processed in real time and 15 or 30 minute predictions. These alarms allow to trigger one or several action plans adapted to minimise the impact of the detected alarm.

2.1.2.48 Study of travellers' demand in Corridors

Spain, through MITMA (INECO), has developed a system to determine the mobility of travellers in different corridors:

- The Mediterranean Corridor, from Algeciras to the French border,
- The Madrid - Segovia Corridor
- The Madrid - Cuenca Corridor

Thanks to big data processing techniques of geolocalised and anonymised mobile phone data and its fusion with other data sources the system allows to obtain the following:

- Source/destination matrices of trips by mode of transport.
- Segmentation by travel purpose.
- Segmentation by place of residence.
- Segmentation by age groups.

In addition, a transport model is being developed, fed with information from the origin/destination matrices, for the prognosis of demand at different time horizons and of future infrastructures.

2.1.2.49 Anti-Fog protection system on the A-8 motorway

At the end of 2019, the Ministry of Transport, Mobility and Urban Agenda awarded the contracts for pre-commercial public procurement to define the anti-fog protection system on the A-8 motorway, with the aim of addressing the design, construction and experimentation with prototypes of innovative solutions to avoid fog problems in a test section.

The contracts have been awarded to seven companies, three in Lot 1, for the development of innovative solutions based on systems to assist driving in foggy situations, and four in Lot 2, for the development of innovative solutions based on systems that act on the fog by isolating, eliminating or displacing it.

Illustration 39. Anti-fog system on the A-8 motorway. Source: DGT

The three proposals corresponding to Lot 1 consist of:

- A system of roadside marking with laser light.
- A horizontal signalling system with LED technology projected onto the road.
- A system based on the use of intelligent beacons.

In the case of the four proposals for Lot 2, these are based on:

- An automatic sprinkler system for hygroscopic materials.
- Variable porosity aerodynamic wind barriers.
- Domed concrete structures on each roadway with side openings along its entire length.
- The combination of static and dynamic barriers using fluid-mechanical devices.

In this way, the Ministry of Transport, Mobility and Urban Agenda will tackle the design, construction and experimentation with prototypes of innovative solutions to combat fog, in a test section attached to the section of the A-8 motorway between Mondoñedo and A Xesta, with the aim of validating their future implementation on the road to minimise the adverse effects produced on traffic by dense fog.

The pre-commercial public purchase will be carried out in competition by temporary phases with the objective of elimination. In this way, the best solutions will be progressively selected in order to solve the existing problems.

To this end, the following temporary phases are contemplated:

- Phase 1 to demonstrate the suitability of the proposed solutions.
- Phase 2 of construction and field experimentation on a real scale with the 4 selected prototypes, in order to verify the correct functioning of the theoretical developments in a real environment in the foggy conditions characteristic of the section of the A-8 between Mondoñedo and A Xesta.

Once the technology tested has been validated/approved, a conventional contract will be awarded for the construction of the anti-fog systems selected to solve the existing problems.

The pre-commercial public procurement is co-financed in 80% through the Innocompra Program of the Ministry of Science, Innovation and Universities, through the European Regional Development Fund 2014-2020.

2.1.2.50 Automated detour on A-8 motorway due to adverse weather conditions

The DGT has implemented an automated traffic detour in adverse weather conditions on the A-8 motorway. This motorway has a very problematic area that is located in the western part of the layout, crossing the area of Mondoñedo (Galicia), specifically between kilometre points 545+680 and 549+680 (known as the upper part of O Fiouco).

The main problem in this area is reduced visibility. The constant airflow originating from the Cantabrian Sea, rises the moist air over the mountains towards the highest point of the highway (±700 m), generating lasting fog in anticyclonic conditions.

Since its opening in February 2014, numerous episodes of intense fog have taken place in the area, causing major multiple collisions.

In order to avoid these events, and in particular after the most serious accident (26 July 2014) involving almost 40 vehicles, a specific action protocol was drawn up to apply speed restrictions or even close the road depending on the visibility levels. .

This protocol establishes four ranges of visibility consistent with the Spanish Levels of Service (LOS). A speed restriction is set for each level, with the aim of preventing risk situations and ensuring road safety. Currently there is also a protocol associated with wind service levels.

Below is a table with the parameters associated with the different levels and the restrictions applied in each case.

Table 58. Levels of Service and restrictions applied in adverse foggy weather conditions. Source: DGT

LOS	VISIBILITY RANGE (m)	VMS MESSAGE	SIGNALLING
ADEQUATE	250 < Visibility < 120	With fog moderate your speed	
CONDITIONED	120 < Visibility < 65	Speed restriction 80 km/h	
ADVERSE	65 < Visibility < 40	Speed restriction 60 km/h	
IMPASSABLE	Visibility < 40	Road closed	

Before the implementation of the automatic detour, and when the worst level was reached (visibility less than 40 meters), the detour was done manually. The main inconvenience of this methodology was the risk to users until the road closure was effective. The average time between the detection of the event and the execution of the detour was approximately one hour, so it was clear that something more sophisticated was needed to reduce this time and ensure the safety of the users.

For the implementation of the automatic detour, it was necessary to install multiple ITS devices (variable message signs, beacons, cameras, traffic lights, etc.) to inform and detect in real time all the actions being carried out on the road. The following scheme summarises the operation in case of road closure:

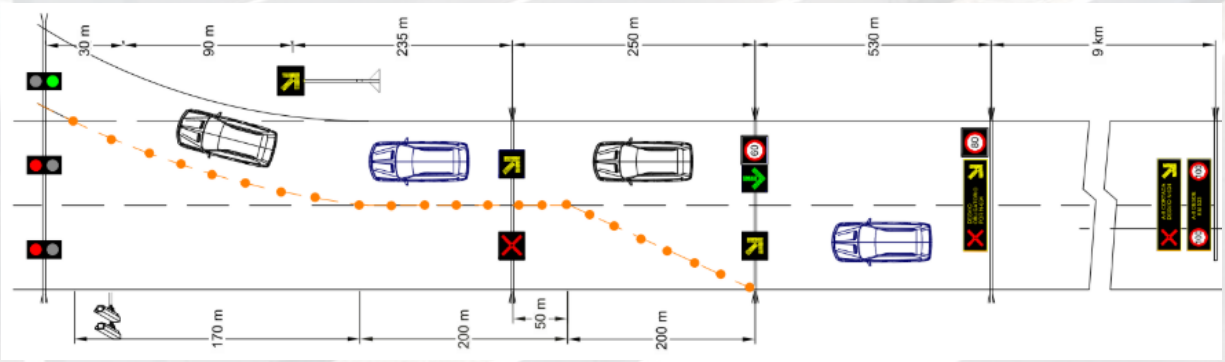

Illustration 40. Automated A-8 detour scheme. Source: DGT

From its implementation until today, different times have been monitored (visibility detection, scenario signalling, closure execution, etc.). These times have been used for multiple analyses within the framework of the EU EIP project, specifically in sub activity 4.1 "Determining quality of European ITS services" with the aim of defining the quality of the information or the data provided to users, as well as the analysis and search for the optimum quality scenario (equipment investment vs. quality of service provided).

The conclusions drawn from these data quality studies are very revealing since, through a simple time measurement analysis, it is possible to evaluate the level of quality of the information provided to users in a very simple way. As a result of this analysis it is possible to detect the weak points in the information chain and thus be able to act on them and provide a higher quality service for users.

Table 59. Limit values for the various quality levels associated with the "timeliness start" parameter. Source: DGT

PARAMETER	BASIC *	ENHANCED **	ADVANCED ***	****
Timeliness start	-	< 10 minutes	< 5 minutes	< 3 minutes

*Timeliness start: time from when the weather station notifies a change in visibility that causes a change in service level until the operators accept that level of visibility and execute a signalling change in the VMS

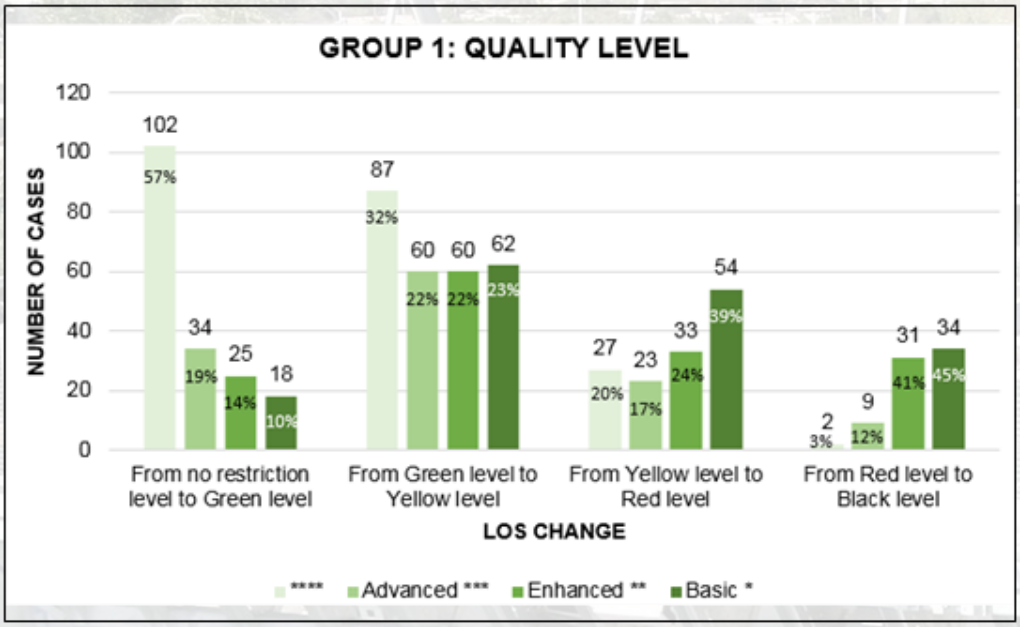

Illustration 41. Classification of number of cases by change of LOS and associated quality level. Source: DGT

2.1.2.51 Detection beacons for the improvement of road safety in adverse fog conditions

Linked to the previous project, in December 2016 the automated detour was put into operation, which optimised the opening and closing times of the A-8 motorway, going from manual to automated, notably reducing the number of closing hours in periods of visibility above 40 metres.

During the first year of operation of the automated detour, the efficiency of use was increased to 80%, doubling the efficiency as can be seen in the attached graph.

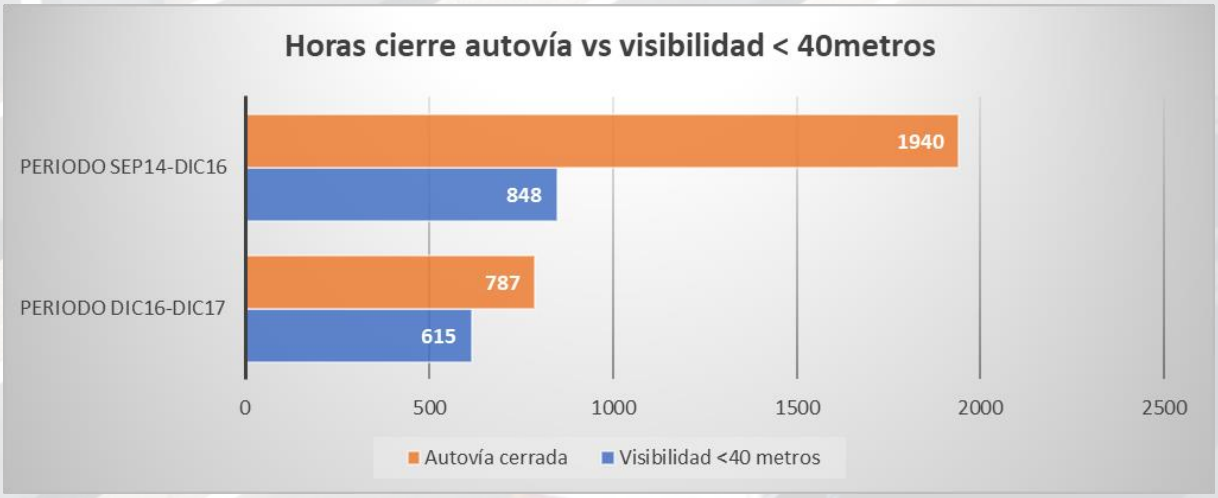

Illustration 42. Hourly chart for motorway closure vs visibility < 40 meters. Source: DGT

Analysing the visibility records in the last three years and in order to have the A-8 motorway operating more hours a year in safety conditions and to minimise the cut-off hours, it was thought to lower the cut-off visibility distance from 40 meters (distance obtained from the stop distance graph of the road layout regulation) to 30 meters, for which it was necessary to provide a system for guiding and warning other road users of the vehicles circulating on the mentioned stretch: the detector beacon system.

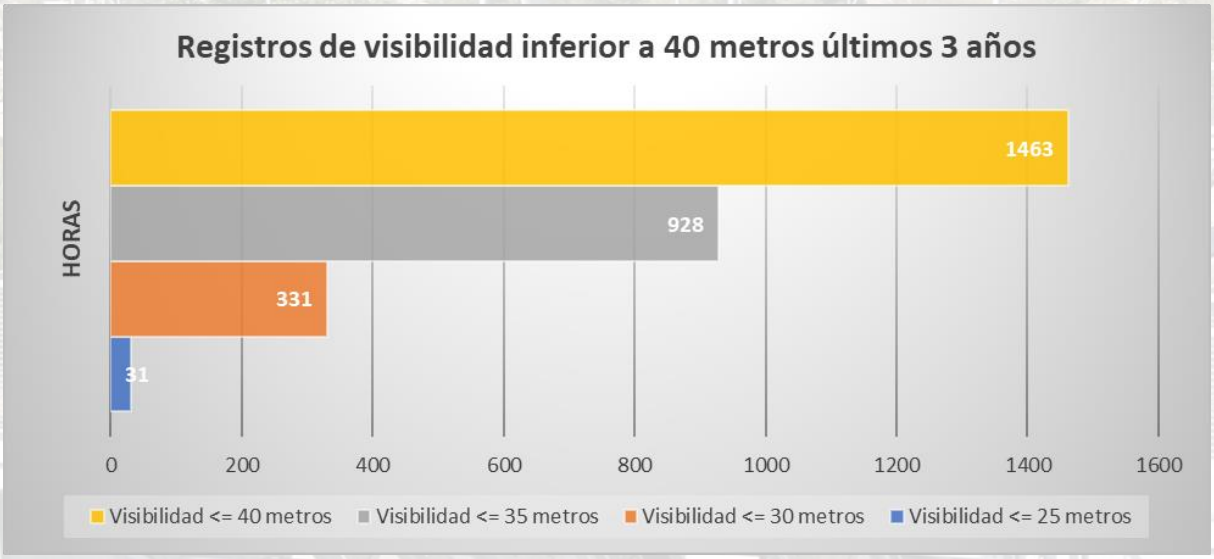

Illustration 43. Records of visibility less than 40 years in the last 3 years. Source: DGT

The action consists of installing a system of beacons equipped with vehicle detection and warning sensors in both directions on the section between the KP 545+500 and KP 549+500 of the A-8 motorway. Each beacon has two LED windows, amber and red, with brightness control. The amber LED window is used in conventional guidance mode and the red LED window is activated when the passage of a vehicle is detected in any visibility situation, as shown in the image below.

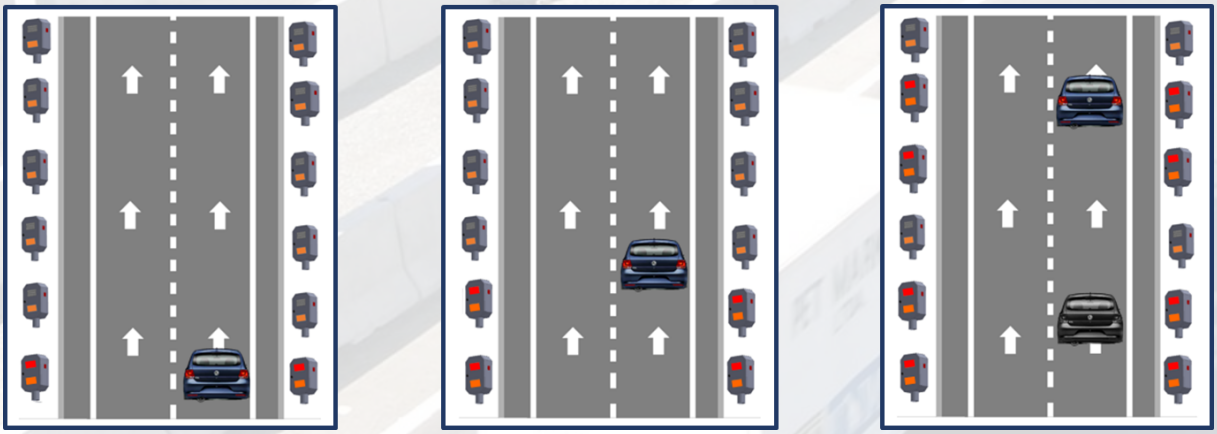

Illustration 44. Operation scheme of the detector beacon system. Source: DGT

In addition to the main functionality that is to detect and alert the vehicles, the beacon records the number of vehicles that have passed, so through specific software it is possible to make a continuous check of correlation of vehicles between beacons alerting of possible incidents.

The pairs of beacons are installed parallel to the roadway margins every approximately 50 metres on a 150 cm high post anchored to a concrete foundation.

Illustration 45. Beacon installed on the A-8 motorway. Source: DGT

2.1.2.52 Fog detection system and implementation of motorway cut-off protocol in case of poor visibility

Between November and February, it is common for the motorway communication channels to report episodes of intense fog on the AP-2 (Zaragoza - Mediterranean), especially on the Castelldans section (from kilometre 150 to 161, in the province of Lleida), which, depending on the traffic flow, makes it difficult for drivers to see, affecting road safety.

In order to manage the road traffic during these episodes, the Road Safety and Operations Centre (COPSV- Centro de Operaciones y Seguridad Vial) in Granollers monitors the warnings issued by official bodies, they have a meteorological service that makes a specific forecast for each section of the motorways and also has visibility meters in this area to monitor the evolution of fog intensity in real time, which provide objective information on the maximum distance that a driver can see when passing through the section. The team on the motorway that travel along this route also ensure the good condition of the road and help to detect and report on these situations.

2.1.2.53 Automated detours in singular infrastructures

Similarly, to the automated detour described in previous sections, and in view of the possibility of incidents occurring in singular infrastructures, such as tunnels, bridges or viaducts, an intelligent detour system using ITS technology has been proposed for this type of scenario.

As each scenario is completely different, it is not possible to define a specific standard scheme for this type of infrastructure as the proposals are adapted to the scenarios in which the service is to be applied.

An example of this type of detour is the system implemented in the “Puente de los Santos”, on the border between Galicia and Asturias. In this infrastructure, high wind speeds are frequently recorded, making the movement of heavy vehicles difficult and dangerous. In a similar way to the automated detour due to adverse weather conditions caused by fog in O Fiouco, in this case LOS are also defined associated with wind speeds which, in the event of being exceeded, lead to both speed and traffic restrictions.

Depending on the wind speed registered by an anemometer installed on the bridge, different speed restrictions are signalled on the VMS. If the wind speed is very high, the deviation is directly indicated by the alternative route highlighted in orange in the following illustration. If the wind allows traffic, the speed restriction to be applied is indicated on the VMS, which will be monitored by the radars located at the accesses to the bridge.

The scheme associated with this system is shown below:

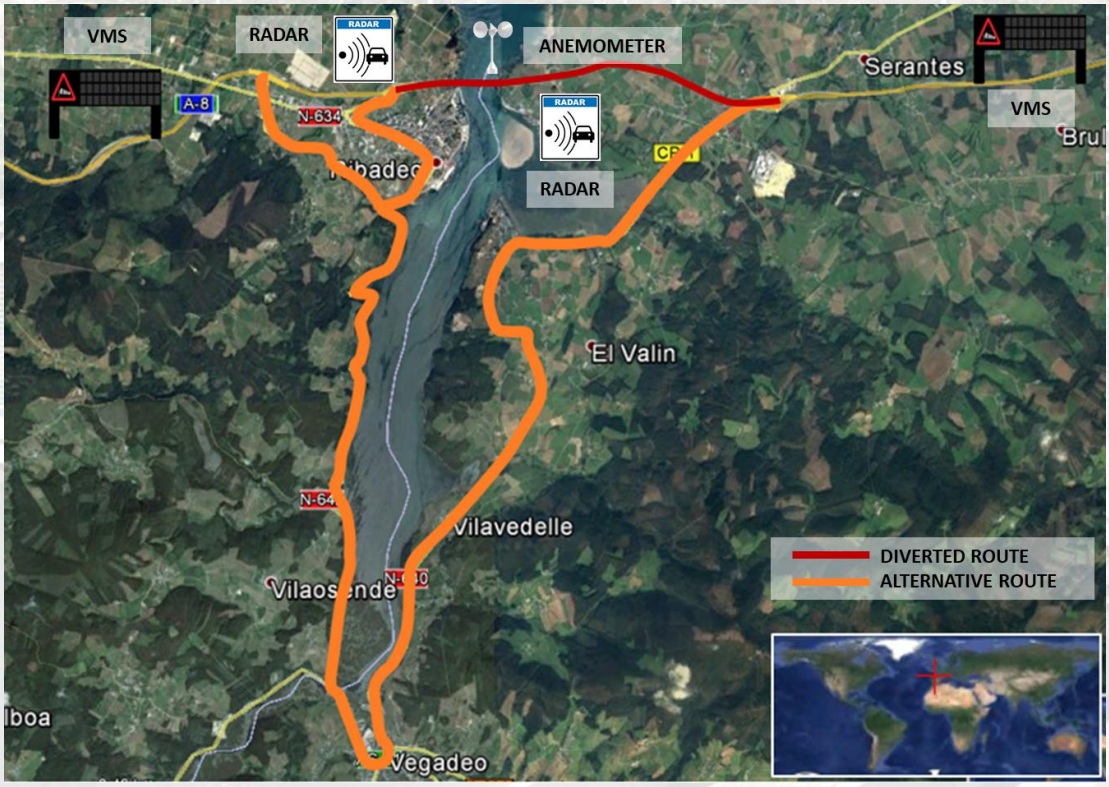

Illustration 46. Automated detour scheme for the Puente de los Santos. Source: DGT

2.1.2.54 Automated detours for emergency parking areas

It is common for adverse weather conditions such as heavy snowfall to trigger heavy vehicle restrictions. Such restrictions consist of diverting these types of vehicles to safe parking areas. In order to speed up this process, the DGT has installed a series of automated detours to emergency parking areas, which have various variable message signs, as well as license plate recognition readers installed before and after these parking areas.

In the event of adverse weather conditions, the ban on the movement of trucks is signalled and their diversion is made mandatory on the VMS. Once the restrictions have been activated and the corresponding messages have been set up on the VMS, the registration of the passage of vehicles through the control points where the license plate readers are located is initiated.

Once the period of restrictions has ended and the messages on the VMS have subsequently been switched off, registration on the LPRs ends and a list of vehicles detected by the control points is drawn up. This list is checked against the database of vehicles held by the DGT to detect whether any vehicle with an MAM higher than 7.500 kg has not respected the restrictions and the corresponding report is drawn up together with a technical report indicating the hours of duration of the episode and the hours of signalling of the VMS.

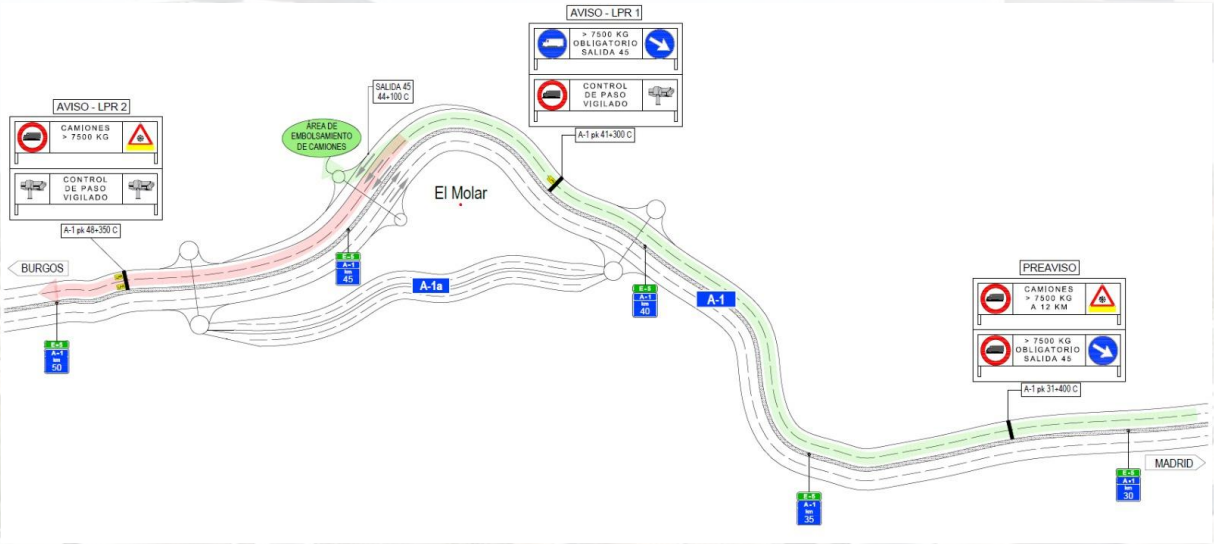

Illustration 47. Example of automated detour for an emergency parking area. Source: DGT

2.1.2.55 Smart Crossings

The Smart Crossings were created with the spirit of increasing traffic safety at junctions at the level of conventional single lane roads, based on real contrasting experiences and international technical references, within the framework of the Safe System concept.

Based on the significant progress made in recent years in the field of road safety, new steps need to be taken with a renewed focus, within the framework of the 2011-2020 Road Safety Strategy, which includes various operational objectives, including that of "improving the safety of conventional roads".

From the equipment point of view, this measure consists of reinforcing conventional signage with a dynamic LED light detection-signalling system that makes it more visible and eye-catching. Inductive loop sensors are installed on the road to detect the approach of a vehicle to the juntion. This information is communicated by means of a light signal, placed on the hard shoulder, to the driver who is driving on the main road and warns him/her that another vehicle is waiting at the junction, as shown in the following diagram:

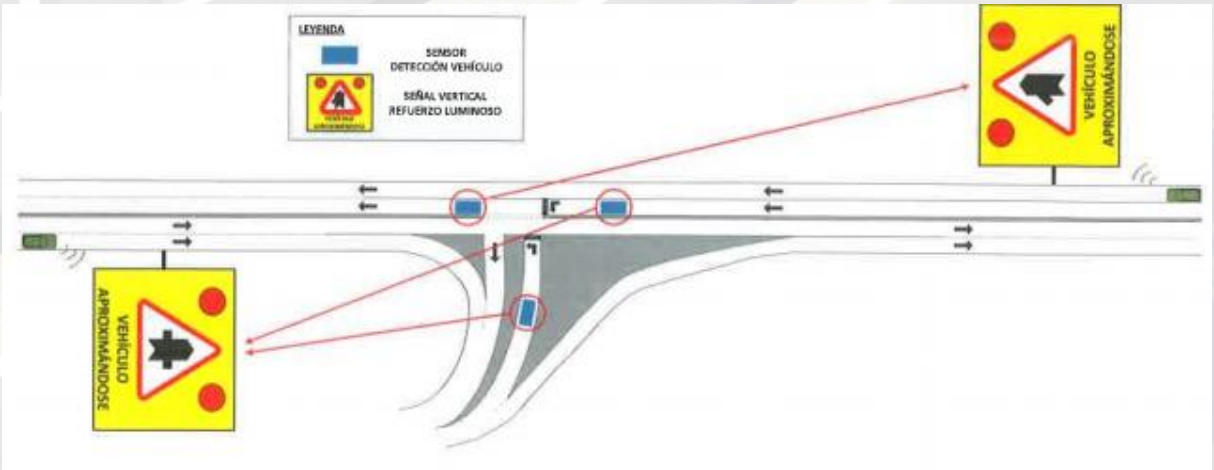

Illustration 48. Diagram of how a Smart Crossing works. Source: DGT

This system, which consists of sensor, signalling and communication elements, promotes a safe use of the roads that is adapted to the circumstances and functions of the roads themselves, by means of signalling which is better adapted to each circumstance, and therefore more credible, which encourages traffic at a safe speed. In fact, based on the commitment of shared responsibility, from the road factor, the aim is to provide the user with an additional tool to that already provided by the other road safety elements as a driving aid system.

