Ministero delle Infrastrutture e dei Trasporti

Ministry of Infrastructures and Transport

ROAD SAFETY GENERAL DIRECTORATE

Road Safety Information Coordination Centre

DIRECTIVE (EU) 2010/40

PROGRESS REPORT 2020

Italy

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1 Introduction

1.1 General overview of the national activities and projects

Italy has a very high density of internal traffic, unevenly distributed throughout its transport network, with road transport accounting for the vast majority of traffic. To cope with this and in line with other European countries, Italy has decided to adopt a systematic approach to address the ongoing challenges of rising demand for mobility since early 2000s, within which information, management and control work in synergy to optimise the use of infrastructures, vehicles and logistic platforms from a multimodal perspective.

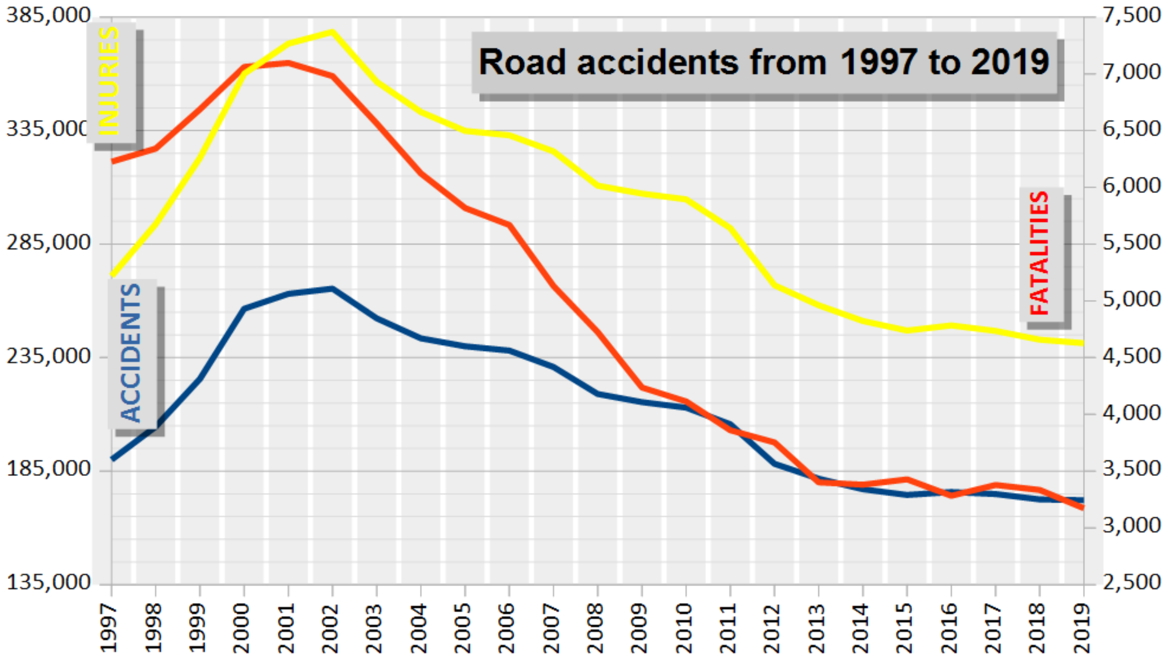

Figure 1 - Trend in accident rate from 1997 to 2019

In figure 1 are shown some indicators of the results in terms of road safety, through the evolution of the number of accidents, deaths and injuries in the period 1997-2019.

As far as activities for publishing traffic information in Italy are concerned, they date back from early 90's; it is worth mentioning briefly the main historical points, developed with European projects aid.

- The road safety information centre, called CCISS, became operational in 1993, as the first real-time information system for managing traffic.
- Thanks to the SERTI and CORVETTE European projects financed by the European Commission, the IT systems made it possible to broadcast the first RDS-TMC service on the RAI "Radio 1" FM channel from 1st July 1998.
- In the early 2000's, DATEX connections were made with the national TICs (Traffic Information Centres) of France and Germany, and web dissemination of information began.
- Since 19th April 2009, a new operation centre has been established at the Ministry of Infrastructures and Transport headquarter in Rome, Via Caraci.
- Since 2009, the refurbished CCISS platform provides information on traffic events and roads conditions, covering both safety related categories of events or conditions (as afterwards defined by Regulation 2013/886) and other real-time traffic information; it operates continuously 24/7 and covers the Italian trans-European road network, several tertiary roads and urban streets of major cities (Rome, Milan, Turin).

CCISS has always published information over various channels, at present web, social (RSS feed, Twitter social network), radio (RSS-TMC broadcasting) and phone (call centre and interactive voice response), completely free of charge and put no limitation on its services.

After the Directive 2010/40, the already existing law framework was adapted to accommodate the new rules and guidelines, in particular with ministerial decree 1st February 2013, about ITS, and a National Action Plan on Intelligent Transport Systems, that complements the already existing National Road Safety Plan and General Transport and Logistics Plan.

CCISS has been identified as the NAP for roads safety information under the following regulations:

- Delegated Regulation 2013/885/EU on the provision of information services for safe and secure parking places for trucks and commercial vehicles;
- Delegated Regulation 2013/886/EU on data and procedures for the provision, where possible, of road safety-related minimum universal traffic information free of charge to users;
- Delegated Regulation 2015/962/EU on the provision of EU-wide real-time traffic information services;
- Delegated Regulation 2017/1926/EU on the provision of information services for multimodal travels, together with another Ministry office, as will be described later.

CCISS is operating in order to improve its infrastructure and systems by implementing solutions and projects that comply in the best way with the content of Directive 2010/40/EU and its related Delegated Regulations.

CCISS is a complex system, involving a multiplicity of actors sharing and updating data on roads and traffic on the whole national territory. It represents the single point of access for users and works on a "Cooperative Model". This cooperative model allows open dialogues between the actors who cooperate, sharing information, to improve the quality of the data, enrich them and allowing for trans-European interoperability.

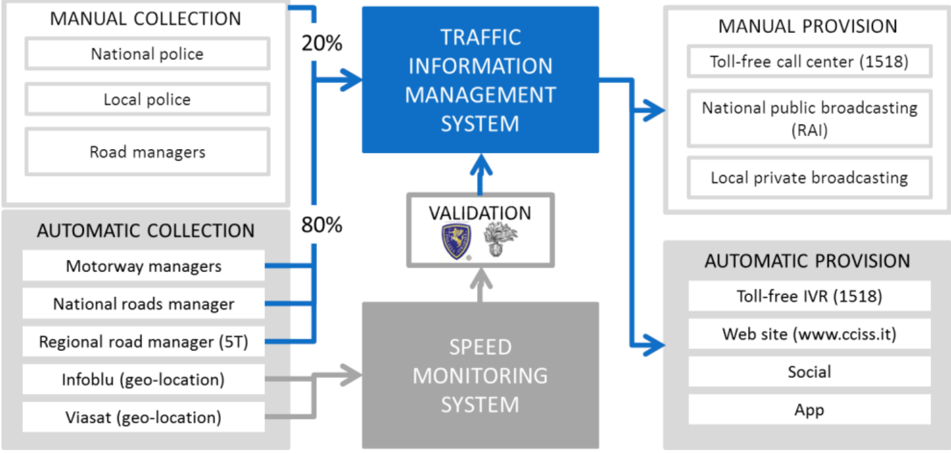

Figure 2 - CCISS information data flow, based on cooperative model

Collaboration and active participation by all the actors in the cooperative model the CCISS uses, allows the enrichment and continuous evolution of the entire National Access Point.

ITS applied to road transport, also linking it with other modes, increase safety and capacity through higher interoperability and better use of the existing infrastructure, with subsequent financial and environmental benefits. Through the harmonisation and continuity of pan-European services across Member States, ITS contributes substantially to the creation of the single European Transport Area.

According to this concept, CEF Transport supports trans-European infrastructure and new technologies and Horizon 2020 supports a vision of seamless transport for passengers and freight.

Italy, through the Italian Ministry of Infrastructures and Transport and its implementing bodies or by means of other Italian partners, is involved in the following CEF projects:

- C-Roads. The C-Roads platform is a joint initiative of European countries and road operators which are in the phase of installing C-ITS for piloting and later operation. Pilot installations are harmonised and ensure interoperability of Day 1 and Day 1.5 use cases recommended by the European Commission's C-ITS Platform.
- MedTIS II & III (January 2014 – December 2020). The two actions implement road safety solutions and traffic management services in a coordinated way on the TEN-T Mediterranean Core Network Corridor. Drivers traveling across the borders of Portugal, Spain, Italy and France will be able to visualise travel times and will receive information on accidents, construction sites, weather-related alerts and the real-time traffic flow, independent of

national borders.

- I_HeERO & sAFE (January 2015 – December 2020). These two actions ensure that the European public emergency Services (PSAPs) are able to handle eCalls (emergency calls from vehicles) across Europe and that vehicles can be retro-fitted with this system. The objective is to reduce the number of fatalities as well as the severity of injuries caused by The Connecting Europe Facility supports the implementation road accidents.
- FENIX (April 2019 – March 2022). This project supports the development, validation and deployment of a common platform for connecting digital information systems along the EU transport Core Network and notably corridors.
- FEDeRATED. The project (January 2019 – December 2023) is an EU Member States driven initiative to contribute to the establishment of a viable federated network of platforms for data sharing in the freight transport and logistics domain at EU level (and beyond). The main objective is to enable a smooth and effective public involvement with logistic chains for the execution of public duties.
- DATA4PT (under Programme Support Action – January 2020 – January 2024) aims to advance data-sharing practices in the public transport sector by supporting the development of data exchange standards and models, to fulfil the needs of multimodal travel information service providers.