From 2016 to date, the DGT has executed and is in the process of executing a total of 32 Smart Crossings distributed throughout the Spanish territory, which are shown in the following list:

Table 60. Smart Crossings executed/in process of being executed. Source DGT

PROVINCE	ROAD	KILOMETER POINT
A CORUÑA	AC-840	35,600
A CORUÑA	N-634	676,000
ALICANTE	N-340	706,200
ALMERÍA	A-370	7,840
ASTURIAS	N-634	370,860
ÁVILA	N-403	82,980
CÁCERES	EX-370	21,200
CANTABRIA	N-611	171,000
CIUDAD REAL	CM-412	88,500
CUENCA	CM-3201	19,900
CUENCA	CM-3201	2,143
GRANADA	N-432	426,800
GUADALAJARA	N-320	309,900
GUADALAJARA	CM-2028	1,700
HUELVA	A-474	49,600
JAÉN	N-323A	40,500
LEÓN	N-VI	399,100
LUGO	N-640	60,730
MADRID	N-VI	56,400
MADRID	N-320	324,500
MADRID	M-505	20,030
MÁLAGA	A-7054	3,300
NAVARRA	N-113	78,812
OURENSE	N-525	169,500
PALENCIA	CL-613	7,500
PONTEVEDRA	N-550	105,400
SALAMANCA	CL-517	29,500
SEVILLA	A-474	23,800
SORIA	CL-116	21,500
VALENCIA	CV-50	76,250
VALLADOLID	CL-602	95,500
ZAMORA	N-610	77,100

Similarly, and taking into account the different junction geometries, in order to facilitate both the design and execution of these systems, a nationwide instruction has been drafted on this subject: Smart Crossings. Instruction 20/TV-110.

Illustration 49. Example of Smart Crossing in operation. Source: DGT

2.1.2.56 Detection of vulnerable users on the roadside

In recent years, the tendency in Spain regarding vulnerable users' fatalities in traffic accidents is increasing. Therefore, the DGT has decided to concentrate efforts on protecting vulnerable people by implementing special measures to guarantee or improve their safety.

An example of this is the implementation of systems for the prevention of accidents involving pedestrians and/or cyclists, consisting of signalling that is capable of detecting pedestrians, cyclists, either alone or in groups, who are travelling on stretches of road with poor visibility, such as sharp bends or changes in slope, or both, and which, by means of a light signal that stays on for a programmable time, warns drivers in the same direction who are travelling behind them on that stretch of road of the presence of vulnerable users.

Illustration 50. Dynamic signalling on the N-525 KP 248 Source: DGT

Illustration 51. Functional diagram of the dynamic signalling warning about the presence of cyclists and example of installation. Source: DGT

2.1.2.57 Automatic detection of animals on the road

Animal trespassing on the road is one of the most serious problems for traffic in rural areas due to the high presence of wild animals in the vicinity and the high risk of accidents that they can cause. For this reason, both the territorial services of the Ministry of Transport, Mobility and Urban Agenda and the DGT have collaborated in recent years to find solutions or measures to minimise or mitigate the risk in the event of accidents of this nature.

One of the systems currently implemented for this purpose consists of warning systems and channelling animals onto the road. These systems are located on the margins of the road with the aim of channelling the passage of wild animals through areas specially marked for this purpose and to ensure that on these stretches drivers take extreme precautions. This system can be composed of variable or static warning signs, physical barriers and presence detection systems.

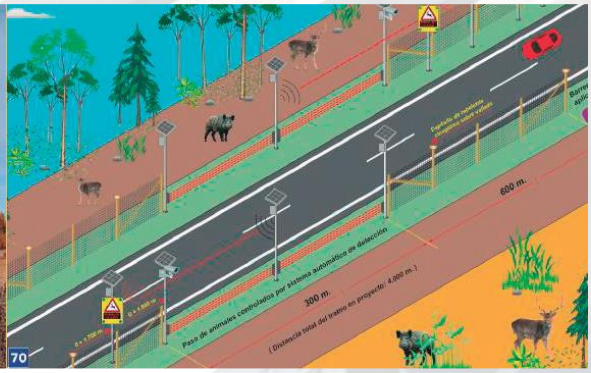

Illustration 52: Example of a warning system and channelling of animals on the road. Source: Regional Government of Castilla y León

2.1.2.58 Sections with speed limit warning signs displaying license plates

The application developed to provide this service analyses the license plates, calculates the average speed and generates the corresponding signalling in a section that is divided into three (3) zones and in which there is a VMS at the end of this section to warn the driver that he/she is exceeding the average speed.

Through an intermediate process, a comparison of license plates is made between zone 1 and zone 2, detecting those vehicles that have circulated above an established threshold. The

distance between zones 1 and 2 is used to calculate the average speed of the vehicles on the section with the speed formula (speed = space/time).

In zone 3 the VMS is used to signal the warning. For example: If the existing speed limit in zone 3 is 80 km/h, the proposed sign is:

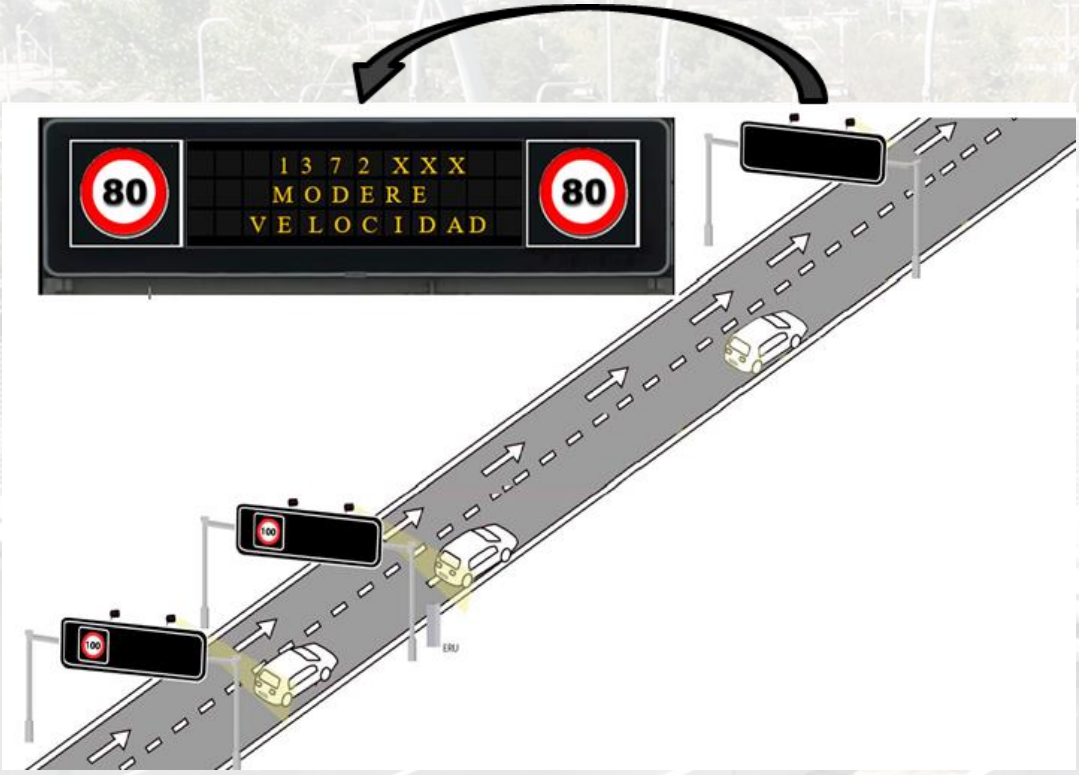

Illustration 53. Diagram of operation of speed limit violation warning system showing license plate. Source: DGT

The first line of the VMS shows the specific number plate of the offending vehicle.

The search for offending vehicles is stopped during the signalling process. Once the application has standardised the VMS the calculation of average speeds is started again. The standardisation of the signalling shown on the VMS in zone 3 is done by defining a signalling time (calculated as a function of the average speed of the offending vehicle on the section).

Illustration 54. Example of signalling. Source: DGT

2.1.2.59 Sections that display warnings after a safety distance violation has been detected

In this case, the application developed for the provision of the service, again within the scope of the TMC of Sevilla, calculates every 15 minutes and automatically, the distance between the vehicles circulating on the A-497 in the three points indicated below:

- A497 KP 4+300 D;
- A497 KP 6+100 D;
- A497 KP 16+500 D;

If this distance is less than that established by DGT, a warning is displayed and the possibility of signalling in the VMS of the KP where it has been breached is offered. The procedure is as follows:

1. Every quarter of an hour, the safety distance is calculated for each section, using the following formula:

$$d\ safety = V^2/100$$

Where:

- d safety: Safety distance for each section, in meters
- V: Quarter-hour average speed for each section, in km/h, calculated as the weighted average of the quarter-hour average speeds of each of the lanes making up each section.

2. The quarter-hour average distance (d average) for each section is calculated as the weighted average of the average distances of each of the lanes making up each section.
3. For each section, the average distance is compared with the safety distance for each quarter of an hour expired.

If the average distance is more than 10% less than the calculated safety distance, a warning message is issued to take this into account. In other words, the warning is issued if the following is true:

$$d\ average < 90 - d\ safety\ /100$$

The application in "no alarm" status, shows the three measurement KPs in green. If the safety distance is not met in one of them, it is shown in red and a message appears indicating whether it is to be signalled automatically. If "Yes" is pressed, the signal is sent to the VMS and appears in the Signalling Manager. Pressing "No" it won't be signalised.

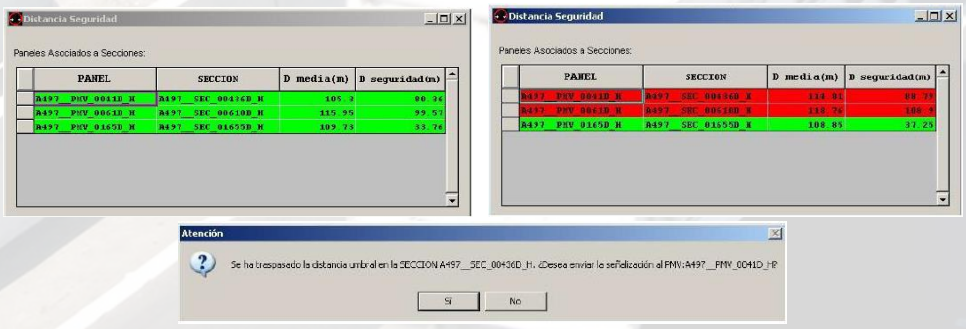

Illustration 55. Warning message after detection of safety distance violation and alarm application interface Source: DGT

If the signalling is accepted, the VMS will show the following alternation:

Illustration 56. Signalling alternation in case of safety distance not being met. Source: DGT

2.1.2.60 PHAROS

In recent years, the concessionaire “Autopistas” has developed PHAROS, a system for the management and registration of roadway incidents. It incorporates a support manual for the Operator to manage the different cases and record all the information associated with them. PHAROS integrates the following systems:

- Voice IP
- Claims management
- Construction management
- Accident management
- Sending information to traffic platforms
- Exporting information to the Reporting Objects database

The system includes a detailed map of the highways/motorways and an environmental scheme, so it automatically detects the precise location of the accident/incident. In addition, it allows to work on a Google map with traffic levels and enables an integral management of winter road maintenance by incorporating GPS data on the equipment.

2.1.2.61 Data Task Force

Data Task Force is the first European Union project and the largest project in the world that focuses on improving road safety through the large-scale use of vehicle data. The objective of this working group is to reach an agreement between all parties involved in the definition and implementation of data models and interfaces, which allow the exchange of road safety related information (Priority Action C Commission Delegated Regulation (EU) No 886/2013) that is useful on Member States' platforms. The main participating actors are Member States, vehicle manufacturers and companies that generate additional information on original vehicle data or distribute information provided by Member States.

Data that is handled:

Both the information managed within the CAN-BUS, or emerging technologies, and any other type of information generated by the vehicle's sensors will be communicated to the platform if it is considered of interest to road safety.

The following would be examples of information relevant to road safety that could contribute to the platform's decision making:

- Temporary slippery roads
- Presence of animals, people, obstacles, road debris

- Unprotected accident zone
- Short term road works
- Reduced visibility
- Detection of vehicle in the opposite direction
- Unmanaged obstruction of a road
- Exceptional weather conditions

2.1.2.62 Ronin

The Ronin project, developed by MITMA through INECO, is a tool for the integrated management of road safety. By means of a software, it facilitates strategic decision-making in the field of infrastructure safety, constituting a powerful tool for road administrations and managers, with a notable impact on the users of one of the main modes of transport. Moreover, this project, framed in the "ODS 9: Industry, Innovation and Infrastructures" was already the winner of the I Edition of the go!ODS Awards.

2.1.3 Delegated Regulation (EU) 2017/1926 on the provision of EU-wide multimodal travel information services (priority action a)

2.1.3.1 National Intermodal Transport Access Point

In accordance with article 4.3.a of the Delegated Regulation (EU) 2017/1926 on the provision of information services on multimodal travel, Spain, in collaboration with the Ministry of Transport, Mobility and Urban Agenda, has begun the implementation of its National Intermodal Transport Access Point.

The aim is for the National Access Point to become a real reference portal for the sector and for developers of applications linked to passenger mobility, of course within the framework of the Delegated Regulation (EU) 2017/1926. Even though it is not possible for this portal to have all the available data on multimodal transport services at the time it is made available to the public - among other things, because not all operators have digitalised and updated information on their services - it is also true that the quality and quantity of information published initially must be such that this National Access Point acquires an impression of credibility and usefulness from the outset that does not compromise its future success. Otherwise, there is a risk that it will not be able to correct this situation later.

As for the architecture of the access point, it has been initially built with the basic functions and is currently in a private pre-production environment, where work is simultaneously being done on the application of improvements, which will be implemented progressively.

It is planned that the National Access Point will have information on all modes of transport: road, rail, air and marine. Initially the focus has been on scheduled road transport, given its combination in terms of the complexity of its integration, the large number of operators and managers in Spain, and the benefits of its capillarity combining long-distance, medium-distance and local services. However, work is being done in parallel to incorporate the rest of the modes of transport.

The delay in the public opening of the Spanish National Access Point is due to the difficulties derived from the feeding of data from that point and, additionally, to the effect that the crisis generated by the coronavirus in Spain.

It is worth mentioning, with regard to the difficulties derived from the feeding of data, that for example the Spanish bus passenger transport sector is very atomized, and furthermore the General State Administration does not have competence over transport carried out within the Autonomous Communities, nor over metropolitan or urban transport, which makes it difficult to obtain data. In any case, significant progress has been made in terms of identifying and contacting the actors, as well as knowledge of the data available in digital format, and data are already being incorporated.

In order to reach all the agents involved, working seminars and meetings have been held and dissemination work is being carried out, both collectively and individually - work which has also been affected by the COVID-19 virus health crisis. In any case, this work had already begun to bear fruit and we are confident that we will be able to incorporate a sufficient volume of data. Likewise, we have been working with the confidence that a chain or call effect will be created, which will facilitate the decision to join those operators who are reluctant to do so when they see that others have already done so.

With regard to the situation generated by the coronavirus crisis and the establishment of the state of alarm in Spain, it should be noted that it has had a high impact on the passenger transport sector, while conditioning the tasks and priorities of the Ministry of Transport, Mobility and the Urban Agenda, which are essentially aimed at monitoring and evaluating the evolution of mobility, and ensuring the proper functioning of passenger and freight transport services, a sector in which it has been necessary to implement numerous measures.

As indicated, the latest events of COVID-19 and their impact on Spain have meant a setback in the planned calendar, so it is expected that the National Access Point will be made public during 2020.

2.1.4 Reporting obligation under Delegated Regulation (EU) 2015/962 on the provision of EU-wide real-time traffic information services (priority action b)

2.1.4.1 National Access Point (NAP)

Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 laying down the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other transport modes, includes among its priority areas the optimal use of road, traffic and travel data. In this sense, there is a growing demand in the use and implementation of communication technologies in the automotive world, which will support new services and technological advances in road safety.

Within the framework of the afore mentioned Directive, as well as its delegated regulations, a common access point should be established to make information from different sources available to all in a standard format.

In compliance with the above, the General Directorate for Traffic put into operation a national access point, as already indicated in 2017, for traffic information (from now on, NAP) that provides high quality real-time traffic information.

In order to ensure that the development and implementation of this National Access Point meets the minimum requirements that guarantee its proper functioning, as well as to be updated on all improvements and progress that can be made in this respect, the DGT, within

the framework of the EU EIP project, is actively involved in the activity linked to the National Access Points (initially sub-activity 4.6 and currently activity 2).

The NAP (http://nap.dgt.es) contains publications of traffic information from the entities listed below:

- General Directorate for Traffic (DGT): http://www.dgt.es/
- Basque Government Traffic Directorate (DT-GV): http://www.trafikoa.eus/
- Catalonian Traffic Service (SCT): http://transit.gencat.cat
- Madrid City Council: http://datos.madrid.es/portal/site/egob
- TOMTOM: https://www.tomtom.com/

Illustration 57.National Traffic and Mobility Access Point. Source: DGT NAP

2.1.4.2 LINCE

LINCE is the acronym in Spanish for "Localizer of Incidents on the Roads of Spain", an application that contributes to the NAP. It is a centralised web system, used by the DGT, designed to allow the joint management of traffic events and traffic conditions on all roads controlled by the various Traffic Management Centres distributed throughout the country. In 2019, 256.197 LINCEs were generated and 551.417 received.

LINCE uses VEOS (Geolocalised Event Viewer) to be able to view, represent and search information about traffic events on the web map in real time.

The application has 1.246 users between Traffic Management Centres, Civil Guard Group and Provincial Traffic Headquarters.

At present, work is being done on an evolution of the application to place greater emphasis on the problem that will be encountered by the driver on the road.

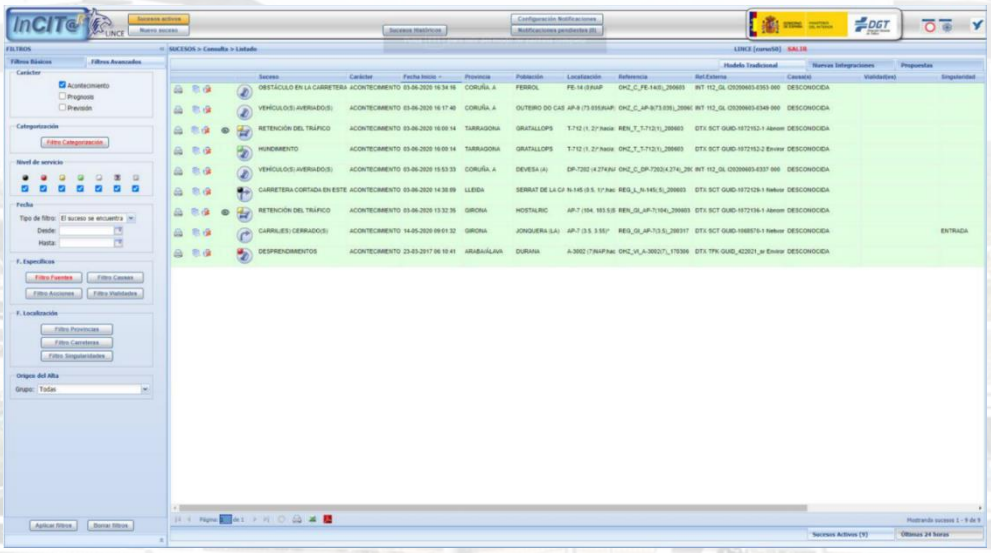

Illustration 58. LINCE application interface. Source: DGT

2.1.4.3 ARCO

At the beginning of the year, the DGT publishes in the Official State Bulletin (BOE – Boletín Oficial del Estado) a series of restrictions on the circulation of specific types of vehicles on certain road sections for certain dates. The ARCO application was developed to enable specialised management of this information.

With ARCO, the traffic manager can enter all the information published in the BOE in an agile way. Furthermore, although this information does not usually change, there may be exceptional circumstances that mean that certain restrictions must be lifted early. Similarly, some restrictions may need to be extended. All this can be done with ARCO.

Once any operation is done with ARCO, it is automatically updated on the DGT website.

The restrictions can be applied to heavy vehicles, dangerous goods, vehicles that need additional authorisation, special vehicles, etc.

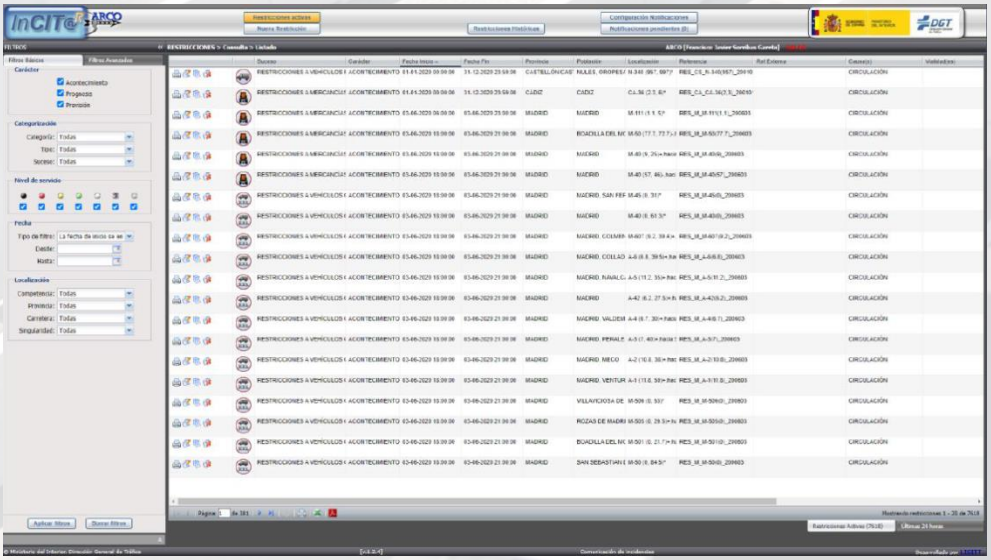

Illustration 59. ARCO application interface. Source: DGT

2.1.4.4 Winter Road Dashboard (WRD)

This application was developed to provide real-time information related to winter road conditions. This tool is conceived as a live instrument, a composition of key aspects related to each other, which must be updated regularly and which, through its consultation, facilitates decision-making on mobility and road safety during the winter.

The WRD is programmed as a LINCE interface to complete the information provided by this platform. This web service has a limited access to certain users with competence in the matter. However, the information can be sent to all interested parties for the correct dissemination of the measures and/or actions to be carried out.

Illustration 60. Application WRD on LINCE. Source: DGT

The combination of quantitative and qualitative characteristics of roads is the best way to describe a specific scenario in detail. A graphic alternative that provides this information in a compact way is based on the creation of a mosaic of tables that initially includes concepts such as:

- Color-coded restriction levels.
- Number of kilometres of road network associated to each restriction level.
- Number of events related to winter maintenance.
- Aggregated information by type of road, province, TMC, etc.

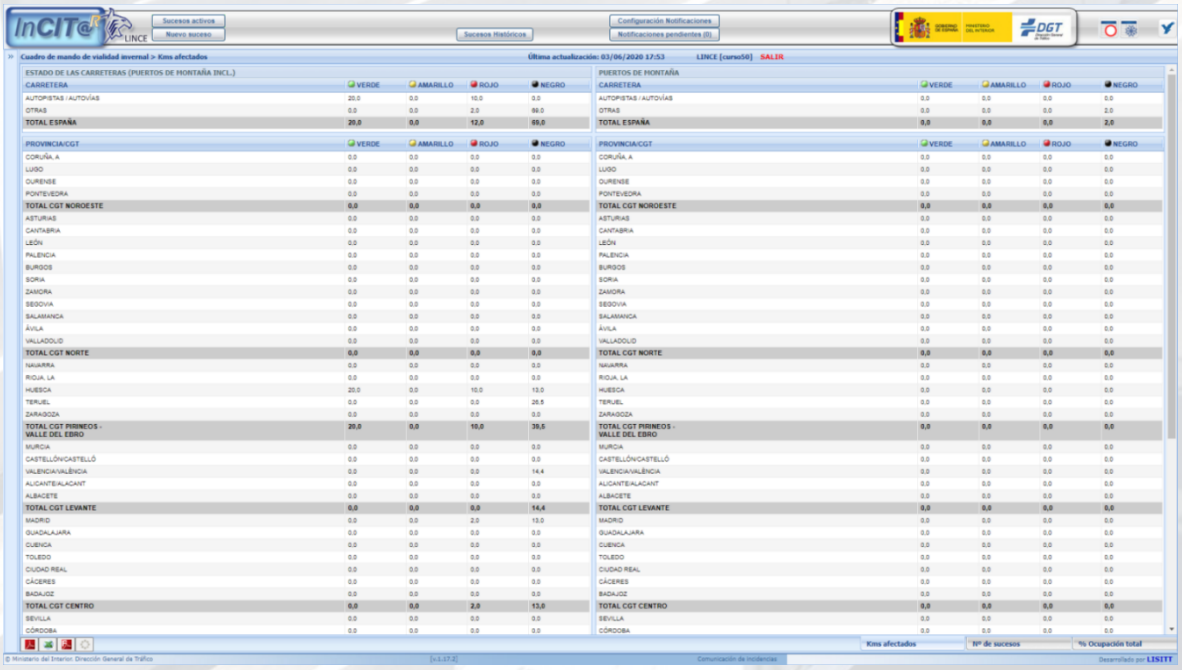

Illustration 61. Kilometres of roads affected. Source: DGT

In short, the WRD is a simple scheme, but with great added value, as it provides enough information to make decisions and assess road conditions in adverse weather episodes.

This nationwide application has been developed by the DGT. The DGC and other road owners have similar applications of their own but limited to the local level of the road networks they own and who supply their information to the DGT. The application of the DGC is integrated into the WRD.

2.1.4.5 Scorecard for cut roads

In order to provide real time information on all those road sections that cannot be driven on, a new section was developed in LINCE called "Cut Roads Dashboard". This tool is very useful for the manager to be able to quickly visualise all these road cuts.

It allows the export to Excel in a filtered way according to the geographic area that interests the traffic manager at that moment.

Illustration 62. Application of cut roads within LINCE. Source: DGT

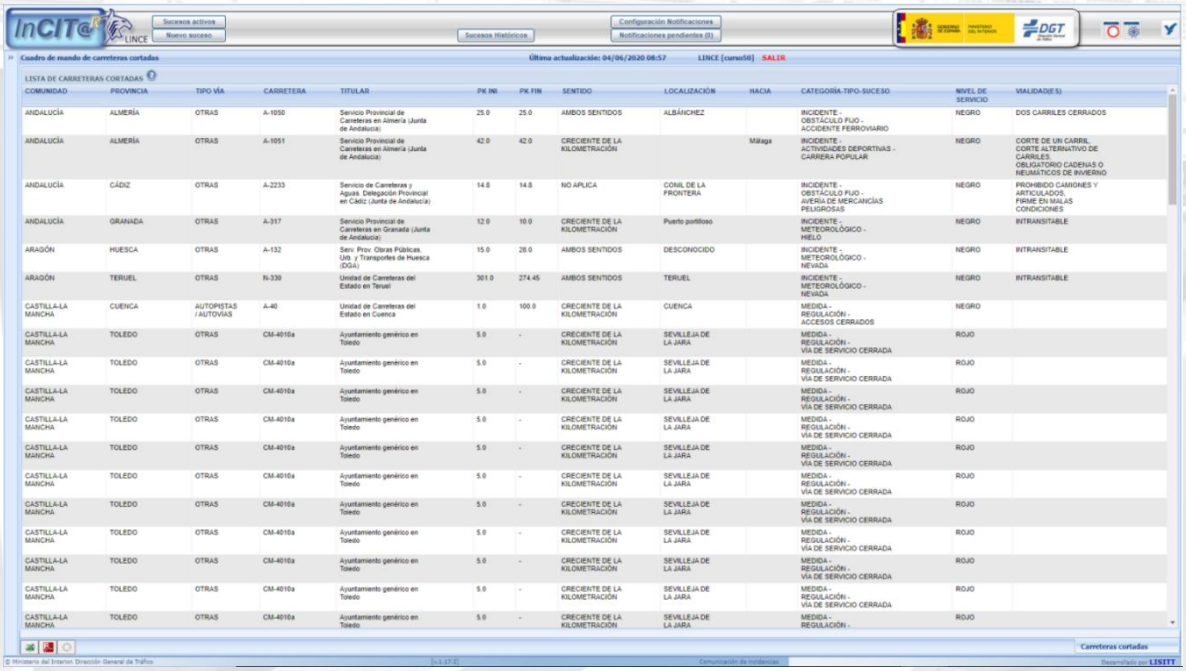

Illustration 63. Cut Roads Dashboard. Source: DGT

This nationwide application has been developed by the DGT. The DGC and other road owners have similar applications of their own but limited to the local level of the road networks they own and who supply their information to the DGT.

2.1.4.6 RENO

One of the problems often encountered by the driver on the road is that of roadworks, which, although unavoidable can affect traffic, it is important for the driver is well informed before he or she reaches the affected stretch of road and to be more reactive in order to avoid a possible accident. This is important both for that driver and for the operators on the road carrying out the specific works.

To achieve this, the RENO application (Ratification of Work Expeditions) was created, which obliges road maintenance companies to notify their actions on the entire road network in real time.

RENO is a simple web application adapted for mobiles, so that the operators themselves can inform with precision of the condition that the work is having at each moment on the road, allowing them to inform of the lane or lanes that they are being forced to cut. Likewise, it will allow to inform about the moment when the works are finished.

Prior to this, the road maintainer will have had to request a permit from the DGT to carry out the work and this will be used by RENO to update the information.

All RENO's operations allow having valuable and updated information on the DGT's website, which is also made available to third parties through the NAP.

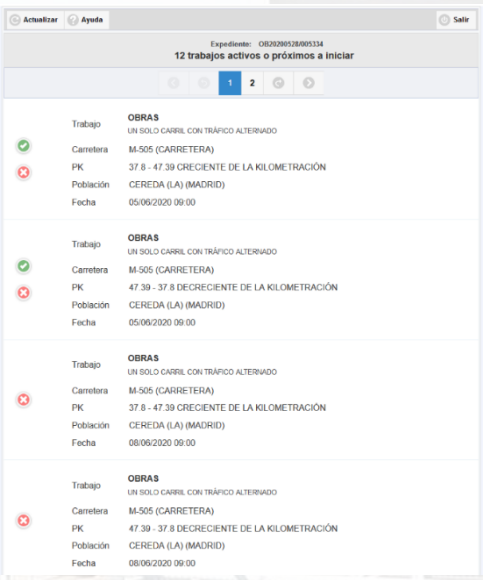

Illustration 64. Example of file and active work in the RENO application. Source: DGT

This nationwide application has been developed by the DGT. The DGC and other road owners have similar applications of their own but limited to the local level of the road networks they own and who supply their information to the DGT.

2.1.4.7 IGLU

IGLU's objective is to enable road operators to feed the NAP directly with real-time data on winter road conditions to provide high quality information to facilitate traffic management.

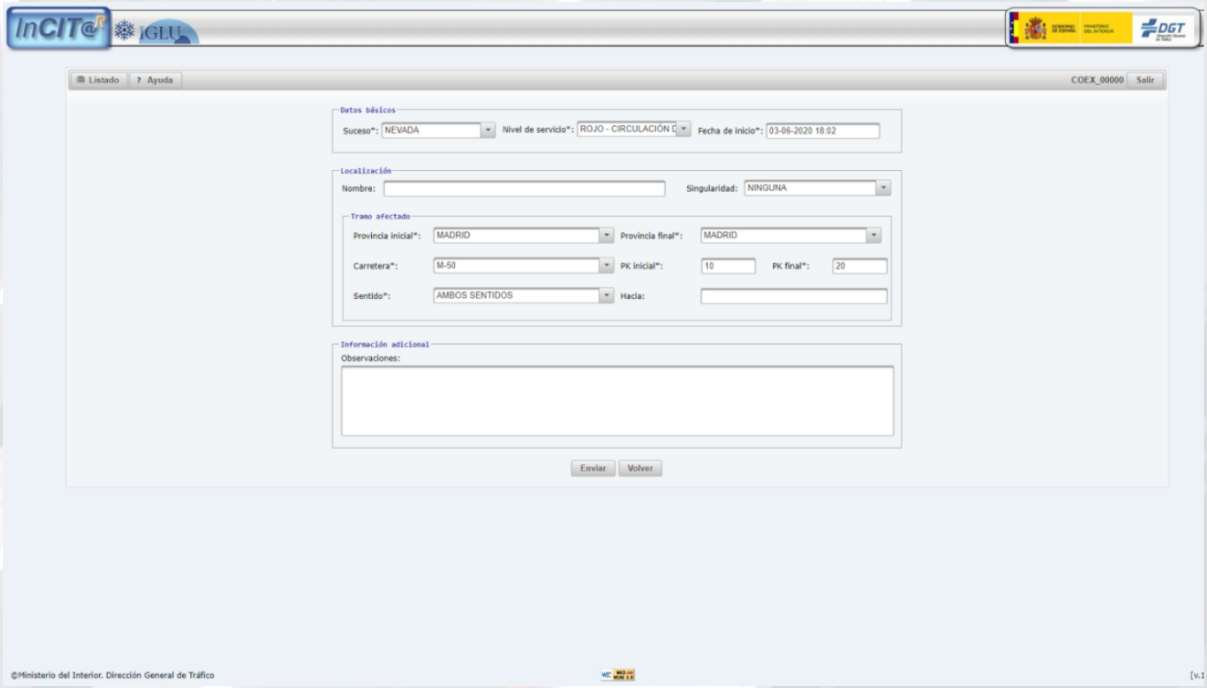

Illustration 65. IGLU main application interface. Source: DGT

The following list shows the characteristics for each incident:

- LOS: icon indicating the type of incident and the impact on the road.
- Incident: describes the type of event, among the following:
  - Snow: snow on the road
  - Ice: risk of slippage caused by ice on the road
  - Snowplough/salt: shows the snowploughs that are used to clear the roads. This type of event does not have any associated LOS.
- Location: road, KP interval and direction in which the event is located.
- Province: province where the incident took place.
- Date: date of last modification.
- Singularity: special characteristics of the location of the incident.

IGLU allows road operators to continuously update the evolution of any incident.

2.1.4.8 VIGIA

To complete the information given about traffic problems on the roads, often the most illustrative thing is to have a picture of the road status. From this idea, the VIGIA project was born so that the citizen can see in an updated way the status of certain images from cameras installed in most of the roads in Spain.

The DGT has 1.744 video surveillance cameras that serve to "have eyes" in those points that can be more conflictive, but also not only traffic managers can benefit from these cameras but the citizen him/herself can view images that will be updated every few minutes thanks to the VIGIA system.

The VIGIA system is in charge of scanning all the cameras, capturing each one of them and publishing them on the Internet so that they are visible through the DGT website and also through third party applications.

It should be noted that there is the possibility of not publishing this information at certain times at the discretion of the DGT in order to avoid misuse of the image that may be made in specific situations, such as a traffic accident.

It is also important to mention that this project is adapting to the technological changes in the installations of the DGT cameras, being able to capture those cameras installed longer ago that work through analogy technology, as well as those more modern ones that use digital technology.

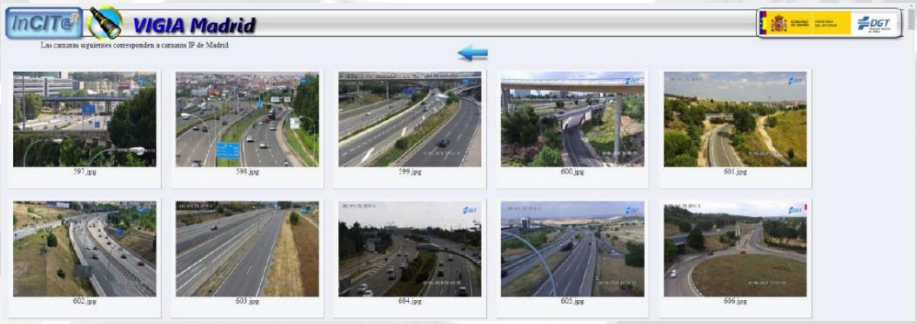

Illustration 66. VIGIA application interface. Source: DGT

2.1.4.9 Mobility Map

The mobility map is a web application linked to the NAP that offers static and dynamic traffic information of all Spanish roads (national, regional and local).

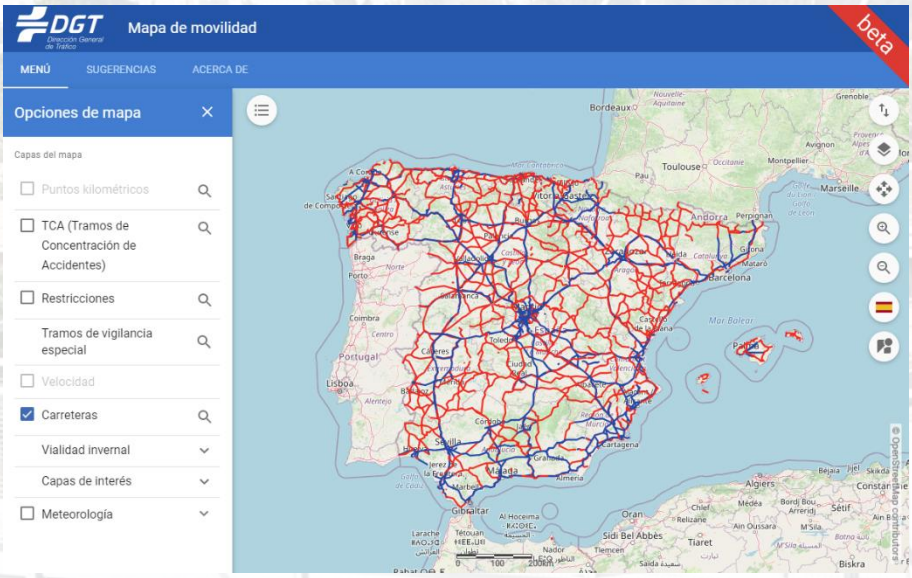

Illustration 67. Main interface of the Mobility Map. Source: [Mobility Map DGT]

The Mobility Map provides an interactive interface where users can view the following information:

- Kilometric points
- High accident concentration sections
- Restrictions
- Special surveillance areas
- Roads
    - Information related to adverse weather conditions
        - Elevation
        - Emergency parking areas
    - Other layers of interest:
        - Level - crossings
        - RIMP (Red de Itinerarios para Mercancías Peligrosas – Itineraries Network for Dangerous Goods)
        - Safe cycling routes
        - Protected cycling routes
        - Trans-European Transport Network
            - Atlantic Corridor
            - Mediterranean Corridor
            - Core Network
            - Comprehensive Network
- Meteorology
    - Observation (AEMET radar)
    - Forecast

The mobility map facilitates the search for accurate information on the above parameters.

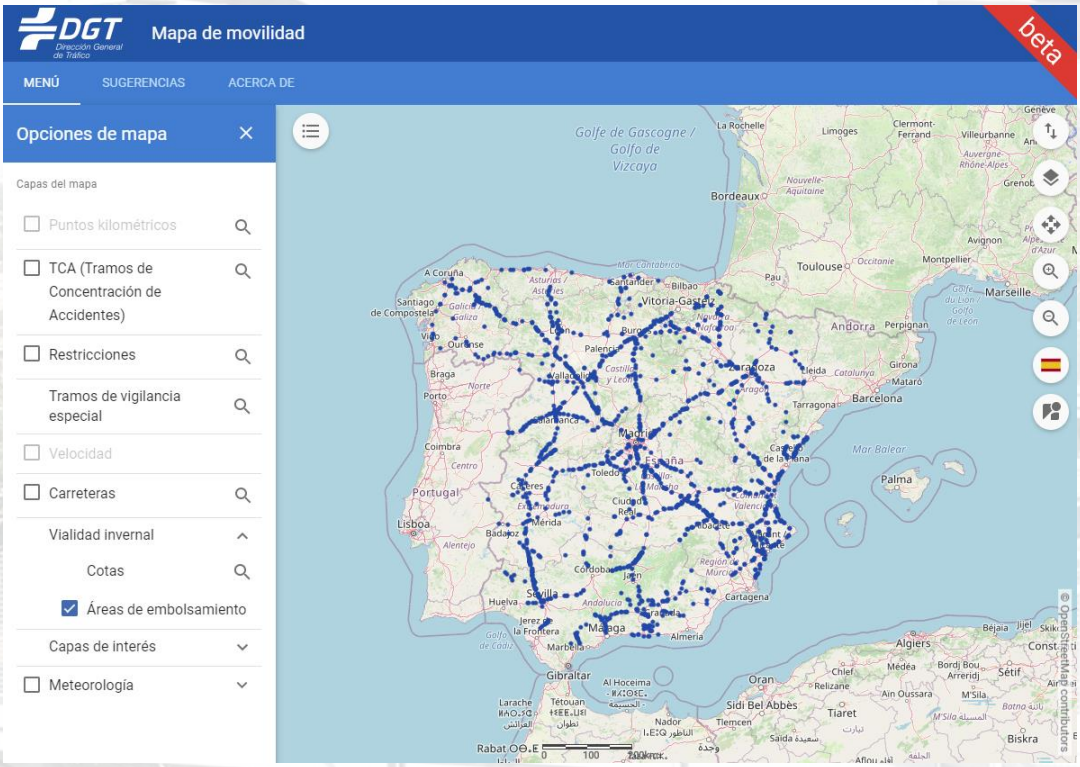

Illustration 68. Mobility map – Emergency parking areas. Source: [Mobility Map DGT]

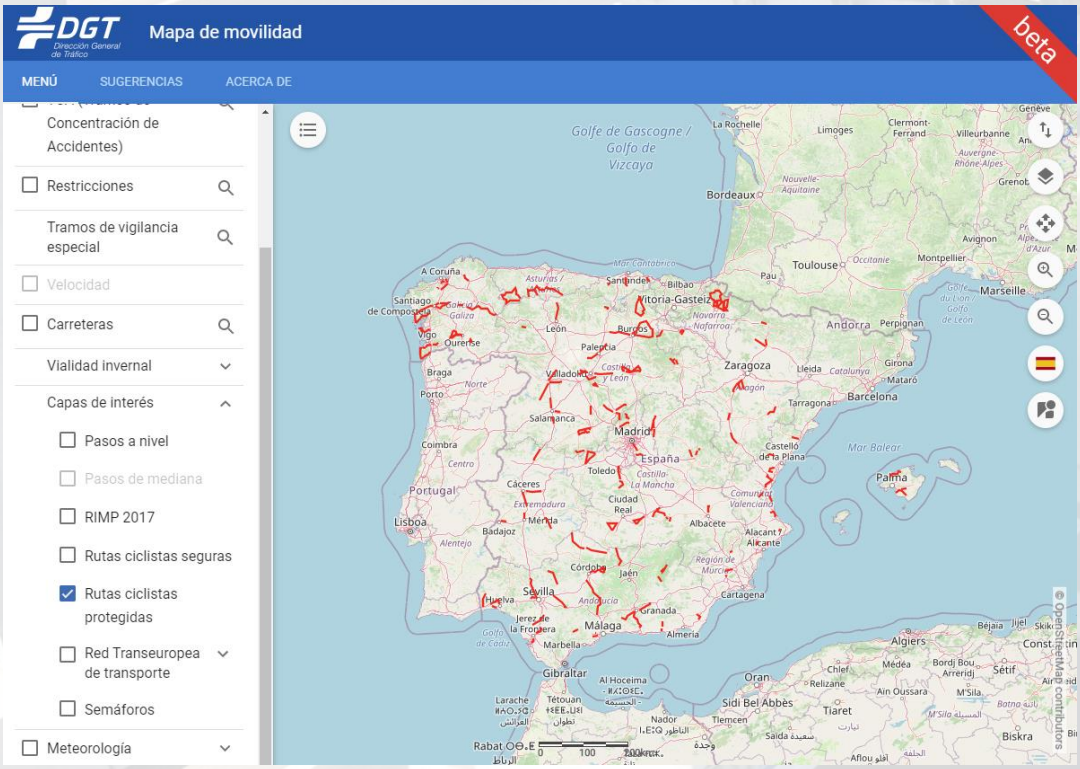

Illustration 69. Mobility map - Protected cycling routes. Source: [Mobility Map DGT]

This nationwide application has been developed by the DGT. The DGC and other road owners have similar applications of their own but limited to the local level of the road networks they own and who supply their information to the DGT.

2.1.4.10 Infocar – eTraffic

This service, developed by DGT, is an example of integration of the information provided by the NAP into a traffic map. On this map it is possible to visualise the following information:

- Incidents updated in real time on national roads based on the information registered in the NAP.
- Scheduled works and restrictions (height and mass).
- Traffic data.
- Customised services:
  - Storage of the most frequent consultation areas.
  - Personalisation of the most relevant services for the user (cameras, panels, etc.).
  - Choice of basic cartography on the map.

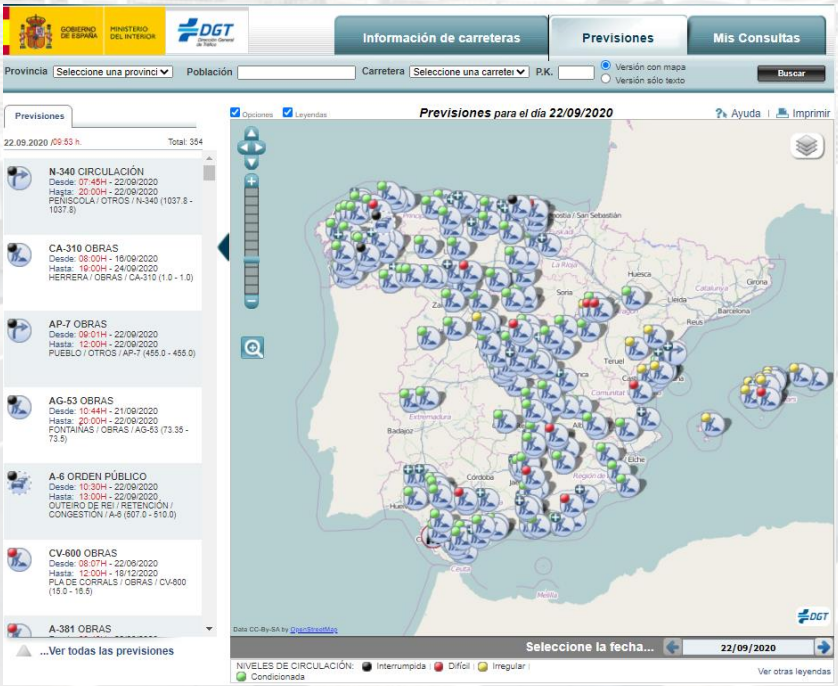

Illustration 70. Interface Infocar - Forecasts. Source: Infocar

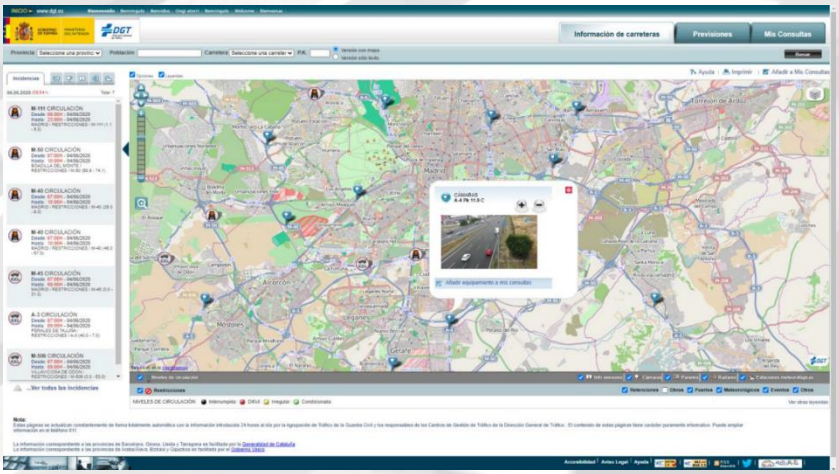

Illustration 71. Interface Infocar - Cameras. Source: Infocar

2.1.4.11 MeteoRuta

This tool links the traffic with AEMET and, through it, it is possible to consult information related to the meteorological variables that can affect driving (rain, snow, wind, low temperature) and their temporary evolution during the following 24 hours.

It consists of a map with an interactive viewer, which shows the weather conditions of the roads by means of a warning layer updated according to AEMET.

This information is automatically generated by the statistical processing of the results of the numerical prediction models.

It is possible to visualise all the information related to the different meteorological phenomena that define the status of the road.

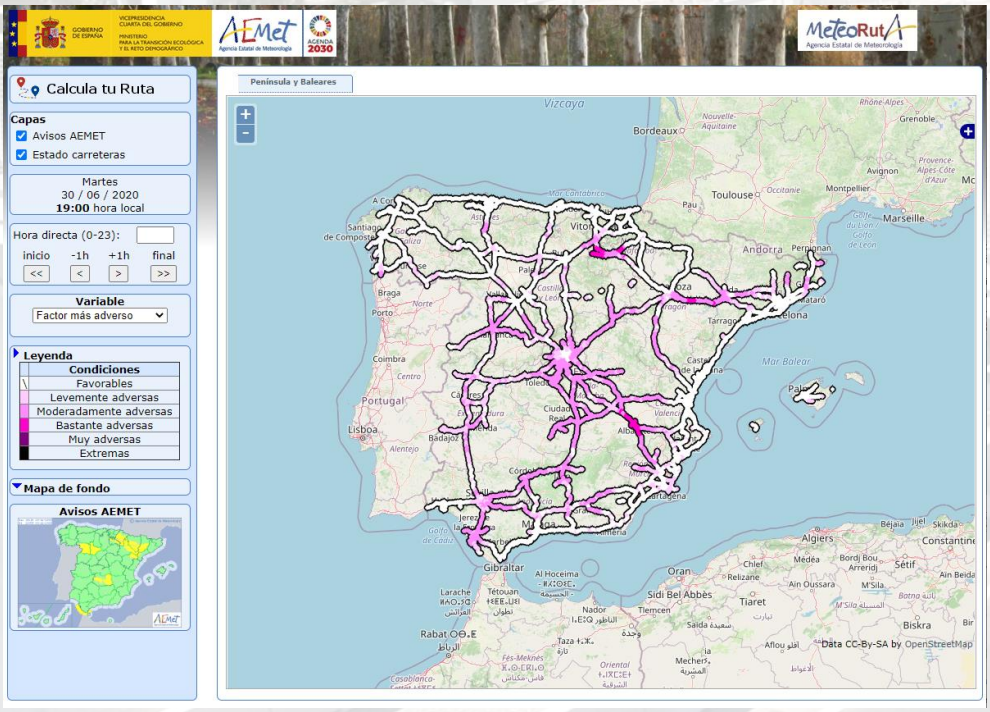

Illustration 72. MeteoRuta - Main interface. Source: MeteoRuta

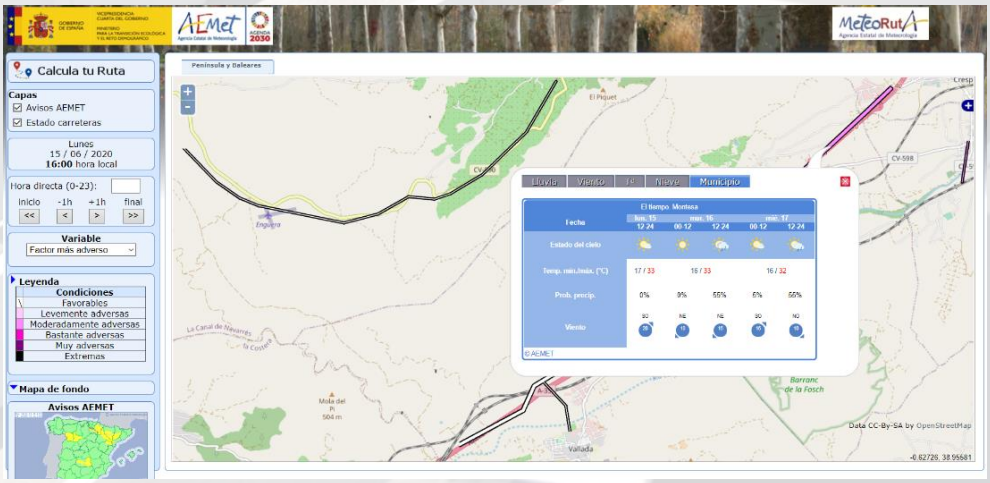

Illustration 73. MeteoRuta - Municipality detail. Source: [MeteoRuta]

2.1.4.12 Sports events and traffic restrictions

In the event that interurban roads are affected and, in accordance with Spanish regulations, each sporting event must be communicated to the DGT, including the duration of the event and the routes where the traffic information is useful. This data is available at the NAP for all users.

In addition, at the beginning of the year, the DGT publishes a calendar of scheduled sports events that affect interurban roads.

Since 2014, DGT publishes a regulation on traffic restrictions which takes into account road safety, mobility and efficiency during the dates when the traffic forecast is highest, considering possible risks from specific vehicles such as heavy vehicles. This information is available through Infocar and efforts are being made to include it in the NAP in the near future.

2.1.4.13 HARMONY Project

The objective of the HARMONY project (01/11/2015 - 31/12/2018) is to promote intermodality and improve the management of transport infrastructures by conducting a study and deploying multimodal transport solutions and services. HARMONY addresses the compatibility, interoperability, and continuity of ITS solutions in Europe, through the development of standards and the harmonisation of multimodal information systems. The project, in which Indra participates, contributes to the harmonisation and standardisation of the use and exchange of information between different actors, including the NAP of the DGT through the DATEX II format, and systems in the field of transport, involving citizens as an innovative source of information to be taken into account in mobility management.

These objectives have been developed through the pilot project carried out during the last four months of 2018 in the northern area of the city of Madrid, where operators, traffic authorities and public transport users have been involved in the improvement of information systems, for the improvement of public transport services, the improvement of road safety and greater efficiency in the city's mobility. The pilot has involved about 500 users through surveys, about 15 operators from the company Interbus, and has created a PPP where users have been able to participate in sending information in real time during the pilot. The investment in this pilot exceeds 1,300,000 euros.

2.1.4.14 Coverage of EU-wide real-time traffic information services in Spain

It is possible to identify some relevant roads that are not included in the Comprehensive Network, according to the inventory of trans-European roads reflected in the "TENtec Interactive Map Viewer" of the European Commission and that should be covered by ITS services.

Below is a classification of some main roads in Spain that are not included in this classification; these specifications will cover most of the Spanish road network, regardless of their category.