The Italian Ministry of Infrastructures and Transport was also involved in CORE project (May 2014 – June 2018), funded under the 7th Framework Program, and Italian partners can be found in the following Horizon 2020 projects:

- ADAS & ME (September 2016 – February 2020): develops adapted Advanced Driver Assistance Systems that incorporate driver/rider state, situational/environmental context, and adaptive interaction to automatically transfer control between vehicle and driver/rider and thus ensure safer and more efficient road usage;
- CoEXist (May 2017 – April 2020): enables mobility stakeholders to become ready for the progressive increase of automated vehicles by supporting national road authorities and their preparedness for the transition towards a shared road network between automated vehicles and traditional ones;
- AEOLIX (September 2016 – August 2019): contributes to the optimisation of logistics operations via the creation of a cloud-based collaborative logistics ecosystem for configuring and managing logistics-related information, enabling more sustainable and efficient transport of goods cross Europe.

Many of these projects have implications on smart roads developments; in order to ensure national coordination with particular regard to smart roads The Ministry of Infrastructures and Transport, with ministerial decree 28 February 2018, n. 70, has implemented the Smart Roads Committee.

With regard to safety and security aspects, the Ministry of Infrastructures and Transport has developed, in 2015, a specific platform to collect dangerous goods real-time tracking and tracing data, and to transmits/forwards the collected data, if necessary filtered according to the interested geographic area, to the platforms operated by regional public entities (that perform monitoring, control and surveillance at regional level in Italy). The platform receives the tracking and tracing data from tracking devices installed on tankers transporting hydrocarbons by road in Italy. In addition to tracking data, it is possible to visualize other information such as operations in progress and alarms.

1.2 General progress since 2017

In early 2018 Smart Roads Committee has been established to manage experimental activities with autonomous vehicles and to promote connection between vehicle and infrastructure.

In its activities, studies and analyses on technological solutions and architectural proposals for the provision of services are in progress.

Studies and analyses have the following main objectives:

- to create the conditions for extending the applications already validated in the pilot sites, facilitating their use for all road operators;
- to create an open national architecture, user-oriented, suitable for facilitating the provision of services and the use of applications.

In September 2018 CCISS platform has undergone a substantial revamping, to accommodate more general publishing needs. To fulfil its specific mission of preserving and ensuring the safety and security aspects of the road network users, the CCISS structure and its functioning is constantly evolving, integrating different aspects of the roads traffic and enabling a digital transformation. In this three years' period, among other enhancements, a new DATEX II module has been added, to manage the entire version 2.3 and work is in progress to migrate to DATEX II version 3 and to add NeTEx and SIRI capabilities, for public transport description.

As for dangerous goods data, MIT platform was enhanced during CORE project developments; in particular, one of CORE demonstrators has proved the values of:

- the combination/integration and processing of various types of data;
- the precise and trustable information on the position;
- the innovative model envisaging the coordination/sharing of data between national and regional platforms/authorities.

Through the direct involvement of the ministries of transport of France and Italy, CORE demonstrator has been conceived to be a concrete proof of concept of UNECE TP1/TP2 architecture, and particularly for:

- cross-border operations;

- the basic requirements for TP1 and TP2;
- the datasets to be used between TP2, TP1 and the authorities/emergency and intervention services;
- UML/XML/XSD for EGNOS-enhanced position data exchange among TP1s and TP2s, based on the specific CEN Workshop Agreement CWA 16390, renewed by CORE project;
- the additional alarms/events needed by the risk assessment functions of MIT Platform/TP1;
- the interoperability with the rail transport (mapping with TAF-TSI of EUAR);
- the interoperability with e-CMR electronic consignment note.

CCISS is responsible for the evolution of the RDS-TMC location table with a continuous monitoring of road changes and improvement of the table itself. The certification process, through TISA, is constantly finalized. The actual table, which is version 4.6, was submitted for verification and certification and passed the compliance test, based on the test requirements described in the latest version of the document "TMC location table test requirements" of TISA. This means that the table is (as a minimum) largely compliant with the current version of the standard, ISO 14819 part 3 - Location Referencing Rules, and the latest version of the Location Coding Handbook of the TMC Forum, and therefore it is suitable for use in TMC applications. The table has obtained Certificate number 2020-041-IT and is available at the TISA web site. The service can be accessed free of charge through web service by every road operator, publisher or broadcaster who asks for it.

1.3 Contact information

The national institution responsible for ITS policies is the Ministry of Infrastructures and Transport.

The relevant office is:
Road Safety General Directorate
Division 5
E-mail: ingresso.cciss@mit.gov.it.

Contact person: Danilo Giaquinto, e-mail: danilo.giaquinto@mit.gov.it, tel.: +390641586088.

2 Projects, activities and initiatives

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

2.1.1 Description of the national activities and projects

CCISS platform, through its portal (www.cciss.it) offers to end users, free of any charge, all mandatory information related to road safety along with other data relevant to particular situations.

CCISS process of publication always mandates: location, category and a description with all important details, including, where appropriate, driving behaviour advice and alternative routing. The event or condition is updated when it shows any change and last update is its removal, when it ceases to subsist. When this happens, event is no more published, but internal operators continue to see it for a specified period of time, to be able to communicate, where appropriate, that an event indeed occurred but it is now ceased.

The final activity of processing information consists in the preparation and subsequent dissemination of information, by operator or through automatic systems, on internal (under the responsibility of the CCISS) or external (under the responsibility of other entities/companies) channels.

CHANNELS	OPERATORS		LOCATION	TRASMISSION SYSTEM
INTERNAL *(CCISS responsibility)*	External	Service providers – ANAS, national road operator	CCISS – Communication Channels	Public number 1518 and social networks
	Internal	MIT	CCISS – NEWS	Portal www.cciss.it
EXTERNAL *(Other entities responsibility)*	External	RAI, public broadcaster	Its Headquarter	TV/Radio/Isoradio
	External	Various private radios	Its Headquarter	Radio
	External	Private publisher (Edidomus)	Its Headquarter	Newspaper

Figure 3 - CCISS: dissemination of events with operator

CHANNELS	SYSTEM	TRASMISSION SYSTEM
INTERNAL *(CCISS responsibility)*	APP	iCCISS
	CCISS PORTAL	www.cciss.it
	SOCIAL NETWORKS	Twitter
EXTERNAL *(Other entities responsibility)*	RDS-TMC (RAI, public broadcaster)	Alert-C
	Third Parties Information Streams: • Coast Guard • RAI, public broadcaster (portal) • Region Valle d'Aosta • National Logistic Platform • Private partners (Infoblu, Viasat)	XML

Figure 4 - CCISS: automatic dissemination of events

In next sections activities and project concerning data standardization and exchange are briefly presented.

2.1.1.1 Activities in CEN standardization groups

Italy is active in CEN technical committee dealing with public transport standards (TC278, WG3): the reference public transport data model, Transmodel, and exchange interfaces based on it, like NeTEx, for topology, timetables and fares, SIRI, for real-time operations, OpRa, for statistics and raw data. Figure 5 shows relations between these standards and subgroups, into which WG3 is divided, responsible for each one.

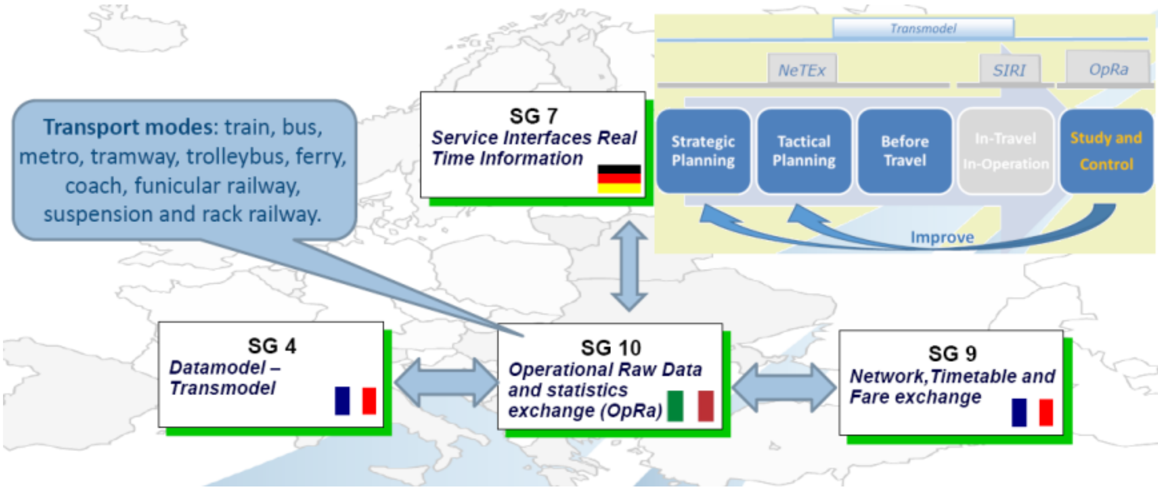

Figure 5 - CEN TC279 WG3 standards and subgroups

5T, an in-house company of Piedmont Region and Turin city, chairs subgroup 10, in charge of drafting OpRa standard, on operational raw data and statistics exchange.