The following table shows the high capacity Spanish roads not included in the TEN-T network:

Table 61. Major high capacity roads not included in the Trans-European Road Network. Source: Own Elaboration

TYPOLOGY	ROAD	ITINERARY
Motorway	A-1	De Miranda de Ebro (L.P. Burgos) a Treviño oeste (L.P. Burgos)

TYPOLOGY	ROAD	ITINERARY
Motorway	A-1	De Treviño este (L.P. Burgos) a Ziordia (L.P. Navarra)
Motorway	A-1	De Pto. Etxegárate (L.P. Navarra) a San Sebastián (AP-8)
Motorway	A-1	De Ziordia (L.P. Álava) a Pto. Etxegárate (L.P. Guipúzcoa)
Motorway	A-11	Valladolid - Tudela del Duero
Motorway	A-11	El burgo de Osma
Motorway	A-12	Rioja
Motorway	A-12	De Pamplona (A-15) a Viana (L.P. La Rioja)
Motorway	A-13	Rioja
Motorway	A-14	Lleida
Motorway	A-15	De Areso (L.P. Navarra) a Villabona (N-I)
Motorway	A-15	De Noáin (AP-15 y PA-30) a Berriozar (AP-15 y PA-34) (Ronda de Pamplona Oeste)
Motorway	A-15	De Irurtzun (AP-15 y A-10) a Areso (L.P. Guipúzcoa) (Autovía de Leitzarán)
Motorway	A-2	Madrid - Barcelona
Motorway	A-2	Sils (enlace N-II con C-63) - Fornells de la Selva (enlace E-15)
Motorway	A-21	De Noáin (AP-15) a Yesa (N-240 L.P. Zaragoza) (Autovía del Pirineo)
Motorway	A-231	De Osorno (L.P. Palencia) a Villalbilla de Burgos (BU-30)
Motorway	A-231	De Onzonilla (N-630 y A-66r) a Sahagún (L.P. Palencia)
Motorway	A-231	De Sahagún (L.P. León) a Osorno (L.P. Burgos)
Motorway	A-26	Besalú (Enlace N260 con C-66) - Olot
Motorway	A-27	Tarragona
Motorway	A-316	De Úbeda oeste (A-401) a Martos oeste (Autovía del Olivar)
Motorway	A-318	De Lucena (A-45) a Cabra (A-339) (Autovía del Olivar)
Motorway	A-32	Bailén (enlace A-44) - Úbeda (enlace N-322)
Motorway	A-33	Estación de Blanca (A-30) - (enlace N-344)
Motorway	A-334	De Fines a Albox
Motorway	A-357	De Casapalma a Málaga (Autovía del Guadalhorce)
Motorway	A-376	De Montequinto a Utrera norte
Motorway	A-38	Valencia
Motorway	A-381	De Jerez de la Frontera (AP-4) a Los Barrios (A-7) por Medina Sidonia
Motorway	A-382	De Jerez de la Frontera (AP-4) a Arcos de la Frontera (A-384, A-372 y A-393)
Motorway	A-383	De A-7 a La Línea de la Concepción (norte)
Motorway	A-395	De Granada sur (A-44) a túneles del Serrallo (Ronda sur de Granada)
Motorway	A-4	jerez de la frontera - Polígono tres caminos
Motorway	A-40	Cuenca – Tarancón - Ocaña
Motorway	A-42	Madrid - Toledo
Motorway	A-45	Antequera (A-92/N-331) - Málaga (A-7)
Multi Lane	A-45	Málaga
Motorway	A-48	Cádiz (CA-33) - Vejer de la frontera (N-340)
Motorway	A-480	De Sanlúcar de Barrameda (Camino de la Reyerta) a Jerez de la Frontera (N-IV)
Motorway	A-483	De Bollullos del Condado (A-49) a Almonte sur (A-474)
Motorway	A-491	De Base de Rota (P.K 15) a El Puerto de Santa María (A-4)

TYPOLOGY	ROAD	ITINERARY
Motorway	A-497	De Huelva a Punta Umbría (A-5050)
Motorway	A-51	Ávila
Motorway	A-58	Trujillo (E-90) -Cáceres (N521)
Motorway	A-6	Betanzos - A Coruña
Motorway	A-60	Valladolid - León
Motorway	A-601	De Viloria (L.P. Valladolid) a Segovia (SG-20 y CL-601)
Motorway	A-601	De Valladolid (VA-30) a Viloria (L.P. Segovia)
Motorway	A-610	De Palencia a Magaz de Pisuerga (N-620)
Motorway	A-66	Onzonilla - Benavente
Motorway	A-67	Aguilar de Campo - Palencia
Multi Lane	A-68	
Motorway	A-68	Tudela
Motorway	A-68	De Castejón (AP-15 y N-232) a Cortes de Navarra (N-232)
Motorway	A-7	Marbella - Fuengirola
Motorway	A-7	Estepona - Marbella
Motorway	A-7/N-340	Tarragona
Motorway	A-70	San Juan de Alicante - Bonavista
Motorway	A-7056	De A-357 a Parque Tecnológico de Andalucía (A-7054)
Motorway	A-77	Alicante
Motorway	A-77A	Alicante
Motorway	A-79	Alicante
Motorway	A-7N	Murcia
Motorway	A-8009	De Sevilla (SE-20) a La Rinconada (A-8004)
Motorway	A-8028	De SE-30 a Torreblanca de los Caños (A-92) (vía borde de "El Pino")
Motorway	A-8062	De Bormujos (A-474) a Gines (A-8076)
Motorway	A-91	Murcia
Motorway	A-92	De Huéneja (L.P. Granada) a Tabernas (N-340a)
Motorway	A-92	De L.P. Málaga a Huéneja (L. P. Almería) por Loja y Granada
Motorway	A-92	De La Roda de Andalucía (L.P. Sevilla) a L.P. Granada por Archidona
Motorway	A-92	De Sevilla (SE-30) a La Roda de Andalucía (L.P. Málaga)
Motorway	A-92G	De Santa Fe (A-92) a Granada (A-44)
Motorway	A-92M	De Estación de Salinas (A-92) a Villanueva de Cauche (A-45)
Motorway	A-92N	De Puerto de El Contador (L.P.Granada) a L.P. Murcia (A-91) por Vélez Rubio
Motorway	A-92N	De Guadix (A-92) a Puerto de El Contador (L.P. Almería) por Baza y Cúllar
Motorway	AC-10	A Coruña
Motorway	AC-11	A Coruña
Motorway	AC-12	A Coruña
Motorway	AC-14	A Coruña
Motorway	AC-14AL	A Coruña
Motorway	AG-11	De Padrón (N-550) a Ribeira (AC-550) (Autovía del Barbanza)
Motorway	AG-13	De O Castelo (VG-1.3) a Coiro (N-VI Km 583,200)
Motorway	AG-31	De San Cibrao das Viñas (A-52) a Celanova sur
Motorway	AG-41	De Curro (AP-9) a Sanxenxo (VG-4.1 y PO-504)

TYPOLOGY	ROAD	ITINERARY
Motorway	AG-51	De Lira (A-52 salida 291 y EP-4102) a Currás (PO-402)
Motorway	AG-53	De Piñor (L.P. Pontevedra) a Barbantes (A-52)
Motorway	AG-53	De Dozón (AP-53) a Piñor (L.P. Ourense)
Motorway	AG-54	De Maside (AG-53) a O Carballiño (N-541)
Motorway	AG-55	De A Coruña (AC-552) a Carballo oeste (AC-552)
Motorway	AG-55	De Carballo oeste (AC-552) a Baio (AC-430 y VG-1.5)
Motorway	AG-55	De Baio norte a Santa Irene (AC-552)
Motorway	AG-56	De Santiago de Compostela sur (SC-20 y AP-9) a Brión (AC-543)
Motorway	AG-57	De Baiona (PO-552) a Vigo sur (VG-20) (Autopista do Val Miñor)
Motorway	AG-57N	De AG-57 a Nigrán
Motorway	AG-58	De Penelas (AG-59 Km 1) a Cacheiras (AC-841)
Motorway	AG-59	De Ostilos (AC-537) a A Ramallosa (AC-841)
Motorway	AG-64	De Ferrol a L.P. Lugo por As Pontes de García Rodríguez (Autovía)
Motorway	AG-64	De L.P. A Coruña a Vilalba (A-8 y LU-861) por Cabreiros (Autovía)
Motorway	AI-81	Avilés
Motorway	AI-82	Avilés
Motorway	AP-1	De Etxabarri-Ibiña (N-622 y N-624) a Léniz (L.P. Gipuzkoa)
Motorway	AP-1	De Léniz (L.P. Alava) a Eibar (AP-8)
Motorway	AP-15	De Tudela (AP-68) a Noáin (A-15 y PA-30)
Motorway	AP-15	De Berriozar (A-15 y PA-34) a Irurtzun (A-15 y A-10)
Motorway	AP-2	Lleida - Villafranca de Ebro
Motorway	AP-36	Ocaña-La Roda
Motorway	AP-36	Ocaña-La Roda
Motorway	AP-4	Jerez de la Frontera - Sevilla
Motorway	AP-41	Madrid - Toledo
Motorway	AP-46	Puerto de las Pedrizas - Málaga
Motorway	AP-53	Santiago - Dozón
Motorway	AP-61	Segovia - El Espinar
Motorway	AP-66	Campomanes - Rioseco de Tapia
Motorway	AP-71	Astorga - León
Motorway	AP-8	De Eibar (L:P. Gipuzkoa) a Basauri (A-8)
Motorway	AP-8	De Bilbao sur (A-8 y BI-631) a Valle de Trápaga (A-8)
Motorway	AP-8	De Behobia (Frontera Francia) a Eibar (L.P. Bizkaia)
Motorway	ARA-A1	De Villafranca de Ebro (N-II) a El Burgo de Ebro (N-232) (Autopista)
Motorway	AS-117	De Riaño (AS-I y AS-116) a Sama de Langreo
Motorway	AS-17	De Posada sur (Pol. Ind. Asipo) a Lugones (AS-266)
Motorway	AS-17	De Meres (A-64) a Riaño (acceso 37)
Motorway	AS-I	De Mieres (A-66) a Gijón por Pola de Siero (Autovía Minera)
Motorway	AS-II	De Oviedo a Gijón (Autovía Industrial)
Motorway	B-22	Barcelona
Motorway	B-23	Barcelona
Motorway	B-23	Barcelona
Motorway	B-24	Barcelona
Motorway	B-30	Barcelona

TYPOLOGY	ROAD	ITINERARY
Motorway	B-40	Barcelona
Motorway	BI-626	De Puente La Salve a (N-637)
Motorway	BU-11	Burgos
Motorway	BU-12	Burgos
Motorway	C-13	De Lleida sur (LL-12) a Els Magraners (C-13B)
Motorway	C-13	De Vilanova de la Barca sur (C-13Z) a Termens sur
Motorway	C-13B	De C-13 y N-240 a LL-11
Motorway	C-16	De Barcelona a Terrassa sur (C-58)
Motorway	C-16	De Terrassa sur (C-58) a Viladecavals
Motorway	C-16	De Viladecavals a Sant Fruitos de Bagès (C-25)
Motorway	C-17	De Centelles sur a Montesquiu (L.P. Girona)
Motorway	C-17	De Montesquiu (L.P. Barcelona) a Ripoll (C-26)
Motorway	C-25	De Ferran (L.P. Lleida) a Manresa (BV-4501)
Motorway	C-31	De Castelldefels (C-32) a L'Hospitalet de Llobregat
Motorway	C-31	De Barcelona (plaza Les Glòries) a El Masnou (C-32 y B-20)
Motorway	C-31C	Sant Boi de Llobregat (A-16) - El Prat de Llobregat (B-17)
Motorway	C-32	De Cubelles (L.P. Tarragona) a Castelldefells
Motorway	C-32	De Montgat (B-20 y C-31) a Palafolls (N-II)
Motorway	C-32	De Castelldefells a Barcelona (Av. Diagonal)
Motorway	C-32	De El Vendrell (AP-7) a Cubelles (L.P. Barcelona)
Motorway	C-33	De Barcelona (Avda. Río de Janeiro) a Montmeló (A-7)
Motorway	C-35	De Maçanet de la Selva (AP-7) a Llagostera (C-65)
Motorway	C-58	De Barcelona (C-33) a Terrassa (C-16)
Motorway	C-60	De Mataró (C-32 y B-40) a La Roca del Vallés (AP-7) (Autovía de La Roca)
Motorway	C-65	De Santa Cristina d'Aro a Llagostera (C-35)
Motorway	CA-31	Cádiz
Motorway	CA-32	Cádiz
Motorway	Ca-33	Cádiz
Motorway	CA-34	Cádiz
Motorway	CA-34	San Roque (Cádiz)
Motorway	CA-36	Cádiz
Motorway	CA-37	Puerto Real (Cádiz)
Motorway	CL-631	De Cubillos del Sil a Toreno
Motorway	CM-10	Ronda norte de Guadalajara (de A-2 km 59 a N-320 por Río Henares)
Motorway	CM-40	Ronda suroeste de Toledo (de Bargas (A-40) a Nambroca (CM-42 y N-401))
Motorway	CM-41	De Valmojado (A-5) a Illescas (A-42 y CM-43) (Autovía de la Sagra)
Motorway	CM-42	De Villafranca de los Caballeros (L.P. Toledo) a Villafranca de los Caballeros (L.P. Toledo)
Motorway	CM-42	De Alcázar de San Juan (L.P. Toledo) a Tomelloso (A-43)
Motorway	CM-42	De Toledo (N-401 y A-42) a Herencia (L.P. Ciudad Real)
Motorway	CM-42	De Alcázar de San Juan (L.P. Ciudad Real) a Alcázar de San Juan (L.P. Ciudad Real)
Motorway	CM-43	De Illescas (A-42 y CM-41) a Añover de Tajo (CM-4004)
Motorway	CM-45	De Ciudad Real (A-41 y CM-4111) a Almagro (CM-412)

TYPOLOGY	ROAD	ITINERARY
Motorway	CO-31	Córdoba
Motorway	CO-32	Enlace A-45 - Enlace N437 (Córdoba)
Motorway	CS-22	Castello de la Plana (Castellón)
Motorway	CT-31	Enlace RM-332 - Enlace AP-7 (Cartagena, Murcia)
Motorway	CT-32	Cartagena (Murcia)
Motorway	CT-33	Entre calle paseo del Muelle y N-332 (Cartagena, Murcia)
Motorway	CT-34	Enlace CT-32 - Enlace N-343 (Cartagena, Murcia)
Motorway	CV-30	De V-30 a CV-31 por Ronda Norte de Valencia
Motorway	CV-336	De San Antonio de Benagéber (CV-35) a Bétera
Motorway	CV-35	De Valencia (CV-30) a Casinos por Lliria
Motorway	CV-36	De Valencia (V-30) a Torrent (A-7) por Picanya
Motorway	CV-50	De Alzira (CV-42 y CV-43) a L'Alcúdia (A-7)
Motorway	CV-50	De Benaguasil (CV-364) a Llíria (CV-35)
Motorway	CV-500	De puerto de Valencia (V-30) a El Saler
Motorway	CV-80	Finaliza en el enlace con A-7. Alicante
Motorway	CV-80	De Sax (A-31) a Castalla norte (CV-806 y CV-815)
Motorway	EL-20	Desde la AP-7. Elx. (Alicante)
Motorway	EL-20	Elx. (Alicante)
Motorway	EX-A1	De Navalmoral de la Mata oeste (A-5) a Moraleja (EX-108)
Motorway	EX-A2	De Miajadas (A-5) a Vivares (L.P. Badajoz)
Motorway	FE-11	Enlace FE-14 - AC-862 (A Coruña)
Motorway	FE-12	Enlace AP-9 - Enlace CP-5401
Motorway	FE-13	Enlace FE-14 - Enlace AC-116 . (Ferrol, A Coruña)
Motorway	FE-14	Fene - Ferrol (A Coruña)
Motorway	FE-15	Ferrol
Motorway	GC-1	De Las Palmas de Gran Canaria (GC-1 AM) a Arguineguín (GC-200) (Autovía Marítima)
Motorway	GC-1 AM	Avda. Marítima Las Palmas de Gran Canaria (Hoya de la Plata (GC-1) a Pza. Belén María)
Motorway	GC-10	De La Garita (rotonda de las Tazas) a Telde (GC-41) (Autovía de Telde)
Motorway	GC-2	De Las Palmas de Gran Canaria (GC-1) a Bañaderos (GC-330)
Motorway	GC-2	De Gáldar (GC-75) a Las Cruces (GC-220 y GC-293)
Motorway	GI-11	De Lasarte (N-I) a San Sebastián (GI-20)
Motorway	GI-20	Variante de San Sebastián (de Errentería (AP-8 a Aritzeta (AP-8))
Motorway	GI-41	De Astigarraga (AP-8) a San Sebastián (Autovía del Urumea)
Motorway	GI-632	De Beasain (N-I) a Urretxu - Legazpi
Motorway	GJ-81	Hasta enlace con A-8 (Gijón, Asturias)
Motorway	GR-14	Enlace A-7 - Enlace N-340 (Motril, Granada)
Motorway	GR-16	Enlace N-340 - A-7 (Motril, Granada)
Motorway	GR-16	Motril (Granada)
Motorway	H30	Desde el enlace con la N-431 (Huelva)
Motorway	H-30	Enlace HU-3101 - Enlace N-442 (Huelva)
Motorway	H-31	Enlace A-49 - Enlace H-30 (Huelva)
Motorway	H-31	Desde enlace H-30 (Huelva)
Motorway	LE-11	Enlace N-630 - Enlace A-231 (León)

TYPOLOGY	ROAD	ITINERARY
Motorway	LE-11	León
Motorway	LE-20	León
Motorway	LE-20	Enlace N-630 - Enlace A-66 (León)
Motorway	LE-30	Enlace LE-20 - Enlace AP-71 (León)
Motorway	LL-11	Enlace LL-12 - Enlace A-2 (Lleida)
Motorway	LL-12	Enlace AP-2- Enlace LL-11 (Lleida)
Motorway	LO-20	Desde Enlace N-232 (Logroño, Rioja)
Motorway	LU-11	Coincide con la N-6 PK494 a PK 948 (Lugo)
Motorway	LU-12	Lugo
Motorway	M-100	De Alcalá de Henares (M-203 y M-300) a Alcalá de Henares (M-118)
Motorway	M-100	De M-111 y M-106 a A-1 (km 23)
Motorway	M-11	Enlace M-30 - Enlace M-111 (Madrid)
Motorway	M-110	Enlace M-13 (Madrid)
Motorway	M-12	Enlace E-5 - Enlace A-1 (Madrid)
Motorway	M-13	Enlace M-12 - Enlace M-110 (Madrid)
Motorway	M-14	Enlace E-5 - Aeropuerto de Barajas (Madrid)
Motorway	M-21	Enlace M-40 - Enlace A-2
Motorway	M-22	Madrid
Motorway	M-23	Madrid
Motorway	M-31	Enlace M-40 - Enlace M-50 (Madrid)
Motorway	M-40	Enlace A-1. Entero (Madrid)
Motorway	M-407	De Leganés (M-406) a Griñón (M-404 y M-415)
Motorway	M-45	De M-40 (Km 29) a San Fernando de Henares (M-50 y acceso A-2) por Leganés
Motorway	M-50	Enlace R-2 (Madrid)
Motorway	M-50	Enlace A-1 - Enlace A-6 (Madrid)
Motorway	M-501	De M-40 (km 36,500) a Navas del Rey (M-855) por Brunete
Motorway	M-503	De Majadahonda (M-50) a Villanueva de la Cañada (M-600)
Motorway	M-607	De Madrid (M-40) a Colmenar Viejo norte (M-609)
Motorway	M-609	De M-607 a Soto del Real (Centro penitenciario)
Motorway	Ma-1	De Cala Major a Peguera
Motorway	Ma-13	De Palma de Mallorca (Ma-20) a Sa Pobla (Ma-2200 y Ma-3420)
Motorway	Ma-19	De Palma de Mallorca (C/ Manuel Azaña) a Llucmajor
Motorway	MA-20	Málaga
Motorway	Ma-20	Circunvalación de Palma de Mallorca (de Ma-19 a Ma-1)
Motorway	MA-22	Málaga
Motorway	MA-23	Málaga
Motorway	MA-24	Enlace A-7S (Málaga)
Motorway	ML-101	Melilla
Motorway	ML-204	Melilla
Motorway	ML-300	Melilla
Motorway	MU-30	Enlace A-7S - Enlace N-301 (Murcia)
Motorway	MU-31	Enlace MU-30 - Enlace A-30 (Murcia)
Motorway	R-2	Madrid
Motorway	R-3	Madrid

TYPOLOGY	ROAD	ITINERARY
Motorway	R-4	Madrid
Motorway	R-5	Madrid
Motorway	RM-1	De San Javier (AP-7) a Zeneta (RM-F16)
Motorway	RM-11	De Lorca (N-340 enlace 541) a Águilas (RM-333 y RM-D14)
Motorway	RM-15	De Alcantarilla (A-7 y MU-30) a Caravaca de la Cruz (RM-730) (Autovía Río Mula)
Motorway	RM-16	De A-30 (P.K.-161) a Aeropuerto de Corvera
Motorway	RM-17	De los Martínez del Puerto (A-30) a RM-16 y RM-E7
Motorway	RM-19	De Puerto de la Cadena (A-30) a San Javier (AP-7) (Autovía)
Motorway	RM-2	De Alhama de Murcia (A-7) a A-30 (enlace 171 a Torre Pacheco) y RM-F14
Motorway	RM-23	De Alhama de Murcia (RM-2 y RM-603) a Canal del Taibilla (RM-3) (Autovía)
Motorway	RM-3	De Totana (A-7 salida 611) a Mazarrón (RM-332)
Motorway	TF-1	De Santa Cruz de Tenerife (TF-5) a Santiago del Teide (TF-375)
Motorway	TF-11	De Santa Cruz de Tenerife (Dique del Este) a San Andrés
Motorway	TF-5	De Santa Cruz de Tenerife a Los Realejos
Motorway	V-14	De AG-55 a As Rañas (AC-14)
Motorway	Z-40	Zaragoza

2.1.5 Reporting obligation under the Delegated Regulation (EU) No. 886/2013 on data and procedures to provide users, where possible, with minimum universal road safety related traffic information free of charge (priority action c)

2.1.5.1 Progress in the implementation of the information service, including the criteria used to define its quality level and the means used to monitor its quality

2.1.5.1.1 ROAD SAFETY-RELATED MINIMUM UNIVERSAL TRAFFIC INFORMATION FREE OF CHARGE TO USERS

Spain provides the information using different tools taking into account the list of events or conditions related to road safety described in the Delegated Regulation of the Commission (EU) No. 886/2013. Most of this information is available in the NAP.

In addition, there are other useful applications and websites (Infocar) to facilitate access to end users and also to feed the NAP for relevant information.

In addition, the DGT is in the process of launching a new platform where service providers, end-users or other platforms can share information on safety events occurring on the road (DGT 3.0).

2.1.5.1.1.1 TEMPORARILY SLIPPERY ROAD

This incident is usually reported by road maintenance. Currently, TMC are working to obtain this information through other sources; for instance, it could be obtained through cooperative vehicle communication, floating car data, etc.

2.1.5.1.1.2 ANIMAL, PEOPLE, OBSTACLES, DEBRIS ON THE ROAD

Safety related information involving animals on the road, people, obstacles or debris on the road is generally reported through 112 (emergency number) or through 011 (traffic assistance number). As soon as users identify that any of these issues may affect road safety, they may

contact through the numbers described and, following a national internal communication protocol, TMCs are notified of the incident in question.

At present, new systems are also being developed that allow this type of incident to be detected automatically (animals through infrared sensors & cameras, IDS -intrusion detection systems-, etc). Depending on the type of incident to be detected, the way of sending the information differs, however the final receiver of this type of information, for the moment, is always the TMC. It will be from the TMC where the information will be verified and published so that users are aware of the situation in the shortest possible time.

2.1.5.1.1.3 ACCIDENT AREA

Nowadays, most of the accident-related information is obtained through cameras, police reports, 112 emergency services and also some service providers feed the NAP with events related to accident breakdowns.

2.1.5.1.1.4 SHORT-TERM ROAD WORKS

It is essential in terms of road safety that the data is accurate and reliable.

The DGT has developed an application named RENO designed for the notification of road works in real time. The maintenance or construction company must use this application to communicate the scheduled road works, the area affected (kilometres, lanes, hard shoulders, etc.), the beginning and end of the work, including the geographical location. This information is automatically uploaded to the NAP (update frequency 2 minutes)

2.1.5.1.1.5 REDUCED VISIBILITY

The phenomenon of reduced visibility is critical for road safety. In specific locations where this phenomenon is a recurrent issue, some ITSs have been deployed. These ITS can identify reduced visibility so that the TMC can decide to close affected lanes, divert traffic flow and forecast the duration of the episode. All of these dynamic road statuses are loaded into the NAP.

The DGT are working very closely with AEMET to integrate into the Mobility Map the information related to the forecast of reduced visibility due to fog, heavy rain, winds, etc.

2.1.5.1.1.6 WRONG WAY DRIVER

This event is extremely dangerous and DGT is really concerned about this situation. Therefore, some pilots have been carried out using video cameras, loops or access controls in order to identify a wrong-way driver. Unfortunately, none of them worked without failure, so they are used as conditional warnings.

When the detectors send an incident alarm, it is validated in the TMC and then uploaded to the NAP.

2.1.5.1.1.7 UNMANAGED BLOCKAGE OF A ROAD

This situation can be controlled by cameras and police reports. The application responsible for reporting all incidents that occur in different ways on the Spanish traffic framework is the LINCE application. These reports include situations where there is an unexpected roadblock. In addition, other users and service providers can report these events through LINCE via NAP.

2.1.5.1.1.8 EXCEPTIONAL WEATHER CONDITIONS

The same applies for reduced visibility, the forecast related information of exceptional weather conditions is included at the Mobility Map and available to final users through the NAP.

2.1.5.1.2 QUALITY CRITERIA

Similar to the real-time traffic information described in the previous sections, the European ITS Platform's 'Framework guidelines for data and service quality requirements' also applies to security-related traffic information.

In this line of work, studies are being developed at national level in which specific analyses are carried out to assess how the quality of the data currently provided in relation to ITS could be improved. However, as analyses are still underway, the DGT has not yet set specific quality targets. It can be said that when they are defined, they will be consistent with the instruction mentioned in the first paragraph.

2.1.5.2 Results of the assessment of compliance with the requirements of Articles 3 to 8 of the Delegated Regulation (EU) No. 886/2013

2.1.5.2.1 ARTICLE 3: LIST OF EVENTS OR CONDITIONS RELATED TO ROAD SAFETY

The data categories (as defined in the Annex to the Delegated Regulation 886/2013) covered by Safety Related Traffic Information at national level are detailed in the table below:

Table 62. Data categories covered at the national level in relation to SRTIs. Source: DGT

DATA CATEGORY	COVERED X=YES (X)=PARTIALLY N/A=NOT AVAILABLE
Safety related traffic events and conditions	
a) Temporary slippery road	X
b) Presence of animals, people, obstacles, road debris	X
c) Unprotected accident area	X
d) Short term road works	X
e) Reduced visibility	X
f) Wrong way driver	X
g) Unmanaged blockage of a road	X
h) Exceptional weather conditions	X

2.1.5.2.2 ARTICLE 4: INFORMATION CONTENT

In order to inform the user of an event or incident detected on the road, it is considered of utmost importance (and this is currently done through the NAP) to provide the following:

- The location of the event provided through the road code and its KP or range of KPs.

- The category of the event. The most commonly used classification at national level are: congestions, roadworks, weather conditions, events and others.
- Warning to the driver: Brief description of what the incident is, in order to take the appropriate measures at the wheel.

The information provided through the NAP follows the specifications of the DATEX II format.

When an incident takes place, there are operators who attend to it from the beginning until the recovery of the traffic flow and report on possible changes that may suffer the traffic in relation to the incident. As incidents are random events at both temporal and spatial levels, their management, monitoring and updating constitute a continuous task in Spanish TMCs.

2.1.5.2.3 ARTICLE 5: PROVISION OF INFORMATION SERVICE

The minimum universal traffic information services related to safety are provided both throughout the TEN-T network and along the road network listed in Table 61.

2.1.5.2.4 ARTICLE 6: DETECTION OF INCIDENTS OR CIRCUMSTANCES AND COLLECTION OF DATA

Means and equipment are being used for the detection of events or conditions on the road that could lead to any kind of alteration in road safety. In particular, along this report it has been explained how minimum safety information is collected at national level.

2.1.5.2.5 ARTICLE 7: AVAILABILITY, EXCHANGE AND REUSE OF DATA

As aforementioned, Spain provides the information to the user using different tools taking into account the list of road safety-related events or conditions which are described at the Commission Delegated Regulation (EU) No 886/2013. This information is available at the NAP using DATEX II to allow the interchange of data.

It is the same NAP as for the EU-wide real-time traffic information services mentioned in the section of the Delegated Regulation of the Commission (EU) 2015/962 (RTTI).

All information published through the different applications described and through the National Access Point is open data that can be re-used by any person or entity.

And finally, it can be stated that the updates of the information are carried out accurately and regularly and that there is a procedure for the revision of the information to be published so that its quality is optimal.

2.1.5.2.6 ARTICLE 8: DISSEMINATION OF INFORMATION

For the Spanish government, road safety is a priority over other types of traffic-related information. This is why it is considered important, when providing information, to take into account the category of data to be shared, in order to ensure, above all, the safety of users.

All the information related to road safety is transmitted through the different applications described throughout the document and through the NAP.

2.2 Priority Area II. Continuity of traffic and freight management ITS services

The aim of the projects and activities described in this priority area is to improve traffic continuity and the competitiveness and safety of road freight transport.

2.2.1 Description of national activities and projects

The ITS Directive provides that specifications and standards for the continuity and interoperability of traffic and freight management in services should include:

- The definition of the measures necessary for the development of the ITS framework architecture of the European Union.
- The definition of the minimum requirements necessary for the continuity of ITS services
- The definition of the minimum requirements necessary to guarantee the continuity of the ITS services for freight management in the transport corridors and in the different modes of transport
- The definition of the necessary measures for the design of ITS applications.
- The definition of the necessary interfaces to ensure interoperability and compatibility between the ITS urban architecture and the European ITS architecture.

The activities and initiatives associated with these themes are shown below:

Illustration 74. Priority Area II. Projects, activities and initiatives. Source: Own Elaboration

2.2.2 Continuity of ITS services for traffic management

2.2.2.1 Traffic Management Centres

The Traffic Management Centres (TMC) are the "eyes" of the General Directorate for Traffic. Currently, there are eight centers covering the national territory (with the exception of Catalonia and the Basque country, whose competences have been transferred). The TMC are those listed below:

- TMC Centre Area, whose headquarters are located in Madrid
- TMC Northwest, based in A Coruña
- TMC North, based in Valladolid
- TMC Pyrenees - Ebro Valley, based in Zaragoza
- TMC Levante, based in Valencia
- TMC Southeast, based in Malaga
- TMC Southwest, based in Seville
- TMC Baleares, based in Palma de Mallorca

Illustration 75. Management Centres of the Directorate General of Traffic. Source: DGT

The main functions of the TMCs are:

- Traffic management and control
- Improving road safety
- Providing information and assistance to users when incidents occur
- Promoting research

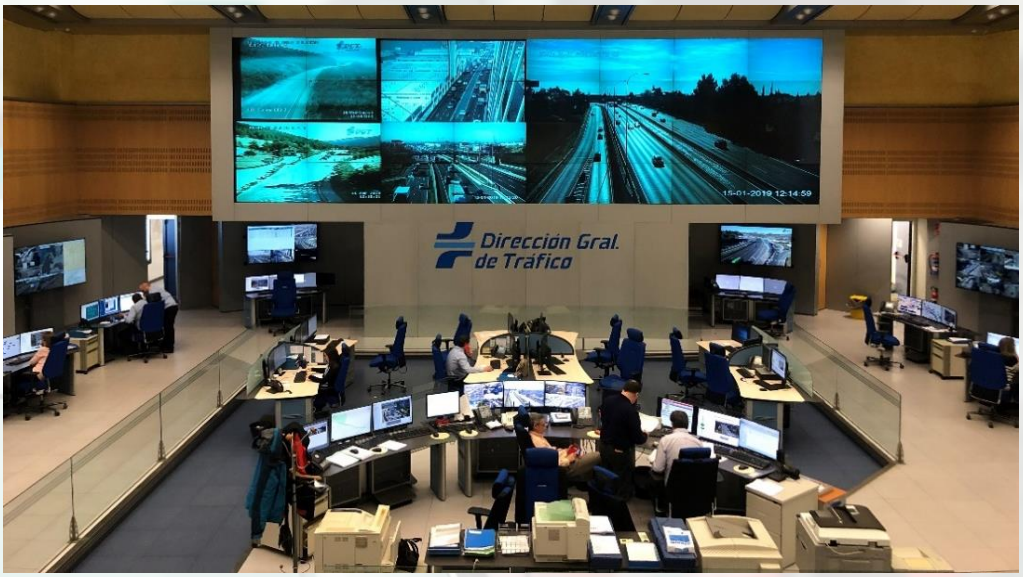

Illustration 76. Traffic Management Centre in Madrid. Source: DGT

In order to perform these functions in a precise manner, the TMC continuously receive traffic information from various sources: data collection stations that measure traffic parameters at the road side, atmospheric sensors, helicopters, drones, surveillance cameras, license plate recognition cameras, digital platforms, etc.

As mentioned above, traffic competences in Catalonia and the Basque country have been transferred.

The manager of traffic and road safety in Catalonia is the Servei Català de Trànsit (SCT), which was created in 1997 when the Government of Catalonia took over the competences of traffic and circulation of motor vehicles.

Illustration 77. Servei Català de Trànsit logo. Source: SCT

A total of 295 people work in the SCT as a whole, carrying out the different functions of the entity. The SCT is organised through the Central Services and four territorial services (STT): Barcelona, Girona, Lleida and Tarragona. With the main objective of reducing the number of accidents on the road network in Catalonia, the SCT carries out the following functions:

- Traffic
- Education and training
- Communication
- Road Safety
- Legislation
- Others

With the aim of informing users of the status of traffic, properly managing the conflicting sections of the Catalonian road network and improving road safety in Catalonia, the SCT has the Catalonia Road Information Centre (CIVICAT). To do this, it has the support of the air resources available from the SCT and with camera devices, necessarysign posts, vehicle counting, among other equipment. Lauched in 2000, the control center was totally remodelled in 2017 and has incorporated the latest technological innovations to provide a better service

to citizens. In addition, in recent years, new management software has been implemented in this center for all systems, which improves, among other things:

- The existing functionalities of camera management, panel signalling, travel time calculations and scenarios representation in the control room videowall.
- The management of roads with dynamic variable speed or with speed plans.
- The automatic generation of reports, support for the monitoring of incident protocols, inclusion of a GIS map for the location and selection of equipment to be operated, generation of traffic alerts and semi-automatic signalling of variable message signs, programming of events, works, sports events, etc.

On the other hand, the body in charge of developing and managing road safety policies in the Basque country is the Basque Traffic Directorate (DT).

Illustration 78. Basque Traffic Authority logo. Security Department. Source: Trafikoa

There are numerous functions within the competence of the DT, among which the following stand out:

- Management and control of interurban traffic
- Planning, directing and coordinating actions to improve road safety and fluidity on interurban roads
- Carrying out studies and researches in the field of traffic and road safety
- Informing users about the state of traffic on public roads
- Developing action programmes and information campaigns on education, training and road safety
- Preparing reports and analysis of traffic accidents

The three bodies (DGT, SCT and TD) work in a coordinated manner to guarantee the best service to users, regardless of the route they take.

2.2.2.2 Intercentros

The DGT is divided into a series of Traffic Management Centers that manage the different areas of the country and are in charge of operating all the ITS equipment. In order to maintain in a single database, the information that each of the TMC collects from the ITS equipment, the UNE standard of “Intercentros” was created.

This standard defines the model and the way of updating information that exists for each of the ITS equipment. This facilitates the publication of data on the Internet that is made available to third parties, as well as on the DGT's own website.

This standard was renewed in 2017 and is in the implementation phase, as it has had to undergo subsequent modifications.

2.2.3 Continuity of ITS services for freight management

2.2.3.1 TRAZA

TRAZA is an application developed by the Ministry of the Interior for the telematic management of authorisations for the transport of goods which require additional authorisation to be able to

travel through the national road network and for the management of requests for lane/road closure due to road works.

This system speeds up the administrative process and the communication of these trips to the traffic authorities in case an escort is required or is mandatory by law. In addition, it is possible to track the position of special vehicle fleets (large and over-mass).

2.2.3.2 Digital tachograph

In accordance with European regulations, the implementation in Spain of the digital tachograph for newly registered vehicles, which we are obliged to use and therefore the installation of this recording equipment, began in January 2006 and its inclusion in older vehicles has been encouraged.

The analogue tachograph discs were replaced by smart cards which, thanks to a chip, store driving information and give access to certain functions according to the user profile (driver, company, control body or workshop). The stored information is the same in terms of times and speeds as it was in the analogue tachographs, but it is virtually impossible to manipulate.

The device is installed inside the driver's cabin so that the driver can see it. The device communicates, by means of a cable, with a sensor installed in the gearbox generally. The installation is sealed so that it cannot be replaced by unauthorized people.

On the website of the Ministry of Transport, Mobility and Urban Agenda there is a simulator that offers the possibility of practicing with the new digital tachographs on the market. The tool consists of an interactive simulator and guided learning sequences specific to each manufacturer.

This simulation can be carried out either by downloading the application directly onto the computer and doing the simulation off-line, or it is possible to run the simulation on-line.

2.2.3.3 ACOTRAM

ACOTRAM (Assistant for the Calculation of Road Freight Transport Costs) is an application to assist in the calculation of operating costs for road freight vehicles.

Thanks to this application, it is possible to consult the direct costs of the different types of vehicles studied in the "Observatory of Road Freight Transport Costs" whose data are updated every three months.

Downloading the application, as well as downloading the Observatory data, can be done through the website of the Ministry of Transport, Mobility and Urban Agenda.

2.2.4 Progress since 2017

2.2.4.1 IMAN

The DGT has ITS equipment deployed throughout much of the country, so it is necessary to have an inventory application, IMAN, which is responsible for having all the information of these equipment updated.

IMAN allows the DGT to fill in all the characteristics of the heterogeneous equipment that exists, with special emphasis on the location of the equipment that serves to display it on the DGT's website.

The application allows the storage of: connections, mobile counters, radar cabins, vandal proof cameras, video surveillance cameras, cymometers, medium speed cymometers, beacon controllers, CVT, double detectors, simple detectors, data collection stations, meteorological stations, universal remote stations, area communication nodes, variable message signs, SOS posts, sections, license plate recognition sections, traffic lights, non-intrusive sensors for vehicle counting, capture and lighting units, control units and areas.

It should be noted that this application is also used to control the publication of this equipment on the Internet, allowing the equipment to be marked as non-publishable during the installation and maintenance phase or when the equipment is malfunctioning. There is a total of 27.363 equipment registered in the application.

2.2.4.2 ROSMIMAN

The Catalan Traffic Service has the ROSMIMAN application, which is exclusively dedicated to the inventory and maintenance management of road ITS equipment.

The Rosmiman Tool, as a document management system, provides improvements in the effectiveness and efficiency of inventory management, incidents for the maintenance of equipment, infrastructure and facilities, and provides a common, dynamic and transparent environment for communication, collaboration and coordination that allows planning, decision making, control and management of data that derive from the activity of the service together with the agencies involved in these tasks.

The application allows managers to continuously monitor the work. With the Rosmiman system for incident management and maintenance, the following general objectives can be undertaken:

- Inventory of Technical Assets, Infrastructures and facilities.
- Accessibility and availability for all of the maintenance data.
- Corrective, Preventive and Technical Legal Maintenance, Routes and Inspections.
- Improvement of the organisation and Optimization of human and material resources.
- Real-time analysis from historical data. Maintenance indicators and control panel.
    - Information Security.
    - Technical-Economic Management of Assets and Maintenance.
    - Operating costs, productivity.
    - Integration with other departments and computer applications of Management.
    - General, SCADA systems and with service subcontractors.
    - Adaptation to existing regulations of the Law on Prevention of Occupational Risks.

2.2.4.3 Information Exchange Services between Traffic Control Centers

Coordination between Control Centers is essential for continuous improvement in infrastructure management. For this reason, a project has been developed consisting of the development of various software services that enable the exchange of mobility information between, in this case, the Traffic Control Center of the city of Vitoria-Gasteiz and the Basque Government. For this purpose, the EcoTraffiX integrated mobility management platform of

Kapsch, installed in the Traffic Control Centre, is used. The information exchanged is as follows:

- Inventory data of measurement points (points) and sections (polylines).
- Traffic data (intensity, occupation and density) per measuring point or stretch in 15-minute groupings between two dates.
- Returns the inventory and operational status (if available) of all cameras.
- Returns the last available image (snapshot) from each camera in jpeg format.

2.2.4.4 City Charger Cargo Bike

City Changer Cargo Bike is a European project framed within the Horizon 2020 program whose purpose is, on the one hand, to consolidate the DUM through bicycle cargo, which there was a previous development of definition of objectives with the Cyclelogistics Ahead project in which the city of Donostia / San Sebastian also participated as a partner city and that in this call is intended to extend not only to the commercial but also to the private sphere so that citizens can also acquire healthy habits in the private distribution of both goods and people.

The project aims to influence the promotion of bicycles cargo not only bringing their presence among citizens with different training and awareness campaigns but also helping to establish regulatory frameworks in reference to their use in both urban and interurban road network. The project will last 36 months, starting in September 2018 and ending in September 2021.

2.2.4.5 Transforming Transport

The aim of the Transforming Transport project (2017-2019) is to apply big data and artificial intelligence technologies to improve transport efficiency. Among the pilots developed, Indra has developed a system (DAS) which is capable of identifying heavy vehicles thanks to the monitoring of the optical fiber using image processing and artificial intelligence technologies.

2.2.4.6 CIVITAS ECCENTRIC

The CIVITAS ECCENTRIC project "Innovative solutions for sustainable mobility in urban peripheral areas and emission-free urban goods distribution" started in September 2016. With a duration of 4 years, the aim of the project is to demonstrate and test the potential and replicability of 50 measures of sustainable mobility and integrated urban planning, to improve the quality of life of citizens in urban areas - with a focus on city peripheries - and on the urban organisation of goods in a clean way.

Specifically, as part of the measures implemented in Madrid, the Regional Transport Consortium (CRTM) has developed a new multimodal mobility portal where information on the different modes of transport present in the region is integrated.

Illustration 79. Multimodal mobility site. Source: Portal de Movilidad Multimodal

It not only contains information on public transport, but also on shared mobility, relevant data from the different municipalities related to mobility, etc. Thus, in the same portal the user can have access to all the information about mobility in the region.

Similarly, in those cases where the information is in open format (as is the case of the CRTM's public transport information) it will serve as an access point for developers who want to create their own applications.

This mobility portal was launched in March 2019 and since then, a process of evaluation, monitoring and measurement of indicators has been carried out with the following outstanding results:

- The development of the regional mobility portal has helped in the creation and improvement of more than 18 mobile applications and 9 web pages that provide information on mobility in the region of Madrid.
- Users have shown their satisfaction with the improvement of the quality of information on public transport through surveys carried out once the platform was in operation; the degree of satisfaction was 3.8 out of 5.
- As for the developers, they also rated it positively with a degree of satisfaction of 3.9 out of 5.

2.2.4.7 Copernicus System for Goods

“Renfe Mercancías” has set up the Copernicus System (with GPS technology) which allows real-time monitoring 24 hours per day, 365 days per year, of all the elements involved in the production and commercial process, from the moment a train is scheduled to arrive at its destination. This system makes it possible to meet the requirements of customers by providing them with traffic forecasts and exhaustive monitoring of their traffic in order to plan their production and logistics operations and anticipate solutions to incidents during transport.

“Renfe Mercancías” has set up a 24-hour Management Centre with permanent service 365 days per year, equipped with the Copernicus Merchandise System.

2.2.4.8 Loading and unloading control and monitoring system

The loading and unloading model is very complex in several areas/neighbourhoods of Seville, especially in its Old Town. In these areas there is a great concentration of hotel and catering activities with a greater need for loading and unloading, and a large number of suppliers. Space is scarce which makes it necessary to avoid simultaneous operations.

The establishment of new timetables, the cataloguing of the type of goods to be served, the type of supplier and the destination of the same, becomes essential to determine the time needed in the operation, constituting in itself a new model of distribution designed ad-hoc for each area of the city.

The system that is the object of this project will control and monitor loading and unloading operations by virtue of the current distribution model, designed to optimize the distribution of goods in each area.

The variables of the system will be the availability of places in real time, the allowed schedules, the types of goods, distributors/suppliers, origin/destination of the goods and other factors that help to a rational use of space and time.

The existence of this continuous monitoring system will help to pursue the excess time spent in the loading and unloading areas.

2.3 Priority Area III. ITS applications for road transport safety and security

Progress in the field of road safety in Spain has made it possible to reduce the number of road fatalities by 6% compared to 2018, with 36 road fatalities per million inhabitants in 2019, while the average for the European Union was 51 fatalities per million inhabitants in the same year.

However, Spain continues to work on finding solutions and innovations to achieve the goal of zero fatalities in road accidents.

Within this framework, ITS play a key role and therefore Spain is committed to the deployment of these systems that will undoubtedly continue to facilitate the safe movement of citizens.

2.3.1 Description of national activities and projects

This priority area focuses on the description of specifications and standards for ITS applications on safety and security in road transport. The following priority actions are part of this area:

- Priority action (d): Definition of the measures necessary for the harmonized provision of an interoperable EU-wide emergency call number (eCall)
- Priority action (e): Definition of the necessary measures for the provision of ITS-based information services on safe and secure parking places for trucks and commercial vehicles, in particular at rest areas on the road network

Illustration 80 Priority Area III. Source: Own Elaboration

2.3.2 Progress since 2017

2.3.2.1 SCOTT

Indra has developed a system to alert connected vehicles approaching a railway level crossing about the presence of rolling material on the road so that the vehicle and the driver can stop the vehicle safely. It has been implemented within the SCOTT project (https://scottproject.eu/) and tests have been carried out at laboratory level.

The project is financed by the Ministry of Industry and the ECSEL program (2017 - 2020). Indra's investment in this project which also deals with railway safety amounts to 4M. The location for the deployment of the pilot is still pending identification by the Railway Infrastructure Administrator (ADIF).

2.3.3 112 eCall (priority action d)

For Spain, the harmonized provision of an interoperable eCall service across the EU is a priority action since it shares the vision that this service would contribute to the reduction of the number of fatalities in the European Union, as well as the severity of injuries caused by road accidents by reducing the response time of the emergency services.

In relation to the current state of deployment, the nineteen (19) 112 autonomous PSAPs (Public Safety Answering Points) meet the requirements of the eCall PSAPs included in the Delegated Regulation (EU) No 305/2013 of 26 November 2012 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonized provision of an emergency call number throughout the European Union, subject to compliance by the other entities concerned (mobile network operators, car manufacturers, ...).

The 112 autonomous PSAPs are committed to carry out a self-assessment of compliance operations, in the same way as they currently work with E112 calls.

The eCall PSAPs have been deployed in the seventeen (17) autonomous communities.

All the infrastructure of these PSAPs is being updated to allow the correct reception and handling of eCalls (automatic and manual) using the number 112.

The geographical coverage of each PSAP eCall includes the respective territory of the autonomous community or city.

The description of the compliance tests has been defined based on the part of the Intelligent Transport Systems Standard - eSafety - eCall End-to-End Compliance Test (EN 16454) that relates the compliance of the PSAPs to the pan-European eCall.

The eCall procedures in Spain related to privacy and data protection included in the Delegated Regulation 305/2013 article 6 comply with the Spanish Law of Personal Data Protection (LOPD) approved on 5 December 2018, in the same way that they currently work with the handling of E112 calls.

In addition, the DGT makes available to the Autonomous Communities and Autonomous Cities a service to report all those incidents related to traffic, including eCalls.

For the time being, these incidents are being received from the 112 in the Valencian community and Galicia, which complete the information that the Guardia Civil Association and the Traffic Management Centres register in the LINCE system.

2.3.3.1 eCall – App

The company “Autopistas”, responsible for the management of toll roads, has an e-Call functionality in its Motorways on the Road app so that, in case a person has an incident, the app geolocates the mobile phone and sends a signal to the Granollers Operations Centre, from where the incident is managed. If the incident occurs outside the motorway limits, the signal is sent to 112.

2.3.4 Reporting obligation under the Delegated Regulation (EU) No. 885/2013 on the provision of information services concerning safe and secured parking places for trucks and commercial vehicles (Priority Action e)

The framework that regulates the deployment of intelligent transport systems on roads is constituted by Directive 2010/40/EU and 2008/96/EC on road infrastructure safety management, by its implementing regulations and by the provisions by which they were transposed into Spanish law: Royal Decree 662/2012 and Royal Decree 345/2011, respectively.

Specifically, Article 3 of Directive 2010/40/EU in its letter "e" establishes as a priority action the provision of information services on safe and secure parking places for trucks and commercial vehicles, developing the necessary specifications to ensure compatibility, interoperability and continuity of the implementation and operation of these information services in the Delegated Regulation (EU) No. 885/2013.

The measures included in this regulation pursue: avoid inadequate parking, contribute to the safety of drivers and goods, and facilitate compliance with the legally established rest periods for drivers of these vehicles.

In accordance with the provisions of these regulations and under the protection of Articles 26 and 27 of Law 37/2015 on Roads, the Director General of Roads approved a resolution for the creation of a National Access Point (NAP) to collect information on existing safe and protected parking areas, understood as those areas intended for the parking of trucks and other commercial vehicles, with protection and security facilities and with access through the Trans-European Road Network, as well as the rest of the roads of the State Road Network.

Nowadays the list of safe and secure parking areas included in the NAP is made up of 32 secure parkings with a total of 5.041 spaces.

The platform can be accessed through the following address:

https://portalweb.fomento.es/VisorGeograficoDGC/AparcamientosSeguros.

The information is available in Spanish and English.

The information shown in relation to these car parks is as follows:

- Name of the facilities
- Location

- Access route
- Longitude/latitude coordinates
- Number of parking spaces
- Parking rates
- LABEL safety and service levels
- Safety equipment available
- Available service equipment
- Phone number
- Facilities website

Facility owners who wish to have their parking area information accessible at the NAP may request this through

- A sworn declaration
- Self-assessment form

A dual classification system, Service Levels and Security Levels, has been adopted to classify the facilities, which is established as part of the European Label project.

Illustration 81 Safe and Secure Truck Parking Areas. Source: MITMA

2.4 Priority Area IV. Linking the vehicle with the transport infrastructure.

The vehicle, throughout its history, has incorporated electricity and computers into its infrastructure and now it has added a new layer: communications. Thanks to this new layer, the driver is not only helped by seeing and hearing, but also by other functions provided by the vehicle's systems. According to the "Digital Society in Spain 2019" report, Spain is the leader in digital connectivity infrastructures in Europe.

2.4.1 Description of national activities and projects

This priority area describes the specifications and standards for linking vehicles to transport infrastructure.

These specifications should include:

- Definition of the measures needed to integrate the different ITS applications into an open in-vehicle platform.
- Definition of the measures needed to advance the development and implementation of cooperative systems (vehicle-to-vehicle, vehicle-to-infrastructure, infrastructure-to-infrastructure).

Illustration 82 Priority Area IV. Source: Own Elaboration

2.4.1.1 C-ROADS

The C-Roads platform is an initiative of different Member States and road operators who wish to collaborate to achieve the deployment of harmonised and interoperable C-ITS services across Europe. C-Roads is a project co-financed by the European Union under the call CEF 2016-EN-TM-0272-S.

Spain participates in some pilot projects in five (5) local study areas along the central TEN-T network in several Spanish areas (regions of Galicia, Madrid and the Cantabrian and Mediterranean coasts), including part of the Mediterranean and Atlantic TEN-T corridors, as well as the urban nodes.

The main objectives of the C-Roads platform are:

- Accelerate the deployment of C-ITS in Spain through 5 pilots, prioritizing the full implementation of "Day 1" and "Day 1.5" services.
- To provide a coordinated framework of activity for Spanish stakeholders in the development of C-ITS products and services, in line with European initiatives in this field.
- To participate in the European C-Roads Platform, contributing actively to the different working groups and with presence in the Steering Committee.
- To guarantee the interoperability and continuity of C-ITS services, promoting cooperation with other Member States.
- To study the complementarity of hybrid communications (G5 and cellular communications) for C-ITS.
- To analyse the convergence of technologies related to the connected and automated vehicle.
- To ensure the scalability and replicability of results in order to address a wide deployment of C-ITS in Spain.
- Involve numerous partners covering the entire value chain. Road operators, telecommunication companies, vehicle manufacturers, equipment suppliers, service providers, fleet managers and IT system providers.

2.4.1.2 SISCOGA EXTENDED

Among the five C-Roads Spain pilots, the extended Siscoga Pilot is the most complete in number of C-ITS service demonstrations, as it will test a total of eighteen (18) services:

- Twelve (12) Day 1 services:
  - Emergency electronic brake light
  - Congestion alert
  - Slow or stationary vehicles
  - Construction site alert
  - Emergency vehicle approach
  - Weather conditions
  - Vehicle signalling
  - Speed limit
  - Vehicle as data source
  - Mitigation of the accordion effect
  - Signal speed/safety at intersections
  - Priority signalling for designated vehicles
- Six (6) of Day 1,5:
  - Re-fuelling of alternative fuels
  - Parking Information
  - Parking management
  - Dissuasive parkings

- Cooperative navigation in/out of the city
- Route Optimizer

The tests will be carried out in urban (Vigo) and interurban (AP-9 motorway and A-55 and A-52 highways) areas of Pontevedra, integrated in an intelligent corridor of more than 130 kilometres used for the tests of the Siscoga cooperative project.

The tests will involve a fleet of 30 private vehicles, 30 buses, 15 taxis and 5 emergency vehicles. The Galician Automotive Technology Center (CTAG), a pioneering entity in the ITS field in Spain, is coordinating the pilot, in which six other partners are participating.

In addition to the tests of Day 1 and Day 1.5 services, two other studies will be carried out. The first one will test the advantages that C-ITS services will bring to the autonomous and connected vehicle. Four prototypes will be used to test functionalities and use cases, such as urban autopilot (including Glosa technology, which sets the optimal speed to find all green lights), last mile urban services, motorway driver or GPS correction service. Cases with intersections or parking will be carried out in urban areas, and those with motorway entry or exit, emergency stop, or hazard information will be carried out in interurban areas.

The second study will consist of a cross-border test to evaluate the interoperability of the Spanish pilot with the C-Roads Portugal pilot, a basic requirement of C-Roads. As activities, there will be interoperability tests of Day 1 and Day 1.5 services and tests of interurban C-ITS services for automatic driving. The tests will be carried out on the Spanish motorway A-55 and on the Portuguese motorways A27 and A28.

2.4.1.3 CONCORDA

The aim of the CONCORDA (CONnected CORridor Driving Automation) project promoted by EATA (European Automotive Telecom Alliance), is to improve and update the environment for existing pilot projects for three main use cases:

- Autonomous driver for highways
- Truck Platooning
- Automatic features to avoid collisions

Illustration 83. CONCORDA project logo. Source: Amsterdam Practical Trial

This project, launched in 2017 and funded by the Connect Europe Mechanism, will contribute to the preparation of European motorways for connected and automated driving and distribution of large-volume trucks. This will help overcome fragmentation and ensure backward interoperability between Cooperative-ITS services and C-ROADS harmonized services in real traffic situations.

2.4.1.4 SCOOP

SCOOP is a project for the deployment of cooperative intelligent transport systems, i.e. systems based on the exchange of information between vehicles (V2V) and between vehicles

and roads (V2I/I2V)). The vehicles are equipped with sensors that detect events such as emergency braking, slippery roads, etc. and with on-board units capable of transmitting the information to the vehicles behind and to the road operator through the roadside units (RSUs). The road operator can also send information to the vehicles through their on-board units.

Illustration 84. SCOOP project logo. Source: Intercor Project

The main objective of SCOOP is to improve road safety, but also the safety of road maintenance agents involved in road maintenance and works, among other matters.

The exchange of information between vehicles and infrastructure is based on the ITS G5, a short-range communication technology designed for C-ITS.

In this project, which benefits from a grant from the European Commission, Spain is participating in cross tests together with Austria and Portugal.

2.4.2 Progress since 2017

2.4.2.1 Autonomous Bus UAM

The Autonomous University of Madrid launched, in January 2020, the first autonomous university bus in Spain, one hundred percent electric and autonomous. The Community of Madrid Transport Consortium, the Directorate General of Traffic (DGT) and the transport company ALSA are also participating in this project, which is a pioneer in Spain.

The bus has a capacity for 12 people and will travel a total of 3,8 kilometres around the university campus. The lane in which the bus runs has been marked with road signs to indicate its journey. In addition, traffic signs have been installed to warn that the lane is ideally for the local bus service.

Illustration 85. Signalling "preferential lane for autonomous bus". Source: DGT

The vehicle will always be accompanied by an assistant who will monitor its operation in the event of possible incidents, such as a vehicle parked in a double row on a preferential lane.

2.4.2.2 5G-MOBIX

This project develops and tests automatic vehicle functionalities using 5G's core technological innovations along different cross-border corridors and in urban environments.

Illustration 86. 5GMOBIX project logo. Source: 5G PPP

The objective of the project is to evaluate benefits in the context of CCAM, as well as to define implementation scenarios and identify and respond to standardization gaps.

Several automated mobility use cases are potential candidates to benefit from 5G, such as cooperative overtaking, merging of road lanes, truck parking, driving in urban environments, detection of road users, vehicle remote control, transparency, HD map updating, media and entertainment.

2.4.2.3 EU EIP 4.2 - Facilitating Automated Driving

The scope of Sub-Activity 4.2 - Facilitating Automated Driving - of the EU EIP project, is to assist road operators in making decisions on the incorporation of automated driving and the automation of their own core business.

Throughout 2019, DGT participated in the updated and consolidated delivery of the second and third deliverables on ITS automation with the aim of identifying the requirements for such automation and facilitating the integration of the infrastructure with the autonomous vehicle.

The scope of this deliverable is to describe which autonomous functions could benefit road operators in improving their ITS operations, maintenance and service delivery. The document begins by describing existing automated functions and systems and proposes a new approach to the architecture and implementation of autonomous applications. Secondly, it identifies good practices in the implementation of automated functions in road systems and traffic control centres. Finally, a set of KPIs is proposed that can be used to measure the effects of introducing such automation.