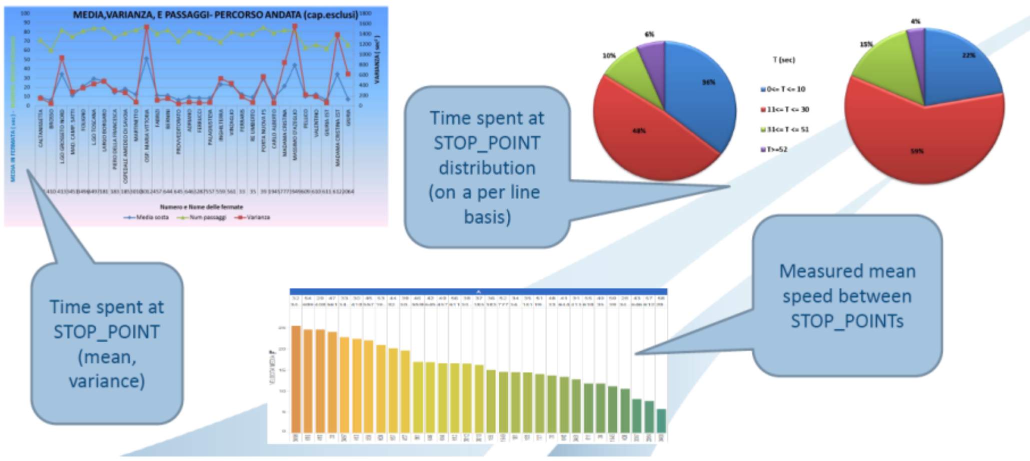

Figure 6 - Examples of data exchangeable using OpRa

Through OpRa, data can be exchanged for the following use cases groups:

- Situation analysis, which covers all the data exchange scenarios where the aim of the exchange is to provide data to examine and study the operating status (e.g. delays because of traffic lights, road works, traffic jams);
- Contractual reporting, which covers data exchange where the actual service must be accounted towards the local, regional or national administrations body responsible for providing public transportation;
- Quality of service analyses and processes, which, based on the planned timetables and the exchanged data, can compute key performance indicators.

In figure 6 are shown some examples of data that could be exchanged using OpRa.

2.1.1.2 DAA4PT project

In the field of optimal use of road, traffic and travel data, the Italian Ministry of Infrastructures and Transport is involved in DATA4PT project, funded under the Programme Support Action.

The action DATA4PT project will implement consists of technical and organisational activities to facilitate the development and deployment of the European public transport data standards Transmodel, NeTEx and SIRI and common minimum profile for the provision of Union-wide multimodal travel information services which apply to the TEN-T network including urban nodes.

The action includes the following activities:

1. Support the technical development of Transmodel, NeTEx and SIRI to fulfil the needs of multimodal travel information service providers;
2. Conduct technical artefact maintenance;
3. Develop data validation tools and test platform;
4. Conduct required updates for all standards;
5. Assist the development of National SIRI profiles;
6. Facilitate the operational use of Transmodel, NeTEx and SIRI standards by Public Transport Operators and Public Transport Authorities;
7. Exchange of best practice;
8. Develop the Transmodel, NeTEx and SIRI end-user community through dissemination actions;
9. Build a long term sustainable governance and business model.

Member States involved in DATA4PT consortium, coordinated by UITP with the technical management of ITxPT (Information Technology for Public Transport), are:

Austria, Croatia, Czech Republic, France, Denmark, Italy, Portugal, Slovenia, Sweden.

In order to meet the expectations of the users of NeTEx, SIRI and Transmodel and to support the deployment of these standards, the proposed organisation is connected to organisations such as UITP, CEN, the EU Commission or EUAR, and opened to a wide range of stakeholders, such as authorities, software companies, start-ups, operators, consulting companies or educational institutions (universities, etc.).

Setting up an efficient expert team is one of the key actions of the organisation of a support group. The expert team is a mix of MS representatives and standardization experts. Since

Transmodel, NeTex or SIRI are deeply technical standards, experts will be expected to have strong technical skill. The main tasks where the expert team is expected are technical artefacts maintenance in order to solve any issues discovered in the XSDs or UML documents and to provide technical expertise, support to MS for writing profiles, technical courses and training sessions.

The overall aim of DATA4PT is to enable interoperable exchange of travel and traffic data in accordance with the Regulation 2017/1926. To build up EU-wide multimodal travel information services (intended by the Regulation) and even bilateral cross-border exchange services this interoperability is crucial. The development of EU common minimum profiles is critical. The combination of these EU specifications and national profiles ensures compliance with the Regulation’s data categories.

EU common minimum profiles are needed in manifold ways:

- to design the national conversion tools,
- to design the NAP metadata.

Validation of conformance is one of the biggest issues for developers (ensuring an implementation is inputting or outputting data in a standard format) and an open-source validation tool is probably the best way to solve such issues. Users can then validate their product against a common benchmark, saving time and effort and ensuring consistency across different companies’ offerings.

NeTEx defines a structured language in which public transport related data can be exchanged between different parties. It is an ontology which defines a broad set of views in which concepts can be exchanged. Parties exchanging NeTEx define a NeTEx-profile which describes what concepts are to be expected in the delivery. A NeTEx-profile can be described as subset of the standard, therefore every NeTEx document can be validated with the full-standard, while subset implementations only implement the views they exchange. The work on profiles has already been started by some member states and also at European level. Existing profiles will, of course, be used as input for new profiles.

At European level, a NeTEx profile for passenger information has been produced by the TC278/WG4/SG9. This profile is a "minimum" profile for passenger information, meaning that instead of being the union of all European needs (that would result in being nearly all NeTEx) it is covering all needs shared by member states. Additional European profiles are anticipated but not yet planned: NeTEx Stop and Accessibility profile, NeTEx Fare profile and a SIRI profile. NeTEx national profiles for passenger information are already available in France, Norway, more recently in Germany and Netherland, the UK is currently working on a NeTEx Fare profile and so does Norway. SIRI profiles are under definition in France, Norway and Germany. Private SIRI and NeTEx profiles have also been produced by companies like Hogia (Sweden) or authorities like IdFM - Ile de France Mobilité (Paris PTA).

Feedback and best practices from all these profiles will be provided by DATA4PT as inputs for countries starting their own profile. They will also be provided as input to CEN for future European profiles (for example NeTEx Fare profile and SIRI profile).

2.1.1.3 Italian NeTEX profile group

Many exchange frameworks are already in place in different Member States (like GTFS and VDV) and the main focus is on the conversion of the travel and traffic data into the EU standards and the further provision over the NAPs. In order to assist this national conversion, EU common minimum profiles are of utmost importance, as these specifications deliver the required content and format of the data and guarantee the compatibility with the other states.

Main objective of the Italian NeTEx Profile group are:

- the definition of the Italian Profile of the NeTEx protocol, to be used by all involved parties: authorities, Transport Agencies, PTOs, Government, NAP, etc.
- Identify the stakeholders and share the process to adopt the standard in Italy;
- Evaluate the tailoring of the process according to the “local reality” (e.g. Regions);

The overall activity of the Working Group is technical and the result will be a protocol to be implemented and used.

NeTEx protocol is divided into three parts, each covering a functional subset of the CEN Transmodel for Public Transport Information:

- Part 1 describes the Public Transport Network topology (CEN/TS 16614-1:2014);
- Part 2 describes Scheduled Timetables (CEN/TS 16614-2:2014);
- Part 3 covers Fare information (CEN/TS 16614-3:2015).

All three parts use the same framework of reusable components, versioning mechanisms, validity conditions and global identification mechanisms defined in a NeTEx frameworkin Part1.

NeTEx also includes container elements called “version frames” to group data into coherent sets for efficient exchange. NeTEx schema can thus be used to exchange:

- Public Transport schedules including stops, routes, departures time or frequencies, operational notes and map coordinates;
- Routes with complex topologies such as circular routes, cloverleaf and lollipops, and complex workings such as short working and express patterns; connections with other services can also be described;
- The days on which the services run, including availability on public holidays and other exceptions;