Furthermore, during 2020, work has been carried out on the roadmap for the implementation of automated systems in current and future Traffic Management Centers with the year 2030 as a target date; a horizon year in which, under pressure from the advances in automated vehicles and C-ITS, road operators will have to improve their systems since the market penetration of automated and specially connected vehicles is expected to reach considerable levels.

Illustration 87. Facilitating automated driving. Source: Connected Automated Driving

2.4.2.4 DGT 3.0

The DGT 3.0 project analyses the implementation of the C-ITS services of day 1 and day 1,5 through an IoT platform, allowing the interconnection of all the actors involved in the traffic and mobility ecosystem. The main objective is to provide mobility and road safety services based on 3G and 4G / LTE cellular communication technologies. This project, promoted by the Directorate General of Traffic, includes the participation of different stakeholders.

Illustration 88. Project DGT 3.0. Source: DGT Magazine

DGT 3.0 analyses the requirements of real-time performance capacity that allows the reception and processing of large amounts of data and the introduction of logic that benefits road safety, promoting its dissemination by making it available to road users who are interested in its direct impact on the prevention and reduction of accident figures.

In the development of the project, the planning, analysis, design and codification and implementation of the "Day 1" and "Day 1,5" use cases are part of the process, necessary to create the algorithms that allow real-time decision making and the dissemination of road information to other affected road users, all based on the information generated in the Spanish road network.

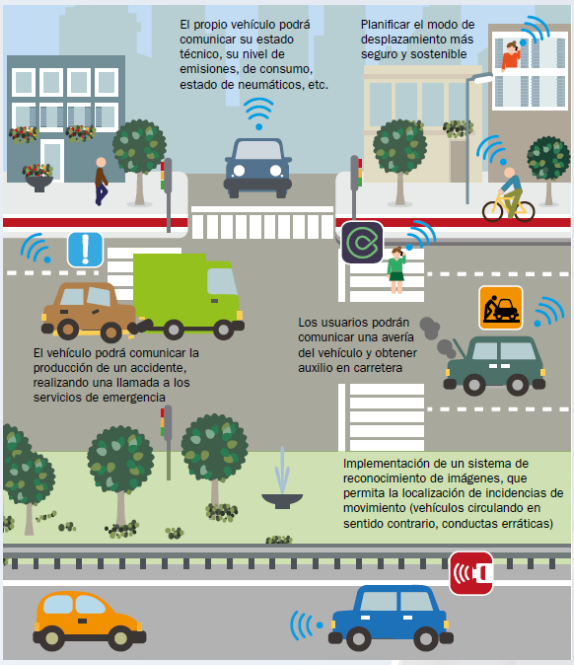

Illustration 89. Smart and Safe Mobility. Source: DGT

The following image shows the structure of the platform:

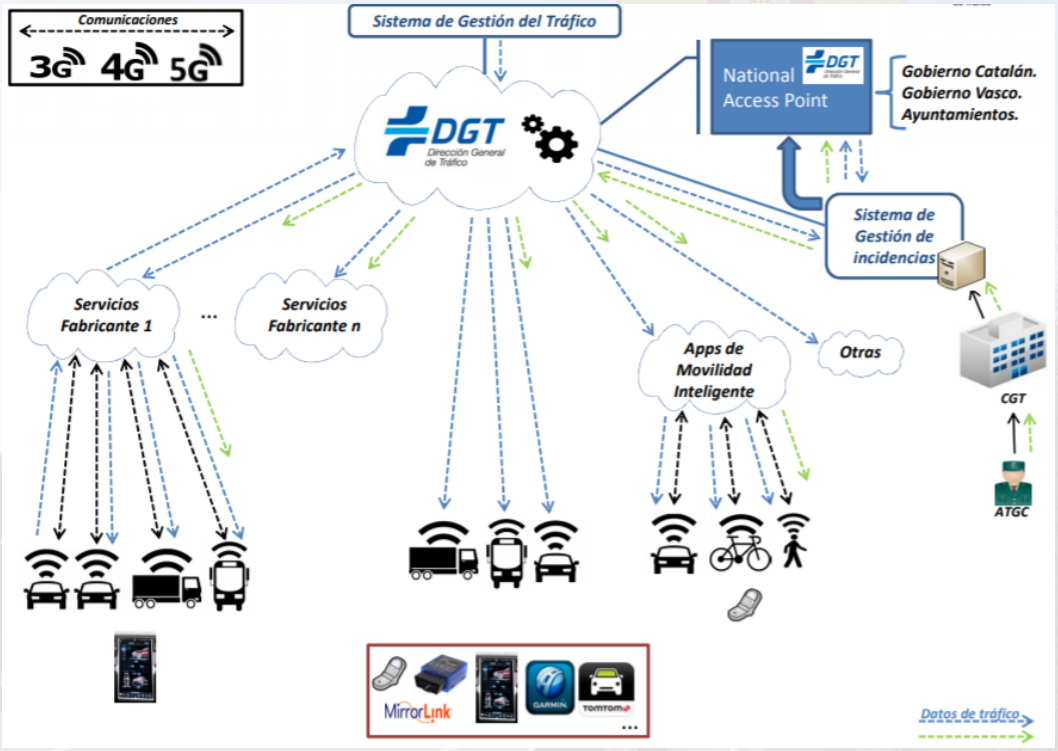

Illustration 90. Structure of the DGT 3.0 platform. Source: DGT

Of the fifteen (15) cases that make up the DGT 3.0 project, the first seven (7) have been developed in the first part of the contract; there are currently five (5) cases in production:

- Use case 1: Generic incidence alert provided by a third party. V-16. This V16 signal is a type of yellow flashing light in the form of a headlight or siren that is placed on the roof of the vehicle in a magnetic way and can be seen from a distance of one kilometre. It is very intuitive to use, as it switches on automatically when it detects contact with the roof panel. However, it can also be switched on manually. This signal, which will replace the hazard triangles on the road, and which are connected to DGT 3.0, will make it possible to publish the exact point where these active lights are active.
- Use case 2: Real-time information on work in progress
- Use case 3: Information provided by vehicles (lights, warnings, ESP, etc.), are available and received from manufacturers participating in the European Data Task Force.
- Use case 4: Virtual message signs. Possible use to inform the activation of pollution protocols and low emission zones.
- Use case 7: Real time traffic light information. Data is currently being received from several regulators in the cities of Barcelona and Vigo. These messages, which include the information on the different phases and the topology of the intersection, are available to the users of the platform in real time, in order to help the development of the cooperative services GLOSSA and Time to Green.

Finally, use cases 5 and 6 corresponding to special vehicle information and information on points of interest respectively, are under development. The other use cases up to 15 will be defined from September 2020 and will be developed until 2022.

2.4.2.5 AUTOCITS

The main objective of the AUTOCITS project (01/11/2016 - 31/03/2019) is to contribute to the deployment of cooperative services (C-ITS) in Europe, improving the interoperability of autonomous driving and promoting the role of C-ITS as catalysts for the implementation of autonomous driving.

The project is developing 3 pilots in 3 European cities belonging to the Atlantic Corridor, Madrid, Paris and Lisbon. These pilots allow to evaluate the deployment of cooperative services with autonomous vehicles, under the current traffic regulatory framework. The pilots include tests of autonomous driving in both open and closed traffic environments, in order to evaluate the application of traffic regulations. Specifically, the action includes a study of traffic regulation for autonomous vehicles aimed at driving in urban roads connected to main transport networks at European and international level.

The pilots monitor the hybrid ITS-G5 infrastructure-vehicle (I2V) communications in real time, which allow the vehicle to receive information in advance about various events such as roadworks warning service, weather conditions service or traffic ahead warning.

The main results of the project are listed below:

- More than 6000 km have been covered during the tests.
- 14 connected and autonomous vehicles have been involved in the pilots.
- 25 RSUs (Roadside Units) from 4 different manufacturers have been installed.

- The validity of C-ITS services and autonomous driving has been demonstrated, after the definition of 3 types of manoeuvres.
- Collaboration with initiatives such as C-Roads in the harmonization of C-ITS systems.
- They have been carried out in different types of urban environments.
- Two cross-border tests have been carried out (Cross-Border), between Spain and Portugal and between Spain and France, contributing to the development of the Mediterranean Corridor.

The total investment has reached 2.606.550 euros.

2.4.2.6 INFRAMIX

Autopistas participates in the INFRAMIX project whose main objective is to prepare the road infrastructure with specific affordable adaptations and to support them with new models and tools, to accommodate the gradual introduction of automated vehicles.

The purposes of INFRAMIX is as follows:

- To design and develop elements for the new digital road infrastructure, integrating also the information received by automated vehicles; this digital infrastructure will become the basis for an improved electronic horizon for automated vehicles.
- To adapt and update the elements of the existing physical infrastructure to allow the gradual insertion of automated vehicles.
- To develop new traffic flow models (sub-micro and microscopic) combined with mature simulation tools (e.g. VSimRTI, ICOS) that integrate real vehicle algorithms for automated driving and human driver behaviour to examine mixed traffic scenarios under various penetration rates of different levels of automated vehicles.
- To design and implement traffic estimation, monitoring and control strategies dynamically adapted to different levels of automated vehicle penetration, infrastructure equipment and general traffic condition.
- To evaluate safety performance in the three selected scenarios, for mixed traffic situations; collect/monitor mixed traffic data to identify new safety performance criteria for road infrastructure

2.4.2.7 5G MED

The contribution of 5G MED represents a significant step forward in the technological revolution that will enable augmented reality entertainment for cars and railways, advanced traffic management and finally continuity of commercial services to the railways during cross-border change. The service will feature on-board sensors and artificial intelligence (AI) for improved connectivity across transport routes.

The project has a global investment of 16 million euros. The work will be developed from September 2020 to November 2022. The tests will be carried out in three test facilities to reproduce real conditions. The final validation will be applied to the motorway and railway between Figueres (Girona) and Perpignan (France). This route is strategic in the transport network, since it supports 55% of the road traffic between the Iberian Peninsula and the rest of Europe, as well as 65% of the rail traffic. One of the 21 partners in the consortium is the Autopistas company, part of the Abertis group.

2.4.2.8 SECREDAS

The objective of the SECREDAS project (2018-2021), in which the company Autopistas is participating, is to develop a software to validate architecture methodologies, reference architectures, components and proper integration, as well as verification approaches for automated systems in different domains. These will combine high security and privacy protection, while preserving functional security and operational performance, complying with the recent General Data Protection Regulation (GDPR). SECREDAS has received funding under the ECSEL JU framework in collaboration with the European Union Framework Programme H2020 (H2020/2014- 2020) and the National Authorities, under grant agreement no. 783119.

SECREDAS will develop a connected vehicle pilot to advance safety mechanisms to provide vehicles with information in a secure manner. The proposal will develop and validate a number of common technological elements for the reference architecture such as ITS-G5/5G communications, development of a centralised gateway, specific communication channels for sensor elements, cryptographic functions, anomaly detection, among others. The definition of the requirements and pilot test is also foreseen in order to advance towards levels 3 of automation, based on the monitoring of the driver's status and the transfer of vehicle/human controls.

Illustration 91. SECREDAS - Digital Privacy. Source: Virtual Vehicle

2.4.2.9 SHOW

The SHOW project is a European project coordinated by UITP and ERTICO that will deploy autonomous buses in different European cities. Together with EMT Madrid, TECNALIA will deploy in Madrid an autonomous bus in the southern area which will be supported by the infrastructure to improve the perception of the environment and therefore the safety of the manoeuvres. The project started in January 2020 and ends in December 2023. It has a total budget of 20M euros.

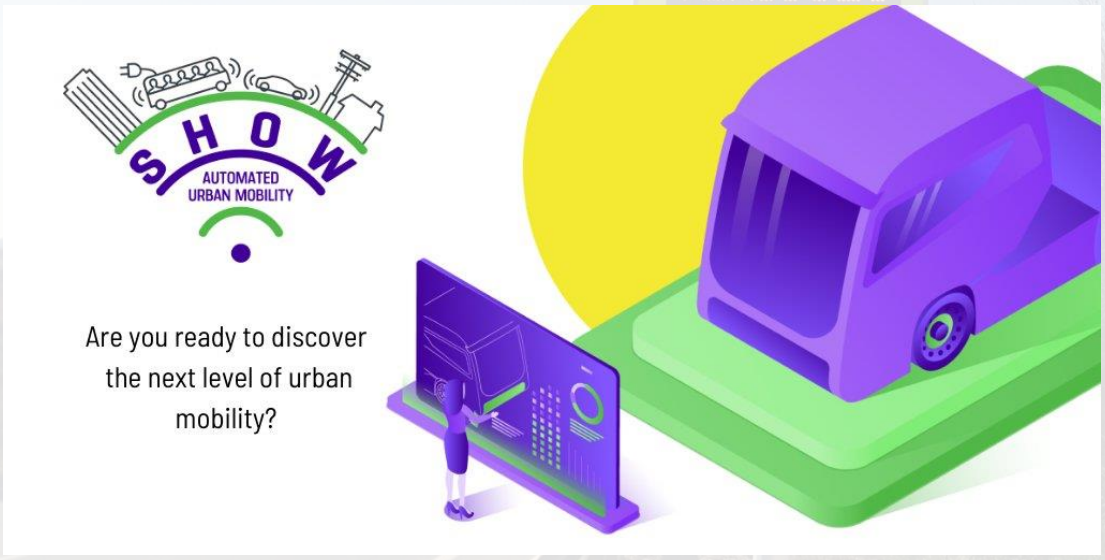

Illustration 92. SHOW - Automated Urban Mobility. Source: Twitter SHOW

2.5 Other initiatives / highlights

2.5.1 Description of other national initiatives / highlights and projects not covered by priority areas I - IV

Spain participates in other initiatives, platforms and projects that, although related to the four priority areas described above, do not fall within any of them clearly:

Illustration 93. Other initiatives. Source: Own Elaboration

2.5.1.1 EU EIP

The harmonized deployment of ITS across the TEN-T network and its core network corridors to make mobility more secure, reliable and environmentally friendly, and to improve corridor performance, is the main mission of the ITS corridors co-financed by the EFC - Arc Atlantique, Crocodile, MedTIS, NEXT-ITS and URSA MAJOR - and of the EU ITS Platform (EU EIP). Spain, through the General Directorate of Traffic, participates in Arc Atlantique, MedTIS and in various sub-activities of the EU EIP platform itself.

EU EIP serves as a knowledge management center by developing, providing, promoting and maintaining harmonization tools and processes of substantial value to National Road Authorities and road operators, to private actors as partners in the ITS value chain and network, to the European Commission in the implementation and advancement of ITS policy and regulation, as well as to relevant stakeholders and multi-stakeholder collaborations in the ITS community.

Among the main achievements of EU EIP are the European Reference Manual for the Harmonized Deployment of ITS Core Services in Europe, an improved mechanism for Corridor Cooperation, KPIs for ITS deployment and benefits, the ITS toolkit and evaluation library, the strengthening of the National Access Points community, innovation schedules and deployment roadmaps, information service quality frameworks and assessment methods, physical and digital infrastructure attributes for automated driving, good practices for automating road operators' own ITS and integration of C-ITs into road operators' daily activities. The results of EU EIP address all ITS Priority Areas I-IV and also contribute to the knowledge of key performance indicators (KPIs) related to ITS corridors. More information is available at www.its-platform.eu.

2.5.1.2 DATEX II

Over the last three years, many improvements and advances have been made under the DATEX II program, the recommended language for the exchange of traffic-related data. The DGT, as an active member of the project, in addition to being responsible for some of the communication and social networking tasks, has gradually introduced improvements from the technical and information exchange point of view at national level, the most important are:

Adaptation to DATEX II version 3.0 of Situations

In view of the publication of version 3.0 of DATEX II, the DGT has made an effort to adapt to it. To this end, it has developed customised software that converts the publication of situations 1.0 into 3.0. It is expected that this information from version 3.0 will be published on the Internet soon.

Publication of the MeasuredData ITS Detector on the Internet

The DGT has different publications on the Internet in DATEX II format, corresponding to Situations, Locations... To this set of publications rolled out at the beginning of 2020, they have added one corresponding to MeasuredData in which the data in real time of the ITS Detectors are found. In addition to MeasuredData, the information on locations corresponding to this equipment was also published. This data is available at:

http://infocar.dgt.es/datex2/dgt/MeasuredDataPublication/detectores/content.xml

http://infocar.dgt.es/datex2/dgt/PredefinedLocationsPublication/detectores/content.xml

Integration of the Winter Way through DATEX II

During the winter, from the end of 2018 to 2019, a collaboration was initiated between the DGT, which belongs to the Ministry of the Interior, and the Ministry of Public Works (currently the Ministry of Transport, Mobility and Urban Agenda).

The Ministry of Transport, Mobility and Urban Agenda is responsible for the maintenance of national roads, so in the event of snowfall, they may be the ones with the most up-to-date and accurate information on these roads, and they have always informed the DGT by any means available (telephone, fax, etc.).

At the end of 2018, the joint work of the IT teams between the DGT and the Ministry of Transport, Mobility and Urban Agenda was carried out. This allowed the DGT to receive the information in its systems automatically, so that the appropriate measures could be taken at

any time (obligation to use chains, banning of certain types of vehicles from circulation, etc.). Likewise, the Ministry of Transport, Mobility and Urban Agenda receives the information generated by the DGT in its systems.

All this work has been carried out using DATEX II as the intermediate language in which the two ministries generated their information.

2.5.1.3 TN-ITS

TN-ITS GO is a PSA (Programme Support Action) for the implementation and facilitation of the exchange of spatial data considered essential for the deployment of cooperative ITS applications.

This project, co-financed by the European Commission and of which the DGT is part, deals with the exchange of information on changes in the static attributes of roads. It is crucial that digital maps for cooperative ITS are constantly updated regarding the attributes that are critical in terms of safety and efficiency. That is why efforts are focused within this initiative on implementing information about changes in infrastructure managed by road authorities, with these agencies being the most efficient and immediate source of such information.

In this sense, and in accordance with the previous paragraph, the work carried out by DGT in recent months within the framework of this project focused on the creation and updating of the speed limit signalling database on the State Road Network in accordance with the ROSATTE XML standard, which is also the result of collaboration with the Ministry of Transport, Mobility and Urban Agenda. Until June 2020 the format in which the data was manipulated was Geopackage, but thanks to this development, this information is now updated (new signage additions and deletions, changes in location, etc). The main figures of this update are shown below:

Illustration 94. GIS representation of the speed limit signal coverage included in the DB. Source: DGT

Table 63. Update of speed limit signalling database in the framework of TN-ITS GO. Source: DGT

SPEED LIMIT SIGNS				
TOTAL SIGNALLING IN DB AS OF MAY 4, 2020	TOTAL SIGNALLING IN DB AS OF JUNE 2, 2020	REGISTRATION	REMOVAL	UPDATES
78358	78484	340	214	426

2.5.2 Progress since 2017

2.5.2.1 LOD-RoadTran18

The DGT participates in the European LOD-RoadTran18 project "Supporting the cross-border use of Road Traffic Data with Linked Open Data based on DATEX II", which aims to promote the reuse of dynamic traffic information within and between two European Union Member States, namely the Czech Republic and Spain. This action pursues to contribute to making the European Open Data Portal and the information hosted in it accessible, interoperable, reusable and all this based on making it possible for traffic information to be connected to data from any other sector through the use of Linked Open Data (LOD). The project started in September 2019 and lasts 3 years.

This project will advance the basic access to open traffic information through a Traffic Information System taken to another level through LOD, according to the ITS Directive (2010/40/EU). The action will facilitate the visualisation and downloading of the data, but above all it will enhance the extraction of meaning from the data, allowing other types of advanced query and information crossing services, which can only be achieved through the use of LOD. Furthermore, this project proposes a framework for assessing and monitoring the impact of data reuse, applicable throughout the European Union. Additionally, it offers a toolkit for National Access Points in other Member States in order to share the use of a specific common metadata model. This project is co-funded by the European Commission under the CEF Telecom 2018 Public Open Data call (CEF-TC-2018-5).

Illustration 95. Supporting the cross-border use of Road Traffic Data with Linked Open Data based on DATEX II. Source: LOD-RoadTran18

2.5.2.2 Autonomous Ready Spain

The Barcelona Autonomous Ready project aims to equip with driving support systems (ADAS) enough vehicles to monitor the city and alert the driver to the presence of other users on the road. The project should demonstrate the positive impact of technologies for the reduction of accidents, contribute as an intermediate step to the appearance of autonomous vehicles on

our roads, and will serve to provide information to the city council so that it can plan actions in the city's infrastructure.

The Autonomous Ready project aims to demonstrate how technology, the driving assistance systems (ADAS), can contribute to the reduction of accidents, especially in those environments where there is coexistence with the vulnerable user. ADAS devices, among other functions, allow motorists, cyclists and pedestrians to be visualized and, in case that the system detects that the direction of the vehicle and the speed could lead to an accident by hitting or running, it alerts the driver so that he or she can react.

The project is currently in development in the city of Barcelona, with public-private collaboration between the administrations and various companies committed to reducing the accident rate, and work is beginning on analysing the relationship between the areas where alerts have been detected and with the city's hot spots in terms of accident rates.

2.5.2.3 Dynamic adaptation of speed limits

As traffic conditions depend not only on the intensity of vehicles travelling on the infrastructure but also on external factors such as weather, graphic lane markings and variable sign posts have been installed at key points on the road network where speed limits need to be temporarily adapted to the road conditions at any given time.

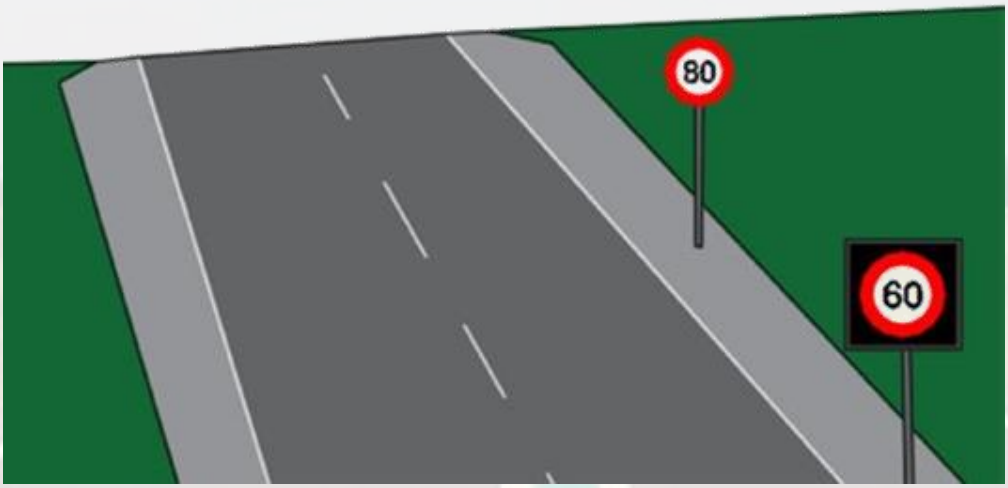

Illustration 96. Dynamic adaptation of speed limits. Source: Own Elaboration

2.5.2.4 Spot speed monitoring by fixed and section radars

The deployment of radars entails a substantial increase in compliance with limits, a reduction in average speed, and in particular extreme speeds, as well as in the number of accidents and their seriousness, which undoubtedly increases road safety. It is for this reason that the DGT continues to support this type of measure in the following ways:

- Fixed radars: generally composed of a lateral radar equipped with an anti-vandal video surveillance system. It is usually accompanied by a variable signpost for advance warning of speed control.

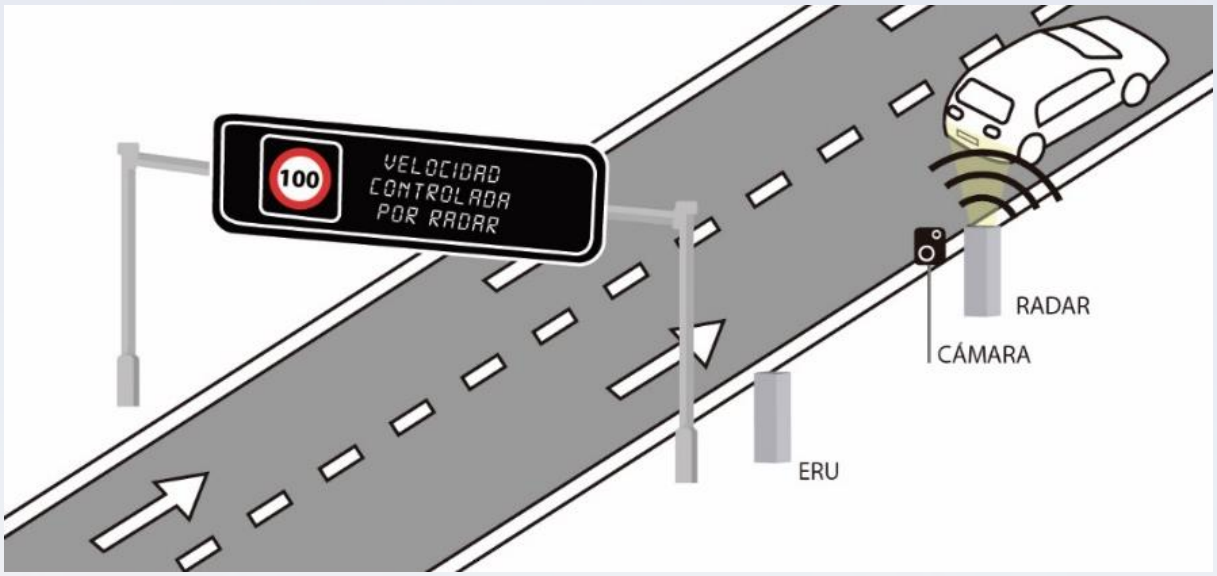

Illustration 97. Typical diagram of the system for controlling point speeding using fixed radars. Source: DGT

- Section radars: generally made up of an automatic medium speed cymometer and two license plate readers cameras equipped with an anti-vandal video surveillance system. It includes a variable sign for pre-announcement of speed control.

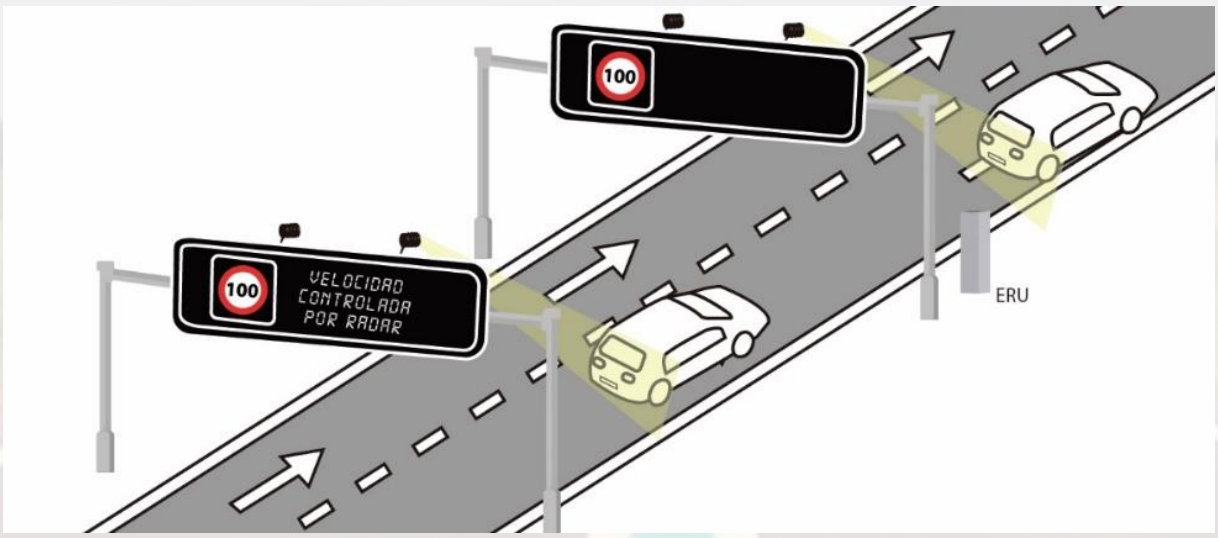

Illustration 98. Typical diagram of the system for controlling excess speed in sections using radar in the industry. Source: DGT

2.5.2.5 Dynamic speed limit adjustment with radar link

This system consists of adapting the speed limits of the radars according to the new limits established by the dynamic adaptation of speed according to traffic and weather conditions in real time.