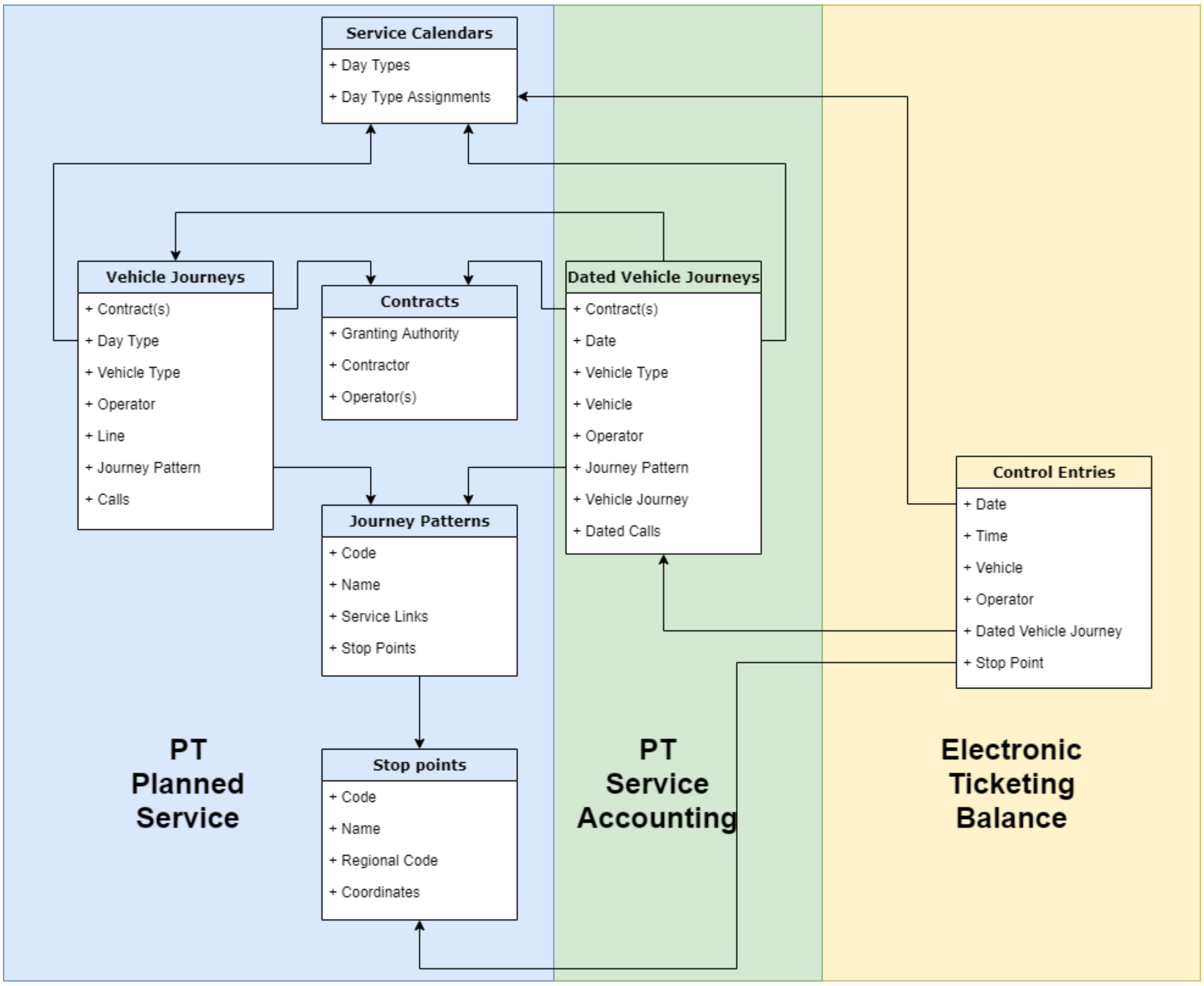

Figure 7 - Bipex structure

- Composite journeys, such as train journeys that merge or split trains;
- Information about the operators providing the service;
- Additional operational information, including, positioning runs, garages, layovers, duty crews, useful for automatic vehicle location and on-board ticketing systems;
- Data about the accessibility of services to passengers with restricted mobility;
- Data is versioned with management metadata allowing updates across distributed systems;
- Fare structure (flat fares, point to point fares, zonal fares);
- Fare products (single tickets, return tickets, day and season passes);
- Fare prices that apply at specific dates.

Figure 8 - DAAT4PT Pilot address EU Directive 2010/40 Priority Action a (Delegated act 2017/1926)

BIPEx protocol, developed in an Italian region, enables standard data exchange flows between transport operators and public authorities:

- it is adopted in Piedmont Region and a good candidate to be used in other Regions;
- it will be used as base for NeTEx Italian profile definition and used for Italian NAP implementation.

Based on XML file, BIPEx protocol enables public authorities to collect the dataset needed for a proper public transport governance:

- Public Transport Planned Service (resources, calendar, network topology, etc.);
- Public Transport Accounting (dated vehicle journeys, events, etc.);
- E-Ticketing Data (fares, sales network and balance, customers, validations, blacklists, etc.);
- Real-time vehicle monitoring.

BIPEx protocol is:

- XML Protocol for PT data exchange, totally open, to grant Public Administration to manage PT services;
- Developed by 5T and inspired to open international standards (Transmodel, NeTEx e SIRI);
- Released by Piedmont Region with Creative Commons 4.0 licence and available for free to other Public Administrations;
- Already transferred to other local systems (Liguria, Alto Adige) and winner of Open Community PA 2020 tender of PON Governance.

BIP & TPL Regional Centre manages and updates BIPEx protocol, in cooperation with PT operators and Public Administration entities, disseminating its good practices in order to foster its application in different areas, easing interoperability at a national level.

BIPEx protocol is defined by 2 XSD documents:

- *bipex_publication.xsd*: it provides structures for static and semi-static data about:
  - PT Planned service;
  - Electronic Ticketing System.
- *bipex_report.xsd*: it provides structures for monitoring and balance data about:
  - PT Service Accounting;
  - Electronic Ticketing Balance;
  - PT Service Real-time Monitoring.

Figure 9 - Exchange of traffic data between Piedmont Traffic Management Service Center and Italian NAP, already in operation (DATEXII)

Timeline of Italian NeTEx profile group, in DATA4PT is organized as the following main mile-stones:

- Kickoff meeting and stakeholders gathering: July 2020
- NeTEx and BIPEx Analisys: September 2020 – November 2020
- Preliminary NeTEx Profile draft: November 2020 – January 2021
- NeTEx Profile validation: January 2021 – March 2021
- NeTEx Profile completion: April 2021 – June 2021
- Start exchange data NAP Italian Pilot: May 2021 – July 2021

2.1.2 Progress since 2017

CCISS platform, as national access point, represents the single point which allows users to access road and traffic data, including data updates, provided by road authorities, road op-erators and service providers and concerning the whole national territory.

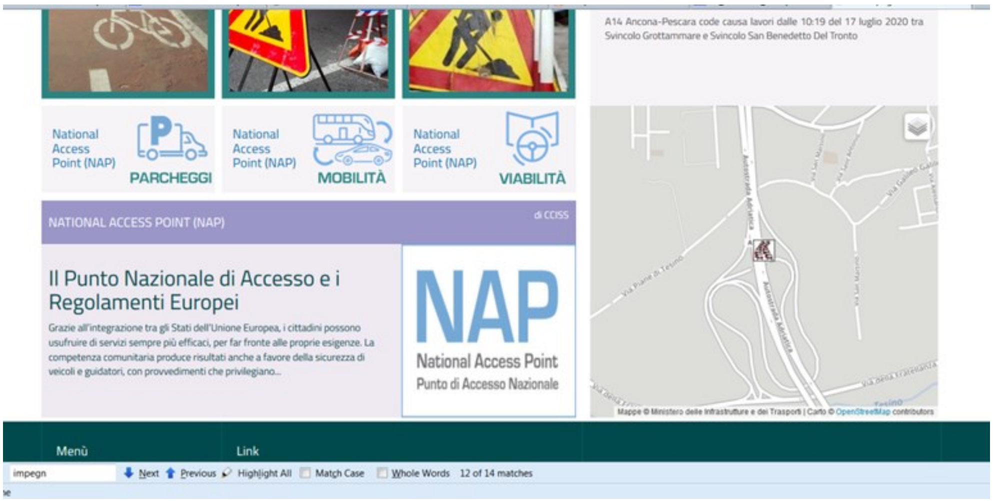

Figure 10 - Particular of CCISS home page, which links to NAPs

During the period from January 2017 to December 2019, the platform has disseminated information on over 3,5 million events, divided by month as in the picture

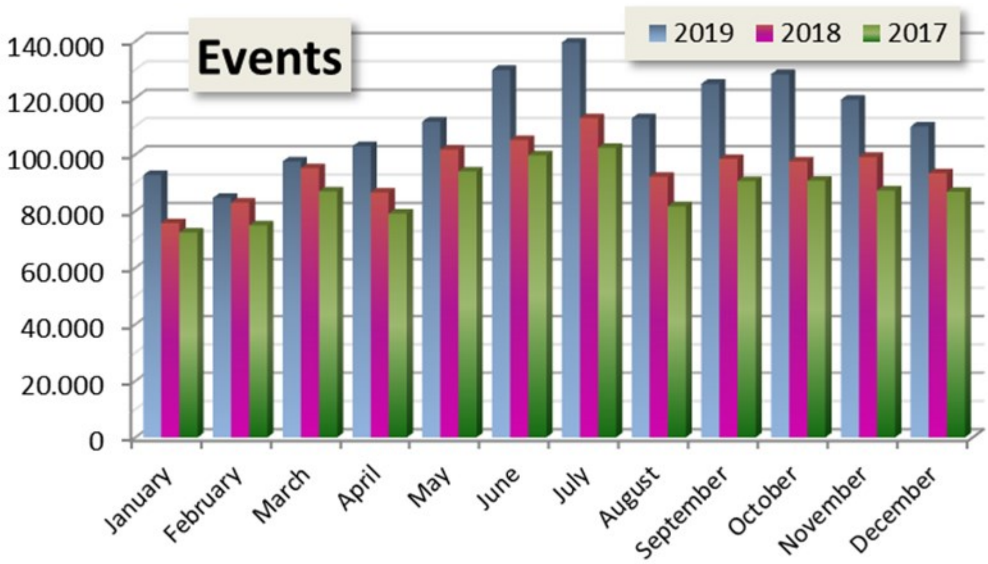

Figure 11 - Events published by CCISS in years 2017 to 2019 divided by month

The platform has been improved in managing information, both textually and graphically, according to DATEX II paradigm: events are locally loaded or automatically received and stored in a very structured way, allowing a number of automatic processing.

The system is also able to build a summary of the main event, grouped by location, and to produce, through text-to-speech software, audio files which can be listening to by calling CCISS toll-free number 1518 and navigating in its interactive voice response system.

On CCISS website information is available in real time and the system is able to translate event in English, French and German. Translation capabilities are being enhanced, with richer dictionaries and Slovenian language added. The system is also able to build a summary of the main event, grouped by location, and to produce, through text-to-speech software, audio files which can be listened to by calling CCISS toll-free number 1518 and navigating in its interactive voice response system.