Although this system is still at the project stage, it is expected that speed cameras can be connected to the variable signs which will indicate the new maximum road speed and thus, simultaneously, these boards will be able to update the speed limit from which violations are recorded.

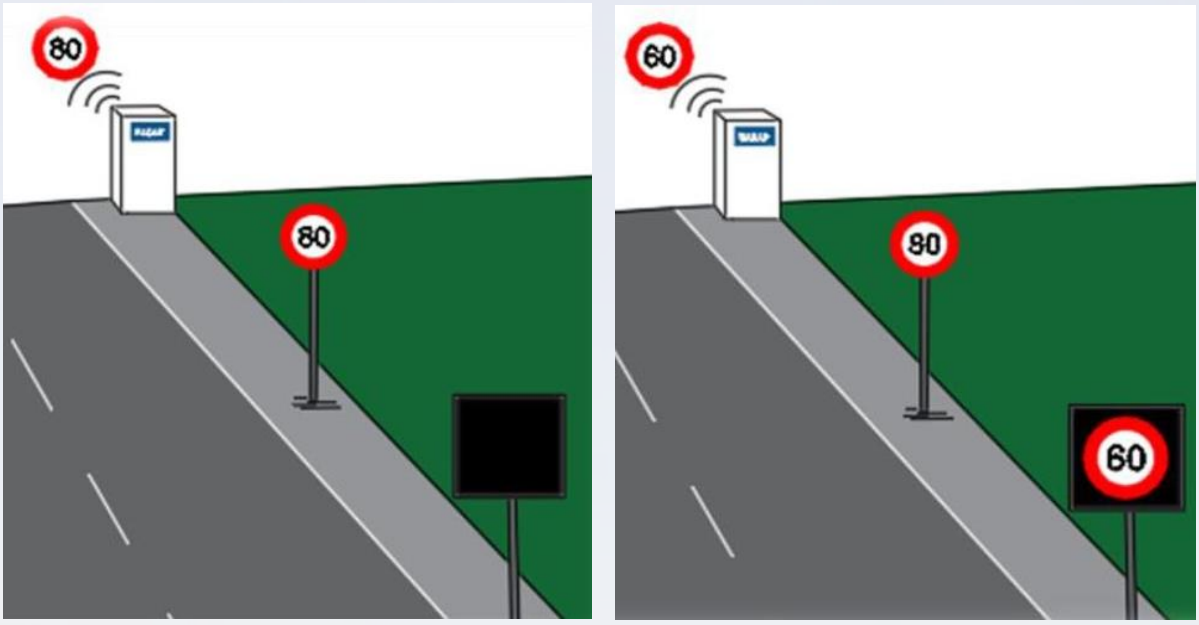

Illustration 99. Speed limits dynamic adaptation with radar link. Source: DGT

2.5.2.6 Helicopters and drones for road surveillance

The Helicopter Unit of the General Directorate of Traffic is the oldest flight unit of the Ministry of the Interior, having to date accumulated experience of more than 200,000 flight hours with a current fleet of 13 aircraft.

The main task of the operations of the helicopters of the General Directorate of Traffic is to collaborate in the reduction of road accidents and the improvement of the flow of traffic, that is, its main objective is road safety and mobility.

The usual missions are:

- Road surveillance
- Traffic regulation
- Instruction
- Participation in special traffic operations
- Transmission support

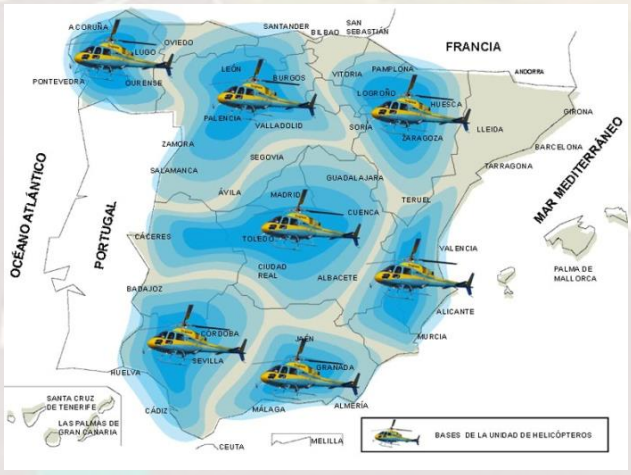

Illustration 100. Bases and areas of competence of the helicopter unit. Source: DGT

The first two, Surveillance and Regulation, are the most important, as between them they account for nearly 85% of flight hours. The surveillance of the roads has been the main mission, using photographic cameras in the beginning and gyro-stabilized video cameras from the 80's. The regulation takes place to provide updated information of the state of the roads to the Traffic Management Centres, on many occasions by sending the image of the camera in real time.

As a unit within the Ministry of the Interior, it additionally attends to any missions required for the benefit of society, collaborating with other bodies, mainly Civil Protection.

In 2019, 537 surveillance and 32 regulation flights were carried out, with a total of 1016 flight hours.

Illustration 101. Pegasus, helicopter for road surveillance. Source: DGT Magazine

2.5.2.7 COMP4DRONES

The main objective of the COMP4DRONES project (2019 - 2023), led by Indra, is to provide a framework of key technologies to develop safe and autonomous drones. In particular, it will enable autonomous and safe drone solutions for civil services. In this proposal, Indra will develop intelligent drone applications for the operation, optimization and improvement of maintenance activities and operation of transport infrastructures (both road and maritime), as well as traffic monitoring and control.

Indra will carry out a pilot for traffic and road infrastructure monitoring, allowing faster detection and action in case of possible incidents through the use of drones. The pilot will be deployed at Rozas airfield as part of the UAV civil initiative coordinated by the Xunta de Galicia. The project has a budget of 30M euros and will have 10 demonstrators in different locations in Europe.

2.5.2.8 Machine vision cameras for infringement control

At the moment, this type of camera is mainly used for controlling the use of the seat belts. However, other possible functionalities are being worked on, such as the control of the number of occupants of the vehicle by means of the application of different artificial vision software.

It consists of cameras capable of taking up to 50 photographs per second, which are analysed by a software designed to identify whether the user is wearing a seat belt. If this program detects that this is not the case (or there is doubt), it automatically transfers this image to a system in which an agent will check it and decide whether the sanction is appropriate.

Illustration 102. Artificial vision cameras to control the use of the belt. Source: DGT Magazine

In addition, these types of cameras do not focus only on detecting seat belt usage. They are equally capable of determining mobile phone use, as well as checking that vehicles have the Vehicle Technical Inspection (MOT) and insurance validated. To do this, they use the data obtained from the photograph.

DGT currently has 225 cameras of this type distributed throughout Spain.

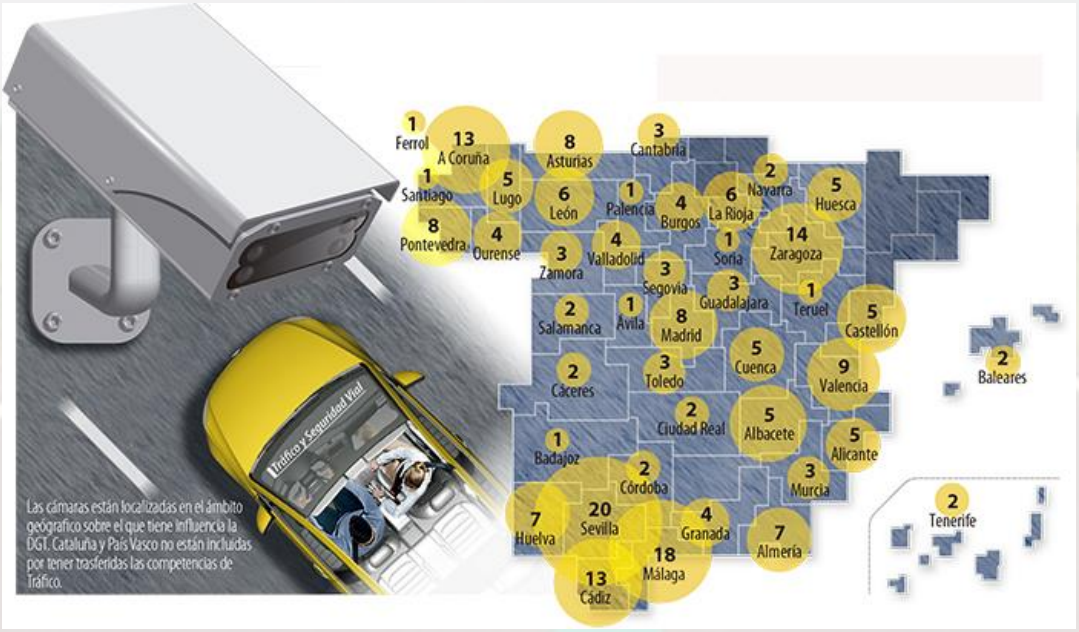

Illustration 103. Location of the cameras for the control of the use of the belt. Source: DGT Magazine

2.5.2.9 Red Phase Traffic Light Control System (photo red)

In certain sections where a continuous failure to comply with the obligation to stop at red lights has been detected, it has been decided to install this type of monitoring and control system. It consists of an all-in-one system that integrates two cameras, infrared lighting and a processing unit. It is located in the control area so that it is able to collect images of the infringement before, during and after it. The equipment is capable of extracting exact information on the license plate, date, time and location.

An example of this type of system can be found in O Fiouco, in Mondoñedo, as part of the automated fog diversion system. If the section is closed due to poor visibility, vehicles that infringe the signs and cross the section marked by red lights will be identified by their license plates and notified with the corresponding penalty.

Illustration 104. Red Phase Traffic Light Control System. Source: DGT

2.5.2.10 System for the Control of the correct signalling of the stop in STOP (photo-stop)

In a similar way to the previous measure, and in this case in the sections in which numerous accidents have been detected due to not respecting the signalling, it has been decided to install this system. It is very similar to that of the photo-red, also consisting of two cameras, infrared lighting and a processing unit. The functionalities of the equipment also allow to collect the images of the infringement before, during and after it, as well as to extract exact information of the license number plate, date, time and location.

Illustration 105. System to control the correct signalling of the stop in STOP. Source: Manzanares el Real City Council

2.5.2.11 Ceuta Safe City

The project includes an integral solution for the improvement of citizen and traffic safety that allows, by means of a proprietary communication system and advanced technology cameras, the automatic reading of license plates, search by appearance, facial recognition and detection of traffic accidents and incidents and security through artificial intelligence. An early detection system for forest fires will also be implemented using thermal cameras with an integrated weather information system. The project is completed by the installation of high resistance bollards - to control mobility and secure the streets against possible attacks - and the placement of citizen information panels to issue warnings related to mobility and security, all of which will be done together with the modernization of the two control centres in the Local Police and the National Police.

The planned investment is 1.818.000 euros and the scope can be summarized as follows:

- System of 65 implementations for Traffic Surveillance Cameras, License Plate Reading, Facial Recognition and Incident Detection.
- Fire Detection System consisting of 4 stations.
- System of 19 retractable elements to prevent access to vehicles.
- System of 7 Panels of information to the citizen.
- 2 Coordinated Local and National Police Control Centres.
- Integration software for all systems, mainly video management.
- Own Communications System formed by Optical Fiber Network that practically covers the city, reusable for other sensors in Smart City strategy.

2.5.2.12 Air Quality Monitoring

Madrid city council has developed a set of regulatory actions aimed at reducing environmental pollution and preventing climate change:

- The Sustainable Mobility Ordinance of 5 October 2018 (modified by agreement of 25 October 2018)

It aims to harmonise the different uses of roads and urban spaces, including pedestrian, traffic and parking, passenger transport, with the special importance of public transport, and the distribution of goods, and cultural, sporting, tourist and leisure use.

Likewise, it is the purpose of this Ordinance to make the aforementioned uses compatible in a balanced way with guaranteeing the safety and health of people, road safety, the necessary fluidity of traffic and the adequate distribution of parking spaces, the improvement of air quality and the protection of the environment, universal accessibility and the rights of people with reduced mobility, and the protection of the integrity of public and private heritage.

- Plan A: Air Quality and Climate Change Plan for the city of Madrid

It is a tool at the local level aimed at reducing air pollution, contributing to the prevention of climate change and defining adaptation strategies. The main objective is to guarantee the quality of the air that Madrid's citizens breathe and to strengthen the city against future climate impacts.

- Madrid 360

Preliminary proposal of objectives, axes and initiatives that will structure the emissions reduction strategy of the city of Madrid, which will be compatible with the needs of mobility and social, economic and territorial development and which will maintain at all times a global (360º) and long-term vision.

As tools for achieving the objectives set by the above regulatory actions, Madrid has an Air Quality Web Site, in which they are published:

- Real-time and historical data on the air quality and noise pollution index
- Predicting short-term air quality indices

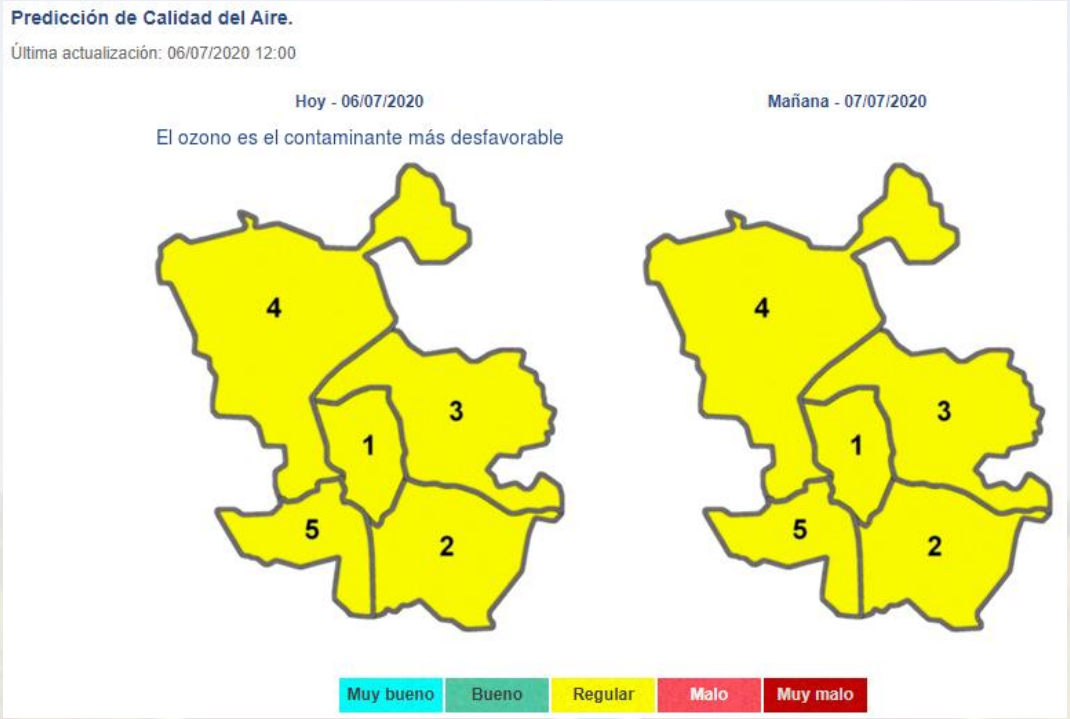

Illustration 106. Short-term air quality prediction. Source: Portal web de Calidad del Aire del Ayuntamiento de Madrid

CALIDAD DEL AIRE	Índice de Calidad del Aire(µg/m³)				
Contaminantes	**Muy bueno**	**Bueno**	**Regular**	**Malo**	**Muy malo**
Partículas $PM_{2.5}$	0-10	11-20	21-25	26-50	51-800
Partículas PM_{10}	0-20	21-35	36-50	51-100	101-1200
Dióxido de Nitrógeno (NO_2)	0-40	41-100	101-200	201-400	401-1000
Ozono (O_3)	0-80	81-120	121-180	181-240	241-600
Dióxido de Azufre (SO_2)	0-100	101-200	201-350	351-500	501-1250

Illustration 107. Levels and values associated with the different pollutants monitored. Source: Portal web de Calidad del Aire del Ayuntamiento de Madrid

- Action protocols for contamination episodes

In order to carry out the permanent control of air quality, Madrid´s city council has a system of monitoring, prediction and information that provides continuous and real-time knowledge of the concentrations of atmospheric pollutants, with the main objective of protecting the health of the population and reducing risk situations to a minimum.

For some of the pollutants, legislation has established information and alert thresholds that require specific information protocols or short-term action plans, in order to reduce the risk of these thresholds being exceeded and for compliance with established limit values.

In the municipality of Madrid there are two pollutants for which action procedures have been drawn up: nitrogen dioxide and tropospheric ozone.

- In the case of nitrogen dioxide, there are episodes with high levels of concentration that lead to exceedances of the hourly limit value (200µg/m3) at different stations in the monitoring network. For this reason, a protocol of measures to be adopted during episodes of high pollution by nitrogen dioxide has been approved by Agreement of the Governing Body of the City of Madrid on 10 December 2018, including traffic restriction measures by zones and scenarios.

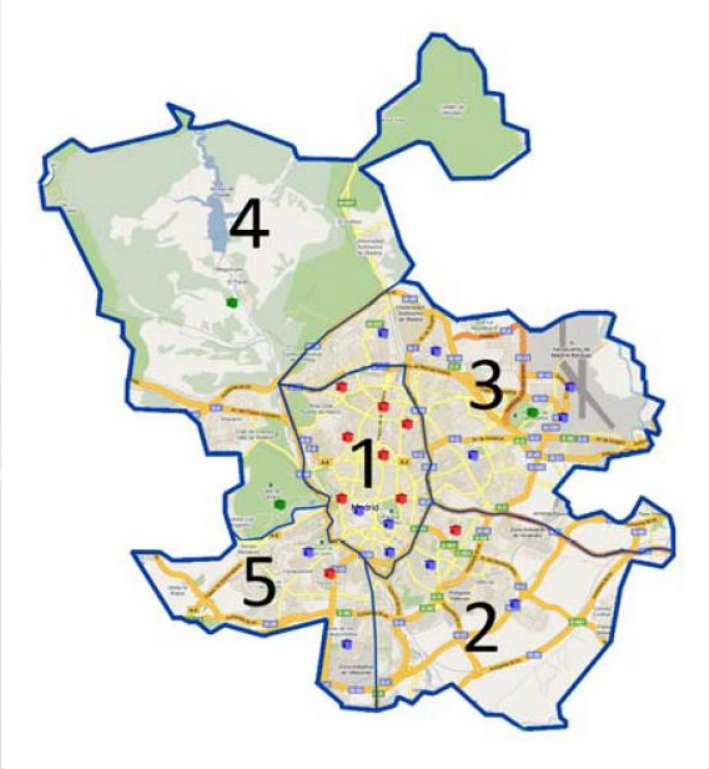

Illustration 108. Delimitation of the zoning for the application of the action protocol for episodes of pollution by nitrogen dioxide Source: Portal web de Calidad del Aire del Ayuntamiento de Madrid

- For tropospheric ozone, in addition to the alert threshold (240 µg/m3 for 1 hour) which has never been exceeded, there is also an information threshold (180 µg/m3 for 1 hour), which has been exceeded several times. For this reason, there is also an action protocol for this pollutant that includes actions aimed at protecting the most vulnerable population, including information measures and health recommendations.

The main means of information available to citizens are:

- The Madrid´s city council website
- Local information signs
- SMS to mobile alert service
- "Aire de Madrid" application and media (radio, TV, social networks).
- APPs, advice and services to citizens

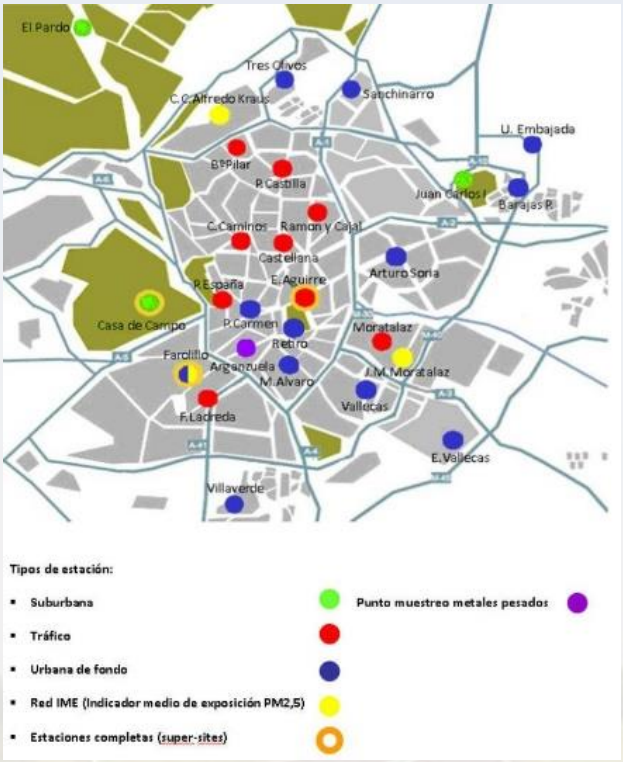

Illustration 109. Air quality measurement stations. Source: Madrid City Council

2.5.2.13 Respira Sevilla Plan

It is a plan focused on generating new areas free of private vehicles to make a city more habitable and sustainable, reducing emissions of CO2 and other pollutants into the atmosphere, thus contributing to the fight against climate change and improving people's health.

The Plan is part of the international commitments assumed by the city of Seville, including the Paris Mayors' Pact, the UN's Seville Declaration to implement the ODS at a local level and the Seville Declaration for the Circular Economy.

This is a system for controlling access to protected areas in the city, based on number plate recognition cameras.

The main objective of the Plan is to preserve the Historical Centre of Seville and the Triana neighborhood from unnecessary traffic, returning the roadway exclusively to the residents and the necessary public services, and thus achieving a more rational and safer use of space.

The project is currently in the awarding phase.

2.5.2.14 The green revolution of the Council of Terrassa

Terrassa has initiated a change of model to move towards a city where moving around is easier, with less traffic, less noise and less polluting gases. A healthier city, with more public spaces, more comfortable and safer for pedestrians. This is a major transformation, which has already begun with the reorganisation of traffic in the central area to establish a Low Emission Zone. These changes will continue over the next few months until the surface area for pedestrians has been doubled in the last 20 years.

But this transformation goes far beyond the Centerand covers all the city's neighbourhoods. As established in the Sustainable Urban Mobility Plan 2016-21 and the Air Quality Improvement Plan 2015-20, interventions will be made in the streets to rebalance public space, reassigning more space for pedestrians, bicycles and public transport and to achieve changes in the mobility habits of citizens.

These are measures to achieve a reduction in accidents, noise and energy consumption, an improvement in the environmental quality and general wellbeing of the streets.

2.5.2.15 Portal for checking the pollutant grade label according to vehicle registration

The fleet classification aims to positively discriminate against the most environmentally friendly vehicles and to be an effective instrument at the service of municipal policies, both restricting traffic in episodes of high pollution, and promoting new technologies through tax benefits or relating to mobility and the environment.

In order to check whether a vehicle meets the requirements that entitle it to obtain some kind of environmental label, the DGT has set up a consultation portal where it is possible to enter the vehicle's registration number and find out which environmental label corresponds to it in terms of its characteristics.

Illustration 110. Consultation portal - Environmental label according to the vehicle's registration number. Source: DGT

2.5.2.16 Parking fees according to the environmental classification of the vehicle

Albacete´s city council is immersed in an important process of progress and improvement in terms of sustainable mobility. Many measures are being implemented in order to achieve an improvement in the environmental, social and economic fields with regard to mobility.

Among the measures being considered, there is a study that will lead to the establishment of differentiated rates in the ordinance for limited parking of vehicles according to their environmental classification, starting with free parking for electric vehicles. To this end, the possibility of using parking meters that have the necessary technology for the required differentiation (four environmental labels created according to the environmental impact of the vehicles used by the DGT) is being considered.

2.5.2.17 My DGT App

The General Directorate of Traffic provides users with a free mobile application for carrying driving license and vehicle documentation in digital format on their mobile phones.

Among the data that can be accessed through the application there are:

- General vehicle data, such as brand, model, chassis and engine capacity.
- Environmental label.
- Data from the last technical inspection of the vehicle.
- Current insurance company and coverage dates.
- Details of the vehicle owner.
- Fiscal municipality in which the vehicle is domiciled.
- Usual driver, in case it has been communicated it to Traffic.

Likewise, the app will notify the user by means of alerts about any special situation regarding the vehicles, such as if they are on temporary leave due to theft, if they are under seizure, if they are rented out, if they have any limitations for their transfer, etc. It will also notify about upcoming dates to take into account, such as the imminent expiry date of the MOT (ITV) or insurance cover in force.

Illustration 111. My DGT APP. Source: DGT

2.5.2.18 APP for loading tickets of the Regional Transport Consortium of Madrid

This is a free application for the user whose objective is to be able to use the mobile phone to load transport tickets on any card of the Regional Transport Consortium of Madrid (TTP, Multi, blue, etc.).

To be able to load a CRTM transport ticket, the phone must incorporate NFC technology, and this technology can be used by the CRTM. Currently, CRTM can only access this technology in Android phones with NFC.

The loading APP will be one more option for the public transport user, and will be part of the extensive CRTM loading network which, in round numbers, consists of 1.400 ATM in BANKIA, 1.000 tobacconists, 1.200 automatic machines in the Metro, 500 automatic machines in Cercanías and 80 automatic machines in MLO.

A first pilot was carried out for this project and work is currently underway to carry out a second pilot:

- First pilot:
  On 1 June 2017, the Madrid Regional Transport Consortium launched the first pilot test to introduce the loading of the Public Transport Card via mobile phone, using NFC technology (500 users were captured through a company). The pilot test ended on 31 August 2017

  During 2018, the necessary implementations and laboratory tests were carried out to improve the APP, and a specification for the contracting of a payment gateway was drafted.

- Second pilot:
  A second pilot was launched on January 28, 2019. Another 500 users were recruited from the CRTM's own website.

  It is important to clarify that this second pilot has no end date, but the objective is to put it into production. The strategy is to gradually incorporate functionalities and users until, at a certain point, the APP is available for use by any user for whom the product is intended.

  Phases of the second pilot (currently the loading APP is in its third phase):

  a) First phase, 28 January 2019: Launch.
  b) Second phase, 29 August 2019: Simplified invoice functionality is added.
  c) Third phase, 10 December 2019: Interface changed, and new payment gateway used.
  d) Fourth phase: During the first half of 2020 it will be gradually extended to 5.000 users

  Before implementing the fifth phase, CRTM will have to recruit to improve its DPC.

  e) Phase five: open to all users, launch in production

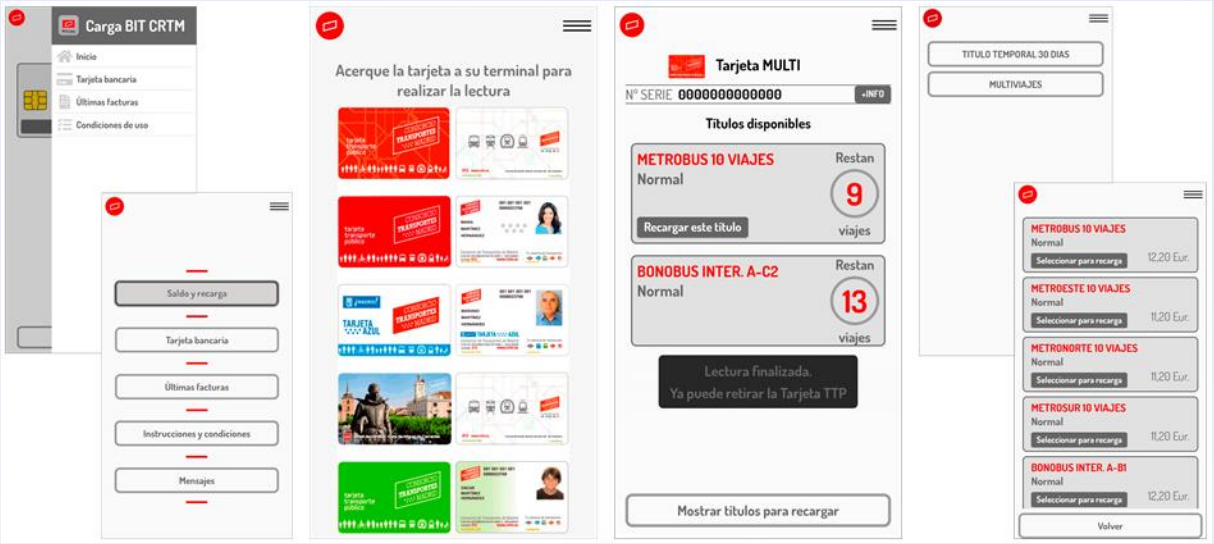

Illustration 112. Carga BIT APP CRTM. Source: CRTM

2.5.2.19 Payment of the public transport service through mobile devices in San Sebastian

In August 2017, Dbus, the company that manages urban public transport in the city of San Sebastian, implemented a contactless EMV bank card payment system and mobile applications on two bus lines. In 2019, this system was extended to all Dbus lines and some improvements were incorporated with respect to the pilot project: payment is made at the vending machine located next to the driver's station, both day and night tickets can be paid for, etc.