ROAD	COMPATIBLE %	DATEX 2 %	OTHER %		ROAD	COMPATIBLE %	DATEX 2 %	OTHER %
A1	96.99%	0.00%	3.01%		**A23**	90.56%	0.00%	9.44%
A2	0.00%	85.37%	14.63%		**A24**	97.94%	0.00%	2.06%
A3	91.55%	0.00%	8.45%		**A25**	99.09%	0.00%	0.91%
A4	96.44%	0.00%	3.56%		**A26**	99.13%	0.00%	0.87%
A5	95.15%	0.00%	4.85%		**A27**	96.96%	0.00%	3.04%
A6	93.27%	0.00%	6.73%		**A28**	99.12%	0.00%	0.88%
A7	83.46%	0.00%	16.54%		**A29**	0.00%	96.46%	3.54%
A8	96.21%	0.00%	3.79%		**A30**	96.62%	0.00%	3.38%
A9	99.63%	0.00%	0.37%		**A31**	91.89%	0.00%	8.11%
A10	66.58%	32.67%	0.75%		**A32**	85.03%	0.00%	14.97%
A11	90.63%	0.00%	9.37%		**A33**	96.91%	0.00%	3.09%
A12	84.36%	0.00%	15.64%		**A34**	94.29%	0.00%	5.71%
A13	97.59%	0.00%	2.41%		**A35**	94.84%	0.00%	5.16%
A14	99.22%	0.00%	0.78%		**A36**	83.56%	0.00%	16.44%
A15	97.99%	0.00%	2.01%		**SS1**	5.67%	78.72%	15.61%
A16	99.40%	0.00%	0.60%		**SS3bis**	0.00%	82.46%	17.54%
A18	65.26%	16.03%	18.71%		**SS73**	0.00%	80.11%	19.89%
A19	0.15%	92.72%	7.13%		**SS106**	0.00%	95.00%	5.00%
A20	33.92%	51.54%	14.54%		**SS223**	0.00%	85.14%	14.86%
A21	96.81%	0.00%	3.19%		**SS675(E45)**	0.00%	0.00%	100.00%
A22	94.77%	0.00%	5.23%		**SS715**	0.00%	79.85%	20.15%
SS131	0.00%	93.19%	6.81%		**E78**	0.00%	81.87%	18.13%

Table 1 - Percentage of total events by DATEX in TEN-T highways

CCISS publishes also events in DATEX format to end users after free registration (at the address https://www.cciss.it/dx2-ems-xml-war-jb/duel/ima/TsdXml) and, through specialized channels, to many stakeholders.

Focusing on information service provided for motorways and primary roads, the following table reports the percentage of event automatically transmitted regarding main roads in TEN network, both motorways, labelled Ax, and other primary roads, labelled either SSx, according to national convention, or Ex, according to European convention, as shown in the figure.

Since last major release, deployed in September 2018, CCISS platform uses heuristic techniques to evaluate event correctness and bring to the operator attention those cases that appear wrong. An experimental version of the algorithm is designed for declarations standardization and automatic inspection, allowing for a first general correctness evaluation and ranking, to manually inspect not only randomly, but also in a probabilistic way.

Another enhancement, the transition to DATEX II standard format, is almost completed for all the data collection operators, to facilitate the data flows into the CCISS platform.

At the Italian government level, road safety is a priority, with the aim, by providing useful information in real time to the final user, to improve driving and to warn about dangerous situations; therefore the coverage of the service will be extended to other roads that are not part of TEN network but relevant for traffic monitoring.

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

Following the EU Directive 2010/40 and the related regulation 2017/1926, the Ministry of Infrastructures and Transport has appointed two of its internal structures for supplying national access point services.

Specifically, the establishment of the NAP for multimodal travel information services will stem from the cooperation between the Road Safety General Directorate - Road Safety Information & Coordination Centre (Centro di Coordinamento Informazioni per la Sicurezza Stradale - CCISS) and the ICT General Directorate. The former will be the reference structure, responsible for management.

The Road Safety General Directorate has been involved with its CCISS platform, already described, while the ICT General Directorate has been involved with its project “OpenTrasporti”.

OpenTrasporti has been defined in 2016, earlier than the Regulation 2017/1926, aiming at collecting data in an online platform from the various transport modes (car rental, taxi, car sharing, public transport, train, private transports and parking), infrastructures and other providers. The aim was to offer digital services supporting transports and enabling the multimodal chain from the travel planning to destination, delivering positive impact not only in the transport sector, but on the Italian system as a whole (tourism, culture, other services). The contextual framework of the OpenTrasporti project is represented in the image below.

The OpenTrasporti project pursues the realization of a NAP on travel information following a top-down and bottom-up hybrid approach.

The top-down approach follows the current NAP guidelines exploited by the EU-EIP ITS platform program and defined a strategy through benchmarks with other European countries projects.

Concerning the bottom up approach, the ICT General Directorate has defined a strategy to perimeter and design a pilot, in which could be developed a proof of concept.

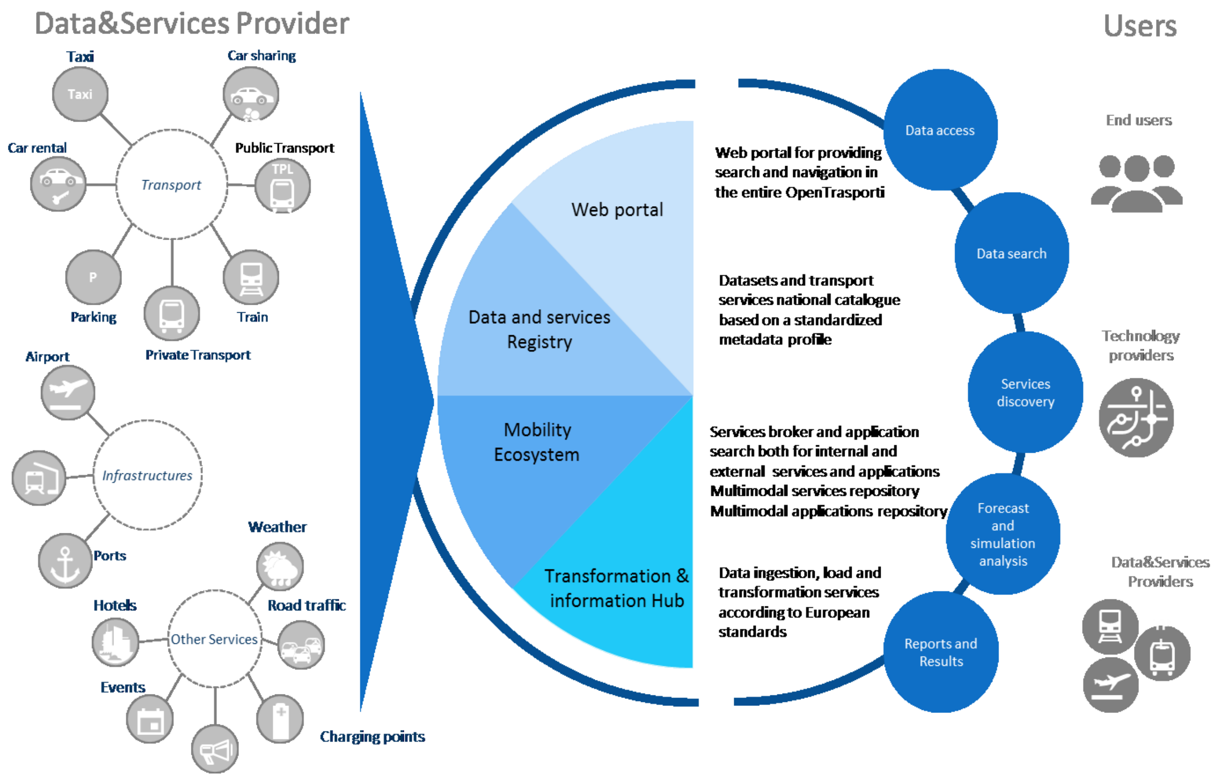

Figure 12 - OpenTrasporti Framework

Given the broad perimeter and the great number of actors involved, the project is still in a development phase and the action plan is in an updating process to achieve the design completion.

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)

Concerning the update of dynamic road data and real-time traffic information, relevant processes are executed as soon as some kind of update or modification is known about, and they quickly complete with validation, upon which users can know about the change. So users practically have parallel knowledge to the acceptance of the change. Dynamic road data updates are performed considering the completion of all those fields that must be taken into account for the correct updating (type of dynamic road status data, location of the event or condition ensuring that the information is unambiguous, period of occurrence and quality of the data update). Updating dynamic road status data or traffic data is intimately linked to real-time traffic information, so any change executed on the former implies an automatic review of all real-time related publications in NAP. NAP update frequency depends on the data provided.