Payment by EMV contactless bank card is an alternative to paying for the ticket in cash. In 2019, payment for the ordinary ticket accounted for 8.40% of journeys, as 91.60% of users travelled with a discount transport card. Of that 8.40%, 10% of the tickets were paid for with an EMV contactless bank card.

2.5.2.20 Barik Transport Card Virtualization

The solution selected by the Biscay Transport Consortium for the availability of the Barik Virtual card is totally independent from mobile phone manufacturers, telephone operators or financial institutions. The standard of the Virtual Barik card is ISO 14443, the same used in the physical Barik card, therefore, no modifications are considered in the Barik card readers currently installed in the transport network supported by the Barik card and specifically in Metro Bilbao, Euskotren and Renfe.

The new SAM cards through which the security measures are implemented are compatible with the hardware and management software of the current SAM modules.

The scope of the project consists basically of the implementation of the modifications to be made in the validation process of the Barik card with mobile phones with NFC technology, called Barik Virtual, as well as its monitoring and evolution through a pilot project in the environment of Metro Bilbao, Renfe and Euskotren.

Specifically, the scope of the project includes

- Validation of the Barik Virtual cards.

- Execution of actions on Virtual Barik cards
- Laboratory testing of the retro compatibility of SAMs
- Communication with updated SAM/HSM module
- Communication of transaction to SAGB according to the current IRS.
- Verification mechanism of Barik Physical/Virtualized cards (MEAT, miniMEAT, MET, CAE and Peana Urbínaga).
- Validator Performance Tests.
- Possible evolutionary developments.
- Installation of the new SAM cards and equipment labelling.

2.5.2.21 Renewal of the sales and validation system on Vitoria's city buses

In Vitoria, Kapsch is carrying out, in a joint venture with Datik Information Intelligent, the technological renovation of the equipment of Tuvisa's bus fleet -composed of a total of 85 vehicles-, for the installation, integration, start-up and maintenance of a renewed information system. This project includes an advanced ticketing system that will be of great benefit to citizens, who will be able to use any of the multimodal contactless cards valid in the three provinces throughout the city: BAT (Alava), BARIK (Bizkaia) and MUGI (Gipuzkoa). In addition, the possibility of payment by mobile phone or bank card is also contemplated.

The new information system for the urban buses of Vitoria will help Tuvisa to manage the fleet from a single tool, in order to optimise the data on punctuality and frequency of the service.

2.5.2.22 Payment of tolls

Although there are multiple configurations and modalities when paying the toll on Spanish motorways, since 2017 there have been advances and technological developments in some points to facilitate and optimise this process.

- Irún Barrera toll collection area.
  The motorway has been equipped with electronic transit systems for TAG devices, which will allow the passage of 1.000 vehicles/hour without the need to stop, in order to speed up traffic, as well as manual payment systems and automatic payment systems with cards or cash. At the software level, Kapsch has installed its SmartTOLL solution, optimizing traffic management on the roads, as well as remote assistance in the event of incidents, and also implementing electronic payment by bank card, both in chip and contactless mode, and in cash in an unattended way, which did not exist until now. In addition, it is integrated with the Free Flow collection system, recently launched by Bidegi, so that vehicles using this system have the opportunity to make their payments at the toll station itself.
  Interoperability has also been improved in the electronic toll collection system, popularly known as Via-T, through TAG elements in the vehicles. This interoperability allows the use of Spanish TAGs (Via-T), as well as TAGs from other European countries such as France, so that the transit of the users of this equipment along the motorway is facilitated, similar to how they operate in their countries of origin.
- Oinaurre Semi-Junction
  The semi-link has reading gantries for Via-T or Abiatu devices, so that vehicles with this equipment will pay for the 3,2 kilometres up to the Irún-Barrera toll and not the 7 kilometres of the complete route between the Irun and Behobia toll.

Those who have this device will have a 50% discount from the first-round trip on the aforementioned route. From 20 return journeys onwards, the discount will be 80%. In this way, the AP-8 will be treated as a variant and all the journeys in and out of Irun will be unified without any discrimination between the Irun residents due to the location of their homes.

- Virtual Free Flow C-16 Highway

  The installation of a freeflow system for the detection of vehicles formed by several Points of Control (PoC) located at strategic points on the Motorway. In each PoC the necessary elements are installed to be able to apply the discount to the vehicle in question. Each PoC detects and stores information of any OBE and license plate passing through it. This information is sent to Centro, where there is a Freeflow System server that stores all the information received from each PoC and daily executes an algorithm that, based on the TAG, passing date, passing point and certain rules that define the discounted journeys, is capable of determining the journeys that a specific TAG has made and thus be able to determine whether or not that TAG is eligible for a discount.

  This information, with all the TAGs that may have a discount, is grouped and stored in a database so that the dealership can export the data to its backoffice, check the data and generate the corresponding discounts.

2.5.2.23 Transport and Logistics Observatory of Spain (OTLE)

The Transport and Logistics Observatory of Spain (OTLE) is a consultation and reference tool on transport and logistics that is openly made available to all those interested in the subject through its website (https://observatoriotransporte.mitma.gob.es/). Among its objectives, is to provide a global and integral vision of the transport and logistics situation in Spain that facilitates efficient and rational decision-making. It was launched in 2013 and since then has been incorporating new elements.

The main actions carried out since 2017 are the following:

- Information on interprovincial passenger mobility collected through a pilot and experimental study has been included, applying Big Data technology.
- The information collection process has been optimized by implementing automated extraction, transformation and loading (ETL) tools.
- The elements for displaying the information have been improved by modernizing the website on the one hand and by including graphics and maps, both in the queries and in the indicators (under development) on the other.
- A specific block on safety in the 4 modes of transport (road, rail, air, sea) has been included to the existing contents where data are shown, monitoring indicators are produced and analysed in the annual report.
- The environmental contents have been improved by including the emissions from transport of certain specific gases (CO2, NH4 and N2O). Contents related to noise pollution from transport infrastructures (major roads, railways, ports and airports) have also been included.
- A more complete characterization of transport flows has been included, especially those related to international freight transport.

2.5.2.24 Smart Cities Regulations

Like other initiatives related to ITS, it is important to note that not only are advances being made in road infrastructure, but in the area of Smart Cities, for example, developments and regulations are being made that pursue to interlink all sources of information related to transport and mobility:

- The Smart Port standard (UNE 178402) has been approved by UNE (Spanish Standardization)

- The regulation related to the Intelligent Station (UNE 178109) has been approved by UNE (Spanish Standardization) and is being processed by the ITU (International Telecommunication Union).

Illustration 113. Smart City. Source: ICEX

3 Key Performance Indicators (KPIs)

3.1 Deployment KPIs

The deployment KPIS have been calculated according to the type of network considered. As a clarification, in the sections corresponding to "Other national roads", it should be noted that all those roads that are not part of the TEN-T network and that have some type of ITS equipment installed along their route have been considered (both high capacity roads and conventional roads).

3.1.1 Information gathering infrastructures / equipment (Road KPI)

Information gathering infrastructures / equipment refers to any ITS on the road, that allows traffic monitoring, control of weather or environmental conditions, emissions monitoring or traffic forecasting. It includes, for example, sensors, cameras, traffic control centers, floating vehicle data, etc.

The technologies used may differ depending on the country, network or geographical area amongst other things.

Infrastructure / equipment can serve several purposes, from traffic measurements to information services.

3.1.1.1 TEN-T Core

- Length of road network / road sections (in km) equipped with information collection infrastructure: 4.853 km
- Total length of the same type of road network (in km): 5.821 km
- KPI = (kilometres of type of road network equipped with information collection infrastructure / total kilometres of the same type of road network) x 100: 83%.

3.1.1.2 TEN-T Comprehensive

- Length of road network / road sections (in km) equipped with information collection infrastructure: 3.122 km
- Total length of the same type of road network (in km): 6.102 km
- KPI = (kilometres of type of road network equipped with information collection infrastructure / total kilometres of the same type of road network) x 100: 51%.

3.1.1.3 Other national roads

- Length of road network / road sections (in km) equipped with information collection infrastructure: 7.307 km
- Total length of the same type of road network (in km): 32.275 km
- KPI = (kilometres of type of road network equipped with information collection infrastructure / total kilometres of the same type of road network) x 100: 23%.

3.1.2 Incident detection (Road KPIs)

Incident detection refers to any ITS used to highlight traffic disturbances (e.g. accidents, congestion) on a section of the road network that can be used to trigger actions to manage the incident.

3.1.2.1 TEN-T Core

- Length of road network type / road sections (in km) equipped with ITS to detect incidents: 2.781 km
- Total length of the same type of road network (in km): 5.821 km
- KPI = (kilometres of type of road network equipped with ITS to detect incidents / total kilometres of the same type of road network) x 100: 48%.

3.1.2.2 TEN-T Comprehensive

- Length of road network type / road sections (in km) equipped with ITS to detect incidents: 1.551 km
- Total length of the same type of road network (in km): 6.102 km
- KPI = (kilometres of type of road network equipped with ITS to detect incidents / total kilometres of the same type of road network) x 100: 25%.

3.1.2.3 Other national roads

- Length of road network type / road sections (in km) equipped with ITS to detect incidents: 2.341 km
- Total length of the same type of road network (in km): 32.275 Km
- KPI = (kilometres of type of road network equipped with ITS to detect incidents / total kilometres of the same type of road network) x 100: 7%.

3.1.3 Traffic management and control measures (Road KPI)

Traffic management and traffic control measures refer to any measures derived from the ITS installed on the road that allow traffic movements to be controlled. It includes, for example, hard shoulder driving, ramp metering, dynamic lane management, heavy vehicle overtaking bans, variable speed limits, as well as parking management and vehicle prioritization.

3.1.3.1 TEN-T Core

- Length of type of road network / road sections (in km) covered by traffic management and control measures: 4.571 km
- Total length of the same type of road network (in km): 5.821 km
- KPI = (kilometres of type of road network covered by traffic management and control measures / total kilometres of the same type of road network) x 100: 79%.

3.1.3.2 TEN-T Comprehensive

- Length of type of road network / road sections (in km) covered by traffic management and control measures: 3.372 km
- Total length of the same type of road network (in km): 6.102 km
- KPI = (kilometres of type of road network covered by traffic management and control measures / total kilometres of the same type of road network) x 100: 55%.

3.1.3.3 Other national roads

- Length of type of road network / road sections (in km) covered by traffic management and control measures: 7.205 km
- Total length of the same type of road network (in km): 32.275 km

- KPI = (kilometres of type of road network covered by traffic management and control measures / total kilometres of the same type of road network) x 100: 22%.

3.1.4 Cooperative ITS services and applications (Road KPI)

Cooperative ITS services and applications refer to road-based ITS infrastructure that enables communication between vehicles or between vehicles and infrastructure.

3.1.4.1 TEN-T Core

- Length of road network type/road sections (in km) covered by cooperative ITS services and applications: 676 km
- Total length of the same type of road network (in km): 5.821 km
- KPI = (kilometres of type of road network covered by cooperative ITS services and applications/total kilometres of the same type of road network) x 100: 12%.

3.1.4.2 TEN-T Comprehensive

- Length of road network type/road sections (in km) covered by cooperative ITS services and applications: 189 km
- Total length of the same type of road network (in km): 6.102 km
- KPI = (kilometres of type of road network covered by cooperative ITS services and applications/total kilometres of the same type of road network) x 100: 3%.

3.1.4.3 Other national roads

- Length of road network type/road sections (in km) covered by cooperative ITS services and applications: 86 km
- Total length of the same type of road network (in km): 32.275 km
- KPI = (kilometres of type of road network covered by cooperative ITS services and applications/total kilometres of the same type of road network) x 100: 0%.

3.1.5 Real-time traffic information (Road KPI)

Real-time traffic information refers to information derived from any road and traffic data, or a combination of both, provided by any road authority, road operator or service provider to road users through the usual communication channels.

Real-time traffic information relates to the on-site traffic conditions on the road network. Such information includes, for example, accident locations, incident warnings (including safety related events/conditions), road works, congestion access points, travel times/delays. These services are covered by the Delegated Regulations 886/2013 and 962/2015.

3.1.5.1 TEN-T Core

- Length of type of road network/road sections (in km) with provision of real-time traffic information services: 5.821 km
- Total length of this same type of road network (in km): 5.821 km
- KPI = (kilometres of type of road network with provision of real-time traffic information services / total kilometres of the same type of road network) x100: 100%.

3.1.5.2 TEN-T Comprehensive

- Length of type of road network/road sections (in km) with provision of real-time traffic information services: 6.102 km
- Total length of the same type of road network (in km): 6.102 km
- KPI = (kilometres of type of road network with provision of real-time traffic information services / total kilometres of the same type of road network) x100: 100%.

3.1.5.3 Other national roads

- Length of type of road network/road sections (in km) with provision of real-time traffic information services: 32.275 km
- Total length of this same type of road network (in km): 32.275 km
- KPI = (kilometres of type of road network with provision of real-time traffic information services / total kilometres of the same type of road network) x100: 100%.

3.1.6 Dynamic Travel Information (Road KPI)

Dynamic travel information refers to updated information derived from any travel information provided by any transport operator or service provider through the usual communication channels. Such services fall within the scope of the Delegated Regulation on multimodal travel information services on which work is currently underway.

Dynamic travel information covers both pre-trip and in-trip information for any traveller. Such information includes, for example, interruptions, travel times/delays, vehicle positioning, accessibility of roads and vehicles. All information available to users should be provided in such a way that they can receive it in full, including for users who may have specific data requirements, e.g. persons with reduced mobility, orientation and/or communication.

3.1.6.1 TEN-T Core

- Length of the type of road network/road sections (in km) with provision of dynamic travel information services: 1.661 km
- Total length of the same type of road network (in km): 5.821 Km
- KPI = (kilometres of type of road network with provision of dynamic travel information services / total kilometres of the same type of road network) x 100: 29%.
- Number of transport nodes (railway or bus stations) with provision of DTI services: not enough data available to make a real comparison.
- Total number of transport nodes of the same type: not enough data available to make a real comparison
- KPI = (number of transportation nodes with provision of dynamic trip information services/ total number of transportation nodes of the same type) x 100: not enough data available to calculate an actual KPI

3.1.6.2 TEN-T Comprehensive

- Length of the type of road network/road sections (in km) with provision of dynamic travel information services: 982 km
- Total length of the same type of road network (in km): 6.102 km
  KPI = (kilometres of type of road network with provision of dynamic travel information services / total kilometres of the same type of road network) x 100: 16%.

- Number of transport nodes (railway or bus stations) with provision of PIT services: not enough data available for a real comparison.
- Total number of transport nodes of the same type: not enough data available to make a real comparison
- KPI = (number of transportation nodes with provision of dynamic trip information services/ total number of transportation nodes of the same type) x 100: not enough data available to calculate an actual KPI

3.1.6.3 Other national roads

- Length of the type of road network/road sections (in km) with provision of dynamic travel information services: 1.753 km
- Total length of the same type of road network (in km): 32.275 Km.
- KPI = (kilometres of type of road network with provision of dynamic travel information services / total kilometres of the same type of road network) x 100: 5%.
- Number of transport nodes (railway or bus stations) with provision of PIT services: not enough data available for a real comparison
- Total number of transport nodes of the same type: not enough data available to make a real comparison
- KPI = (number of transportation nodes with provision of dynamic trip information services/ total number of transportation nodes of the same type) x 100: not enough data available to calculate an actual KPI

3.1.7 Freight information (multimodal - if possible - or road KPI)

Freight information refers to static and dynamic information adapted to the needs of the freight industry. Such information includes, for example, parking/loading availability and cost, access restrictions, incident and interruption warnings, travel times/delays, vehicle positioning.

3.1.7.1 TEN-T Core

- Length of the type of road network/road sections (in km) with provision of freight information services: 5.821 km
- Total length of the same type of road network (in km): 5.821 Km
- KPI = (kilometres of type of road network with provision of freight information services / total kilometres of the same type of road network) x 100: 100%.
- Number of loading nodes (e.g. ports, logistics platforms) with provision of freight information services: not enough data available for a real comparison.
- Total number of freight nodes of the same type: not enough data available to make a real comparison
- KPI = (number of freight nodes with provision of freight information services / total number of same freight nodes) x 100: not enough data available to calculate an actual KPI.

3.1.7.2 TEN-T Comprehensive

- Length of the type of road network/road sections (in km) with provision of freight information services: 6.102 km
- Total length of the same type of road network (in km): 6.102 km
- KPI = (kilometres of type of road network with provision of freight information services / total kilometres of the same type of road network) x 100: 100%.

- Number of freight nodes (e.g. ports, logistics platforms) with provision of freight information services: not enough data available for a real comparison.
- Total number of freight nodes of the same type: not enough data available to make a real comparison
- KPI = (number of freight nodes with provision of freight information services / total number of same freight nodes) x 100: not enough data available to calculate an actual KPI.

3.1.7.3 Other national roads

- Length of the type of road network/road sections (in km) with provision of freight information services: 32.275 km
- Total length of the same type of road network (in km): 32.275 Km
- KPI = (kilometres of type of road network with provision of freight information services / total kilometres of the same type of road network) x 100: 100%.
- Number of freight nodes (e.g. ports, logistics platforms) with provision of freight information services: not enough data available for a real comparison.
- Total number of freight nodes of the same type: not enough data available to make a real comparison
- KPI = (number of freight nodes with provision of freight information services / total number of same freight nodes) x 100: not enough data available to calculate an actual KPI.

3.1.8 112 eCalls (Road KPI)

112 automatic and manual eCalls as defined by EU legislation.

Illustration 114. eCall - the lifebutton.Source: DGT Magazine

As defined in the COCOM questionnaire at 112, dummy calls are calls that are not followed up with intervention or assistance from the PSAP or the emergency services. Calls that report an emergency event that has already triggered intervention or assistance by the PSAP and that do not involve separate intervention or assistance, will not be considered as hoax calls.

N/A. - To be provided through COCOM 112 questionnaire.

Illustration 115. how eCall works in Spain. Source: DGT Magazine

3.2 Benefits KPIs

3.2.1 Change in travel times (Road KPI)

Percentage change in travel times in peak period along routes/in areas where ITS have been implemented or improved.

The peak period refers to the time with the highest traffic flow during a day of the week. It is defined for each route/area individually. An aggregate average can be calculated for the estimation of consolidated results at the level of the road network.

Routes/areas where ITS have been implemented or improved must be specified. The length / area along which the change in travel times is measured should be long enough / wide enough to be representative.

- KPI = ((travel times before ITS implementation or improvement - travel times after ITS implementation or improvement) / travel times before ITS implementation or improvement) x 100: not enough data available to calculate an actual KPI.

3.2.2 Change in road accidents resulting in death or injury (Road KPI)

Every year, the DGT makes an inventory of the number of accidents on national roads. These accidents are classified according to the type of road on which they occur and the severity of the accident.

In addition to these data, accidents are listed according to the type of accident suffered and the personal characteristics of the victim.

- Personal characteristics:
  - Age of the victim
  - Gender of the victim
  - Pedestrian/Driver/Passenger
- Characteristics of the accident:
  - Province where the accident occurs
  - Infraction committed
  - Brightness and atmospheric factor
  - State and type of vehicles involved
  - Age of the vehicles involved

The numbers in the following sections compare the data from the statistical studies published by the DGT in 2016, which were used in the preparation of the 2017 ITS Report, and the data from 2018, the last year for which consolidated and published data are available.

3.2.2.1 Interurban roads

3.2.2.1.1 Accidents with victims

- Number of road accidents resulting in death or injury before ITS implementation or improvement: 36.721.
- Number of road traffic accidents that resulted in death or injury after ITS implementation or improvement: 37.892
- KPI = ((number of road traffic crashes resulting in death or injury before ITS implementation or improvement - number of road traffic crashes resulting in death or

injury after ITS implementation or improvement) / number of road traffic crashes resulting in death or injury before ITS implementation or improvement) x 100: (-3.19%).

3.2.2.1.2 Accident victims

- Number of traffic accidents that resulted in accident victims before ITS implementation or improvement: 57.720
- Number of traffic accidents that resulted in accident victims after ITS implementation or improvement: 58.892
- KPI = ((number of traffic accidents that resulted in accident victims before ITS implementation or enhancement - number of traffic accidents that resulted in accident victims after ITS implementation or enhancement) / number of traffic accidents that resulted in accident victims before ITS implementation or enhancement) x 100: (-2.03%)

3.2.2.1.3 Fatalities

- Number of road accidents resulting in death before ITS implementation or improvement: 1.291.
- Number of traffic accidents that resulted in death after ITS implementation or improvement: 1.317.
- KPI = ((number of traffic accidents that resulted in fatalities before ITS implementation or enhancement - number of traffic accidents that resulted in fatalities after ITS implementation or enhancement) / number of traffic accidents that resulted in fatalities before ITS implementation or enhancement) x 100: (-2.01%)

3.2.2.1.4 Seriously injured

- Number of traffic accidents resulting in Seriously injured before ITS implementation or improvement: 5.050.
- Number of traffic accidents that resulted in Seriously injured after ITS implementation or upgrade: 4.451.
- KPI = ((number of traffic accidents that resulted in serious injury before ITS implementation or upgrade - number of traffic accidents that resulted in serious injury after ITS implementation or upgrade) / number of traffic accidents that resulted in serious injury before ITS implementation or upgrade) x 100: 11.86%.

3.2.2.1.5 Slightly injured

- Number of traffic accidents resulting in Slightly injured before ITS implementation or improvement: 51.379.
- Number of traffic accidents resulting in Slightly injured after ITS implementation or improvement: 53.124.
- KPI = ((number of traffic accidents resulting in Slightly injured before ITS implementation or improvement - number of traffic accidents resulting in Slightly injured after ITS implementation or improvement) / number of traffic accidents resulting in Slightly injured before ITS implementation or improvement) x 100: (-3.40%).

3.2.2.2 Urban Roads

3.2.2.2.1 Accidents with victims

- Number of road traffic accidents resulting in death or injury before ITS implementation or improvement: 65.641

- Number of road traffic accidents that resulted in death or injury after ITS implementation or improvement: 64.407
- KPI = ((number of road traffic crashes resulting in death or injury before ITS implementation or improvement - number of road traffic crashes resulting in death or injury after ITS implementation or improvement) / number of road traffic crashes resulting in death or injury before ITS implementation or improvement) x 100: 1.88%.

3.2.2.2.2 Accident victims

- Number of traffic accidents that resulted in accident victims before ITS implementation or improvement: 84.480.
- Number of traffic accidents that resulted in accident victims after ITS implementation or improvement: 81.523.
- KPI = ((number of traffic accidents that resulted in accident victims before ITS implementation or upgrading - number of traffic accidents that resulted in accident victims after ITS implementation or upgrading) / number of traffic accidents that resulted in accident victims before ITS implementation or upgrading) x 100: 3.50%.

3.2.2.2.3 Fatalities

- Number of road accidents resulting in death before ITS implementation or improvement: 519.
- Number of traffic accidents that resulted in death after ITS implementation or improvement: 489.
- KPI = ((number of traffic accidents resulting in death before ITS implementation or enhancement - number of traffic accidents resulting in death after ITS implementation or enhancement) / number of traffic accidents resulting in death before ITS implementation or enhancement) x 100: 5.78%.

3.2.2.2.4 Seriously injured

- Number of road accidents resulting in Seriously injured before ITS implementation or improvement: 4.705.
- Number of traffic accidents that resulted in Seriously injured after ITS implementation or upgrade: 4.484.
- KPI = ((number of traffic accidents that resulted in serious injury before ITS implementation or upgrade - number of traffic accidents that resulted in serious injury after ITS implementation or upgrade) / number of traffic accidents that resulted in serious injury before ITS implementation or upgrade) x 100: 4.70%.

3.2.2.2.5 Slightly injured

- Number of road accidents resulting in Slightly injured before ITS implementation or improvement: 79.256.
- Number of traffic accidents resulting in Slightly injured after ITS implementation or upgrade: 76.550.
- KPI = ((number of traffic accidents that resulted in Slightly injured before ITS implementation or improvement - number of traffic accidents that resulted in Slightly injured after ITS implementation or improvement) / number of traffic accidents that resulted in Slightly injured before ITS implementation or improvement) x 100: 3.41%.

3.2.3 Changes in CO2 emissions linked to traffic

Traffic-related CO2 emissions refer to the amount of CO2 emitted collectively by vehicles using a route/driving within an area. This must be aggregated to produce an annual figure. CO2 emissions are generally estimated based on traffic flows and speeds, along with assumptions about fuel consumption and/or average vehicle efficiency per kilometre for different types of vehicles using a route/driving within an area.

The routes/areas where ITS have been implemented or improved should be specified. The length/area within which the change in CO2 emissions is calculated should be long enough/wide enough to be representative.

- KPI = (CO2 emissions from traffic before implementation or improvement of ITS - CO2 emissions from traffic after implementation or improvement) / CO2 emissions from traffic before implementation or improvement of ITS) x 100: not enough data available to calculate an actual KPI

Illustration 116. CO2 Emissions. Source: DGT Magazine

3.3 Financial performance indicators

The following table details the investments made both in new ITS equipment and in the maintenance of all devices installed on the roads in the last three years:

Table 64. Investment and maintenance costs related to ITS equipment. Source: DGT

YEAR	INVESTMENT	MAINTENANCE
2017	2.562.017,86 €	36.227.176,87 €
2018	7.093.734,30 €	24.133.484,17 €
2019	2.115.821,18 €	10.364.782,65 €
AVERAGE	**3.923.857,78 €**	**23.575.147,9 €**

For the calculation of the KPIs, despite the fact that there is an important difference in investment between years, the average of the values will be taken in order to "annualise" the figures and make them comparable with those of previous reports.

As in the last report, it should be noted that all types of ITS systems and services are considered in the calculation.

- Annual investment in road ITS (as a % of total transport infrastructure investment): 3.92 million
- Annual costs of road ITS operation and maintenance (in euros per kilometre of network covered):
    - Annual operation and maintenance cost: 23,57 M
    - Total number of kilometres considered: 44.198 km
    - KPI: 533,40 euros/km

Illustration 117. ITS investment and maintenance. Source: Own Elaboration

4 Contributions

For the development of this report, the collaboration of different administrations and entities has been fundamental. Thanks to all of them it has been possible to provide the document with the corresponding entity:

- General Directorate for Traffic of Spain - Ministry of the Interior
- Ministry of Transport, Mobility and Urban Agenda
- Catalonian Traffic Service - Servei Català de Trànsit (SCT)
- Basque Government Traffic Directorate (DT-GV)
- Albacete City Council
- Alicante City Council
- Aranjuez City Council
- Arganda del Rey City Council
- Ciudad Real City Council
- El Ejido City Council
- Gijón City Council
- León City Council
- Lleida City Council
- Madrid City Council
- Molina de Segura City Council
- San Sebastián City Council
- Sant Boi de Llobregat City Council
- Sevilla City Council
- Talavera de la Reina City Council
- Terrassa City Council
- Vitoria-Gasteiz City Council
- Madrid Transport Consortium
- Indra
- Kapsch
- Ineco
- Lisitt
- Autopistas
- RACC Foundation
- Renfe
- CGT Madrid Joint Venture (TEKIA Ingenieros - ICEACSA Consultores)

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- Delegated Regulation (EU) No 886/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council as regards data and procedures to provide, where possible, minimum universal traffic information relating to road safety, free of charge to the user.
- Delegated Regulation (EU) No 305/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonised provision of an emergency call number throughout the Union (eCall)
- Delegated Regulation (EU) No 885/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council as regards the provision of information services for safe and secure parking areas for trucks and commercial vehicles.
- ROYAL DECREE 662/2012 of 13 April, establishing the framework for the deployment of Intelligent Transport Systems (ITS) in the road transport sector and for interfaces with other transport modes.
- ROYAL DECREE 645/2020, of 7 July, by which the basic organic structure of the Ministry of Transport, Mobility and Urban Agenda is developed.
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