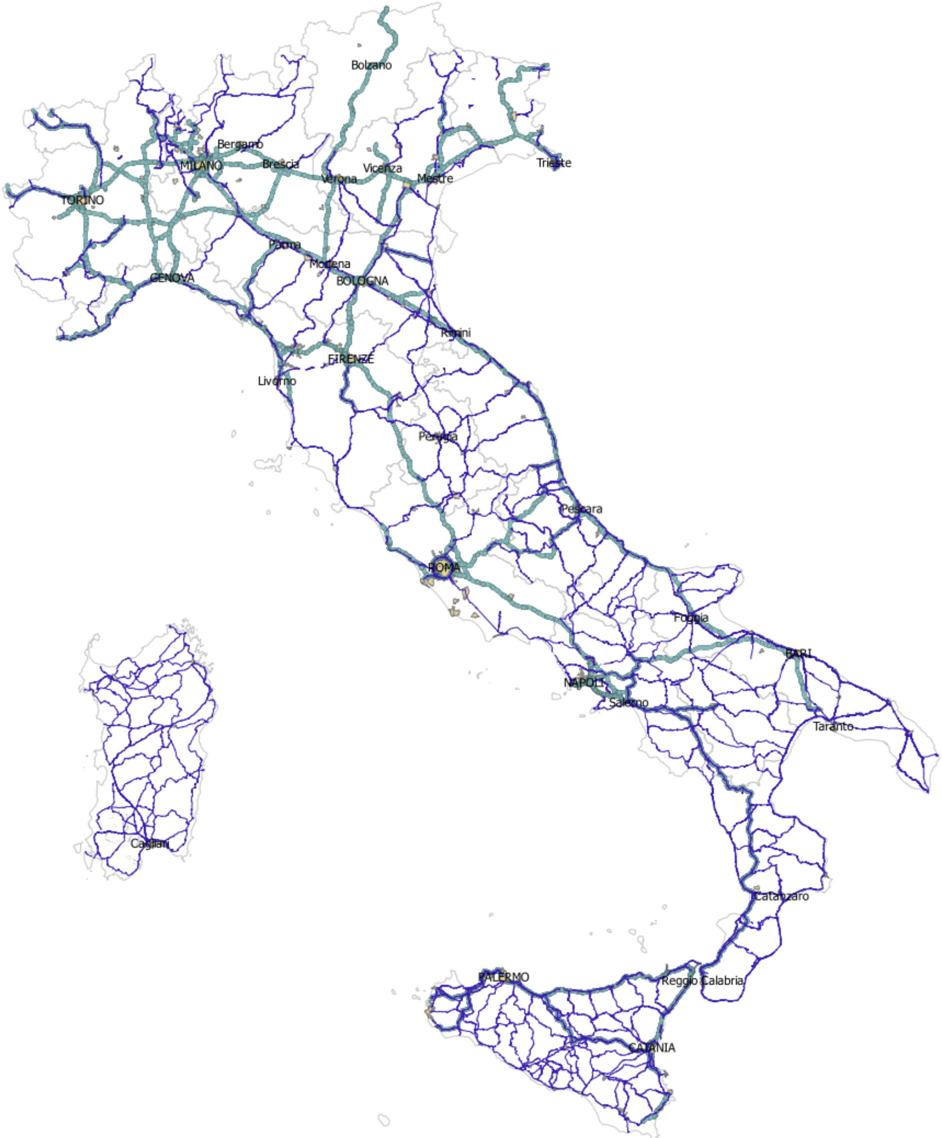

Figure 13 – Motorways (green) and primary roads (blue) network

As for dynamic road data and real-time traffic information, CCISS accepts, besides the Italian profile, the entire European DATEX II - version 2.3 set and can share it through Social Media, Web Portal, App Mobile, Public number 1518, Radio and News Bulletin. CCISS, publishes information over web, radio and phone channels completely free of charge and put no limitation on its services.

In order to facilitate management and up-to-dateness, the easy exchange and re-use of static road data, dynamic road status data and traffic data, CCISS portal makes available services in order to enable the sharing and the interactive consultation of these information on a spatial data infrastructure, organized for all national territory. Through spatial data infrastructure, static road data are collected by CCISS and made available to other users organized in data-set tables and geographical layers.

Data publication, extended to the whole national territory, regards all motorways, all primary national roads, some secondary and tertiary roads and selected urban areas. In particular, motorways extent is 7,022.247 km and national roads extent is 27,128.077 km and both networks together represent a superset of trans-European road network.

The number of secondary and tertiary roads and urban areas covered by the service is constantly increasing. The following figure represents motorways and primary roads, about which static and dynamic road data and traffic information are available.

Road operators are in charge of collecting static and dynamic data, as prescribed by law, in particular Italian Road Code (legislative decree 30 April 1992, n. 285) and ministerial decrees 1 June 2001 and 1 February 2013.

Actually, all types of dynamic road status data and traffic data, defined in the Regulation Annex, are available about the whole motorways and primary roads network.

About static road data, Italian State has also implemented Directive 2007/2/EC, concerning a European Union spatial data infrastructure, with legislative decree 27 January 2010, n. 32, and ministerial decrees 10 November 2011 (for different acts).

According to these decrees, road static data set-out in the Annex are available from public authorities and roads operators regarding mainly:

- geometry;
- road width;
- number of lanes;
- gradients;
- junction;
- road classification;
- location of parking places and service areas.

In order to acquire also the other information set-out in the Annex, Ministry of Infrastructures and Transport is collecting all data type from public entities involved in roads management.

The figure below represents a geographical layer about a detail on a single national road section with its physical attributes.

Figure 14 - Detail on a single national road section and its physical attributes

The following figure represents a geographical layer about a detail on a single motorway section with its physical attributes.

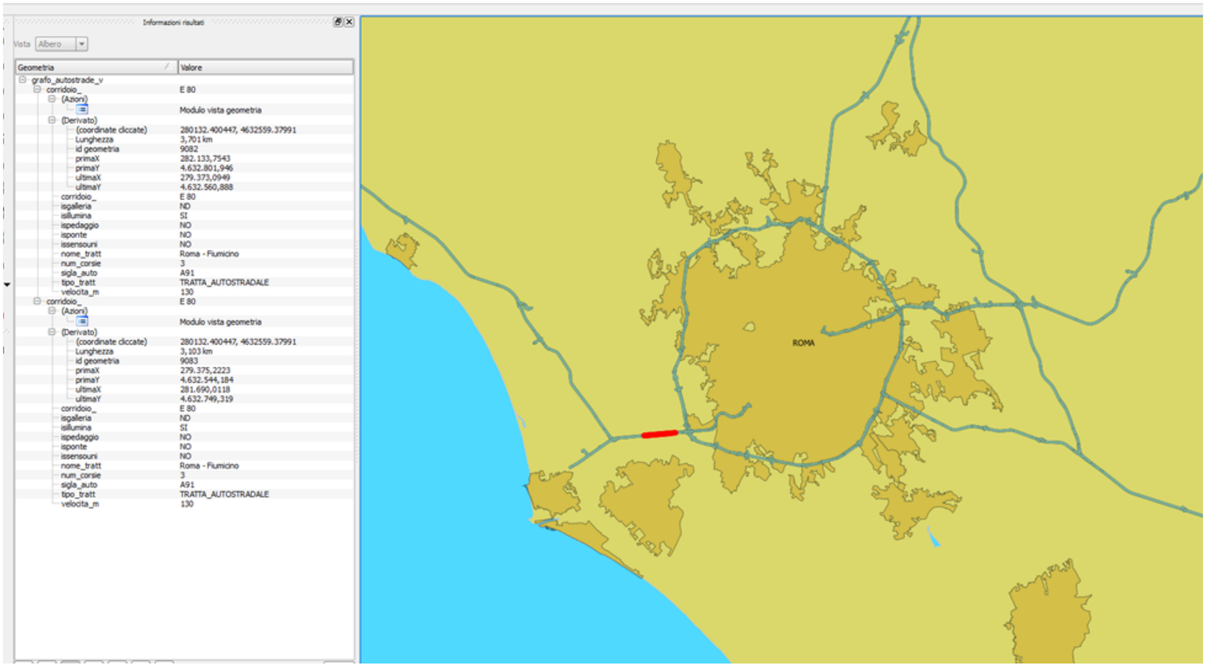

Figure 15 - Detail on a single motorway section and its physical attributes

On CCISS website, information on traffic data and safety-related traffic data are available in real time. In the pictures below is shown an example about the presentation concerning “Location and length of traffic queues”

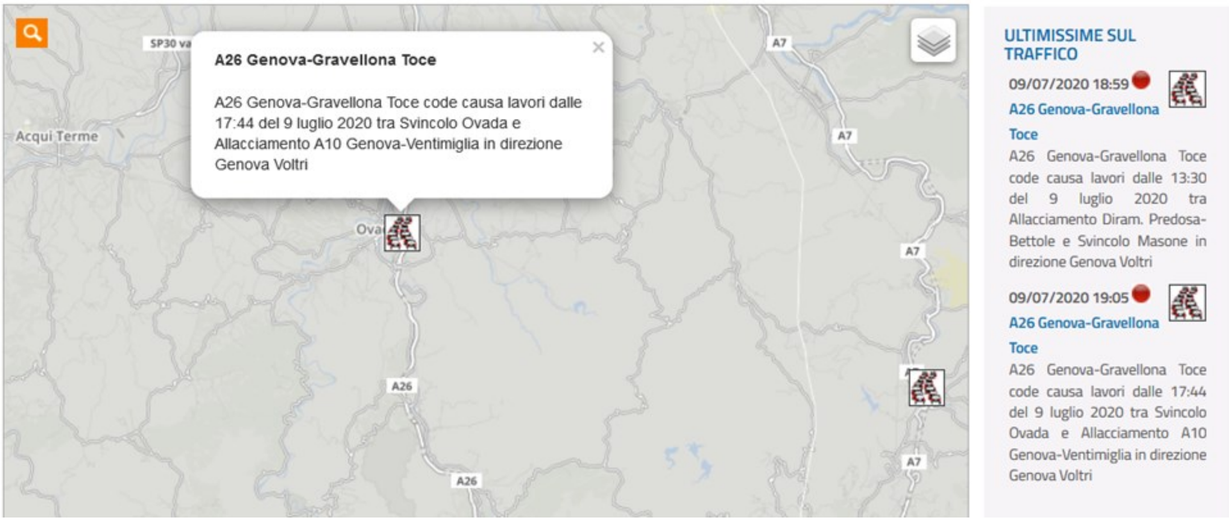

Figure 16 - Example event: A26 Genova-Gravellona Toce, queue from July 9, 2020 at 17:44, web site view

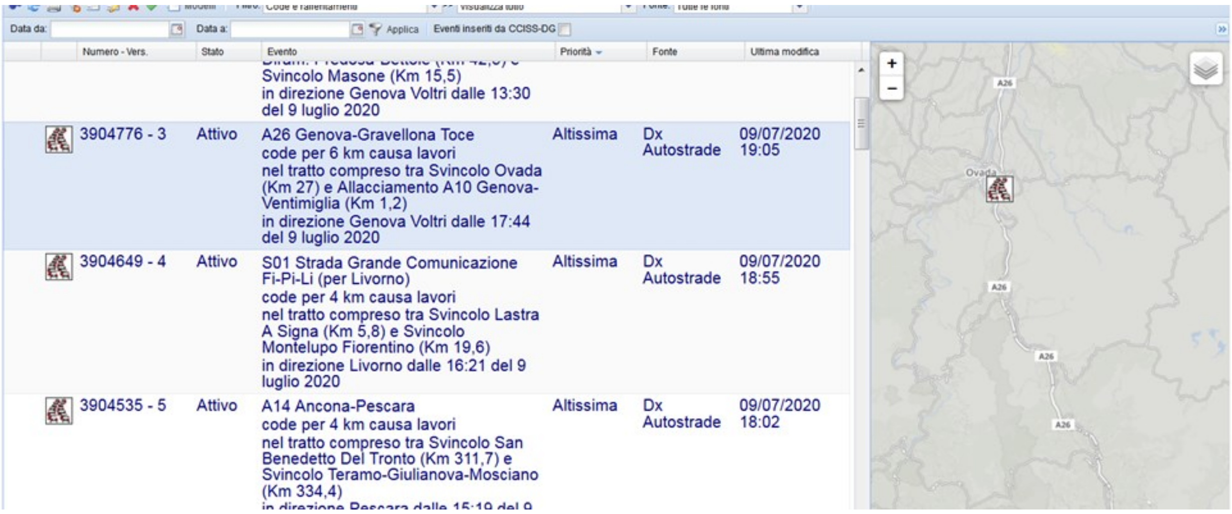

Figure 17 - The same event as in figure 11, A26 Genova-Gravellona Toce, queue from July 9, 2020, operator view

Events published by CCISS fall in three classes: safety-related traffic events, covered by Regulation 2013/886, dynamic road status data and real-time traffic data. In the following figure distribution of the events already presented in figure 6 are divided into the three classes.

Since many years, CCISS attention is focused on safety-related events and real-time situation, to allow safer conditions and more comfortable journeys for user and a better road use. For both classes there are two opposite trends: event detection improvement, which rises numbers, and accident decrease, which lowers numbers. Dynamic events are constantly increasing because the extent of the road network covered by the service is also increasing.

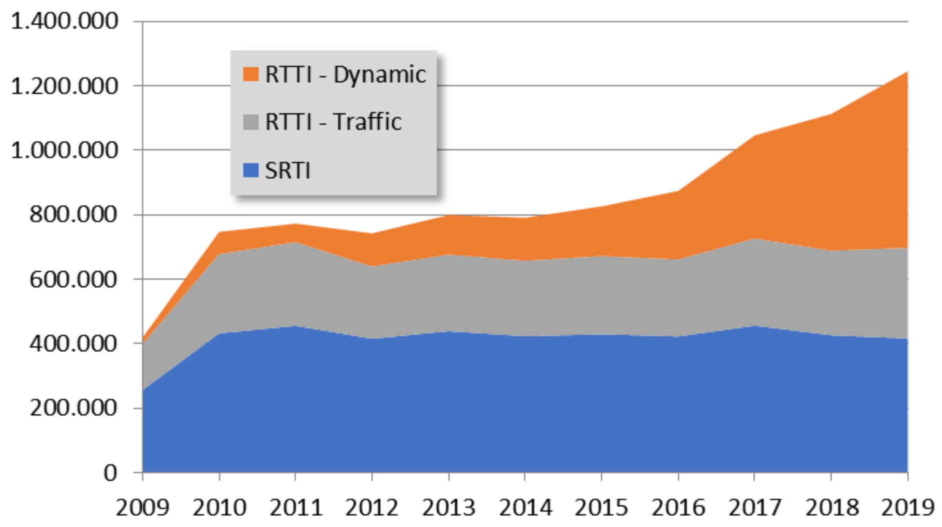

Figure 18 - Events published by CCISS since 2009, divided by class

2.1.5 Reporting obligation under Delegated Regulation (EU) 2013/886 on data and procedures for the provision, where possible, of road safety-related minimum universal traffic information free of charge to users (priority action c)

In compliance with the ITS Directive (2010/40/EU), CCISS is the National Access Point for road safety information, providing information on the categories of safety-related events or conditions.

At the CCISS Operations Centre news regarding mobility are constantly monitored in order to identify and create new rules, or possibly modify those already existing, for the provision of automatic services able to guarantee greater efficiency for processes and greater effectiveness in the dissemination of certified information.

In the cooperative model used by the National Access Point three kinds of actors are involved, identifiable in network operators or dealers, service providers and content providers, all communicating through computerized connections (with the aim of achieving interoperability and application co-operation). The quality of the information provided is ensured through the validation process of the data collected, performed by:

- Supervisors (Police Forces);
- Validators of the information sources.

The validators of the information source can manage only their own events, while the supervisors (Police Forces) can check, modify, validate and delete every event.

The traffic events entered by the various operators in the system are immediately displayed and must be validated or rejected by the supervisors and the validators within a preestablished maximum time (actually 3 minutes).

The supervisors, in any case, can reject the event already validated by the validators of the information owner before its publication.

Validation depends on an organization's quality policy, and it is not used in the definitions of the quality parameters, as we can see in the document by European ITS platform “Quality of SRTI and RTTI, Practical Guidelines” EU EIP SA 4.1/2018.

Traffic information with a good quality is the right traffic information at the right time. Thus, two items must be covered by the quality parameters: time and right information. For time, two quality parameters have been defined: timeliness and latency. Timeliness is the time span from the occurrence of an event until it is detected and accepted at the traffic centre. Latency is the time span from the acceptance until the information (message) about the event is available for the users.

The document EU EIP 4.1 provides service quality requirements both for real-time traffic information and for road safety related traffic information. For the time being, the CCISS has not yet defined specific quality objectives, but they will be set in accordance with that instruction.

Member States must designate an impartial and independent national body competent to assess whether the requirements set out in Articles 3 to 8 are fulfilled by public and private road operators and service providers and broadcasters dedicated to traffic information.

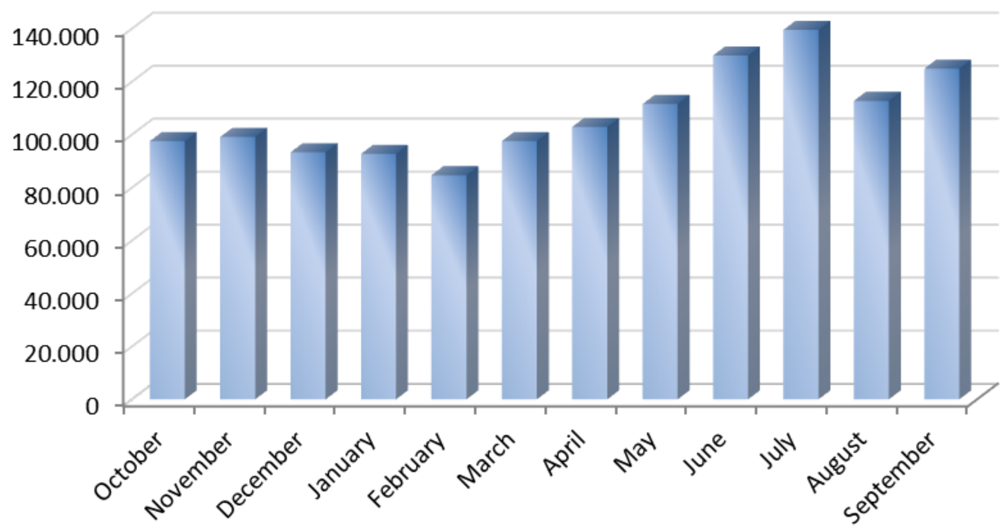

Figure 19 - Total event published by CCISS in period October 2018-September 2019

ART, the Italian Authority for Transport Regulation, has been designated by the Italian Ministry of Infrastructures and Transport as the competent body for assessment of compliance in December 2018. In 2019, the verification process has been planned and the designated national body acquired the declaration of compliance with the requirements.

During the year 2019, period from October 2018 to September 2019, the platform has disseminated information on about 1,286,000 events, divided by month as in figure 19.

In this amount of events we can estimate that 354,700 should be included into the eight categories of universal events for road safety.

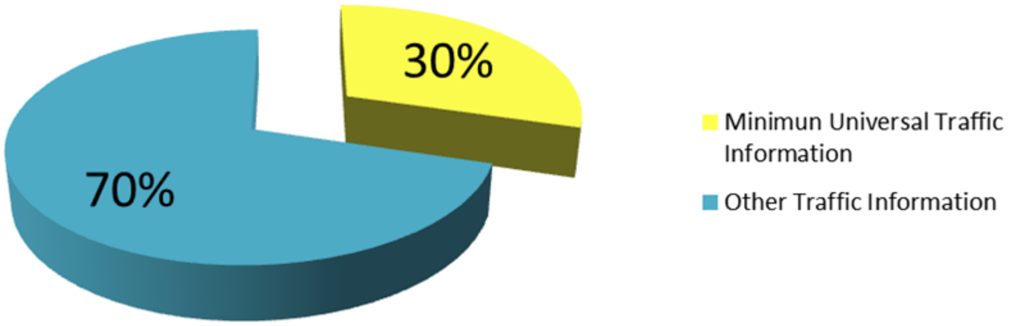

Figure 20 - The minimum universal traffic information in comparison with the total number of events

Besides minimum universal traffic information, which are 30% of the total number of published events, CCISS processes a lot of other road information, in order to prevent accidents and too large traffic jams, and to guarantee optimal use of road network. Among diffused data, information required by Regulation 2013/962 can also be found.

CATEGORY	EVENTS COLLECTED
Temporary slippery road	11,707
Animal, people, obstacles, debris on the road	31,716
Unprotected accident area	116,399
Short-term road works	49,892
Reduced visibility	5,216
Wrong-way driver	1,523
Unmanaged blockage of a road	158,484
Animal, people, obstacles, debris on the road	6,350
TOTAL	**381,287**

Table 2 - Data collected from October 2018 to September 2019 divided by category

In table 2, data collected in order to be compliant with the Delegated Regulation EU 2013/886, related to the period October 2018 - September 2019 are shown.

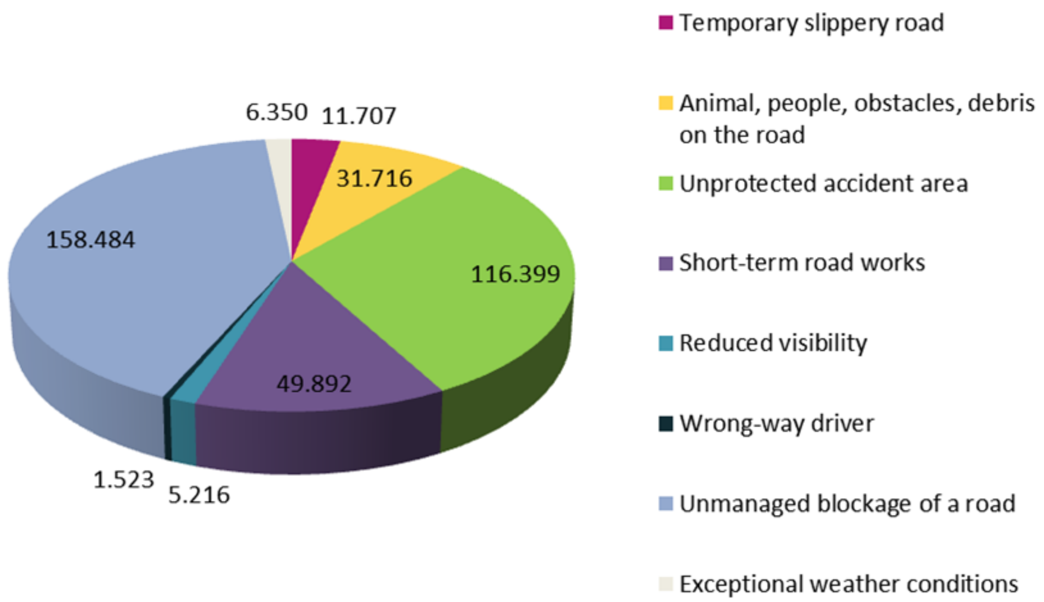

Figure 21 - Data collected from October 2018 to September 2019 divided by category

Accident related events are stable in number over time; nowadays, most of the accident-related information is obtained through cameras, police reports, 112 emergency services, but also some service providers feed the NAP with events related to accident breakdowns.

Concerning the short-term road works, it is essential in terms of road safety that relevant data are accurate and reliable, but the higher figure is partly due also to greater maintenance work that took place in the period.

The phenomenon of reduced visibility is critical for road safety and, as in the exceptional weather conditions, the forecast related information are available to final users also through the NAP.

The wrong-way driver is an extremely dangerous event and we are really concerned about this situation. The operators are working to find a different solution and one of these solutions will be based upon the collaboration with a service provider to receive notifications if a user identifies a wrong-way driver.

With reference to Article 4, the events or conditions contain location to be published; events or conditions include category and a description, description can contain driving behaviour advice. 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.

With reference to Article 5, the information service is provided for the entire trans-European road network.

With reference to Article 6, road operators are in charge of collecting static and dynamic data, as prescribed by law, in particular Italian Road Code and ministerial decrees 1 June 2001 and 1 February 2013.

With reference to Articles 7 and 8, part of road operators transmit data use newer and more detailed Datex II format, part use Datex compatible format, part other telematic links and remaining operators semi-automatic systems.

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

2.2.1 Description of the national activities and projects

2.2.1.1 CORE project

CORE (Consistently Optimized Resilient Secure Global Supply-Chains) is a European project funded under the 7th Framework Program, launched in May 2014. The aim of the project is to address the use of innovative technologies to improve the safety of the chain logistics and to develop new solutions to increase safety and efficiency in intermodal transport of dangerous goods. In particular, the project aims to reduce the elements of vulnerability in a supply chain, due to natural events or terrorist attacks, integrating criteria of interoperability, security, resilience and optimization in real time.

As part of the CORE project, Italian Ministry of Infrastructures and Transport, was involved in the experimentation activities, coordinated by Telespazio, of the use of the European satellite navigation services EGNOS / Galileo for the tracking of intermodal transport of dangerous goods. The main partners involved, with Italian Ministry and Telespazio, were TTS Italia, Ministère de l'Environnement, de l'Énergie et de la Mer (France), Hoyer GmbH (Germany), Click & Find S.r.l. (Italy). The project started in May 2014 and was completed in June 2018.

Research activities, regarding CORE's WP16 dedicated to the "Intermodal transport of Dangerous Goods demonstrator", were aimed to validate the "Localisation and tracking solution for the intermodal transport of Dangerous Goods" developed in another WP.

The solution developed for the demonstrator makes use of EGNSS (EGNOS and Galileo-multiconstellation) for tracking and tracing the intermodal transport (through road/rail tankers) of dangerous goods. The solution is based on state-of-the-art components and technologies, partly off-the-shelf and partly inherited from previous research, integrated with ad-hoc developments, customisations and enhancements to cope with the specific needs and requirements coming from the involved users and stakeholders. The demonstrator was operated and ran in real-life conditions and scenarios and directly involves two types of users, business (i.e. the road/rail tankers' owner and transport operator) and institutions (i.e. France's and Italy's ministries of transport).

The demonstrator provided a proof-of-concept/validation through a concrete demonstration, to assess:

- The technical feasibility, i.e. use of Global Positioning System GPS/EGNOS/Galileo-multiconstellation and an innovative device for tracking tank containers transporting dangerous goods;
- The added value of real-time tracking and tracing based on GPS/EGNOS/Galileo-multiconstellation. In particular, the high-quality and reliable position information, obtained thanks to the use of GPS/EGNOS/Galileo-multiconstellation, and the relevant main benefits and added values for the involved business stakeholders and authorities in the dangerous goods transport;
- Specifically for institutional purposes, the risk assessment functions, which can be built on the availability of robust tracking and tracing, such as risk analysis/prevention/mitigation, support to emergency management.
- Linked to this, the specification of requirements and the definition of a model for risk assessment functions (analysis/prevention/mitigation) envisaging the coordination and sharing of data between national and regional authorities;
- Standardisation and regulatory aspects;
- Practical demonstration of the architecture based on Trusted Parties (TP1/TP2) proposed by the informal Working Group (WG) on telematics established by UNECE in the framework of the RID/ADR/ADN Joint Meeting (hereafter, "UNECE joint WG on telematics" www.unece.org/trans/danger/danger.html), at national level and with emphasis on cross-border transport operations (involving Italy and France);
- The revision of CEN (Comité Européen de Normalisation/European Committee for Standardisation, www.cen.eu) Workshop Agreement 16390 (CWA 16390);
- Promotion/awareness creation in relation to the adoption of tracking and tracing towards the interested community.

Figure 22 shows the architecture of the tracking and tracing solution and its main elements, namely:

- LCS (LoCation Server) for the processing of EGNOS Open Service (OS) and EDAS (EGNOS Data Access Service) to provide GPS/EGNOS/Galileo/multi-GNSS based value added positioning services;
- The tracking device to be installed on the tanker transporting dangerous goods (argon). Two tracking devices have been developed/installed/operated in the demonstrator, the first being a prototype configuration and the second being the relevant evolution/improvements (i.e. pre-operational configuration) taking into account the results of the early demonstration.
- T3 Platform, acting as TP2 (Trusted Party 2, data holder on behalf of owner and supplier of services for TP1, with reference to the architecture defined by UNECE joint WG on telematics);
- TP1 It and RP Platform acting respectively as TP1 in Italy (Trusted Party 1, supplier of ser-

vices for authorities, with reference to the architecture defined by UNECE joint WG on telematics) and a regional platform in charge of coordinating the monitoring and the management of emergency operations in case of accidents;

- TP1 Fr Cerema acting as TP1 in France, in order to consider the architecture defined by UNECE joint WG on telematics in cross-border scenarios.

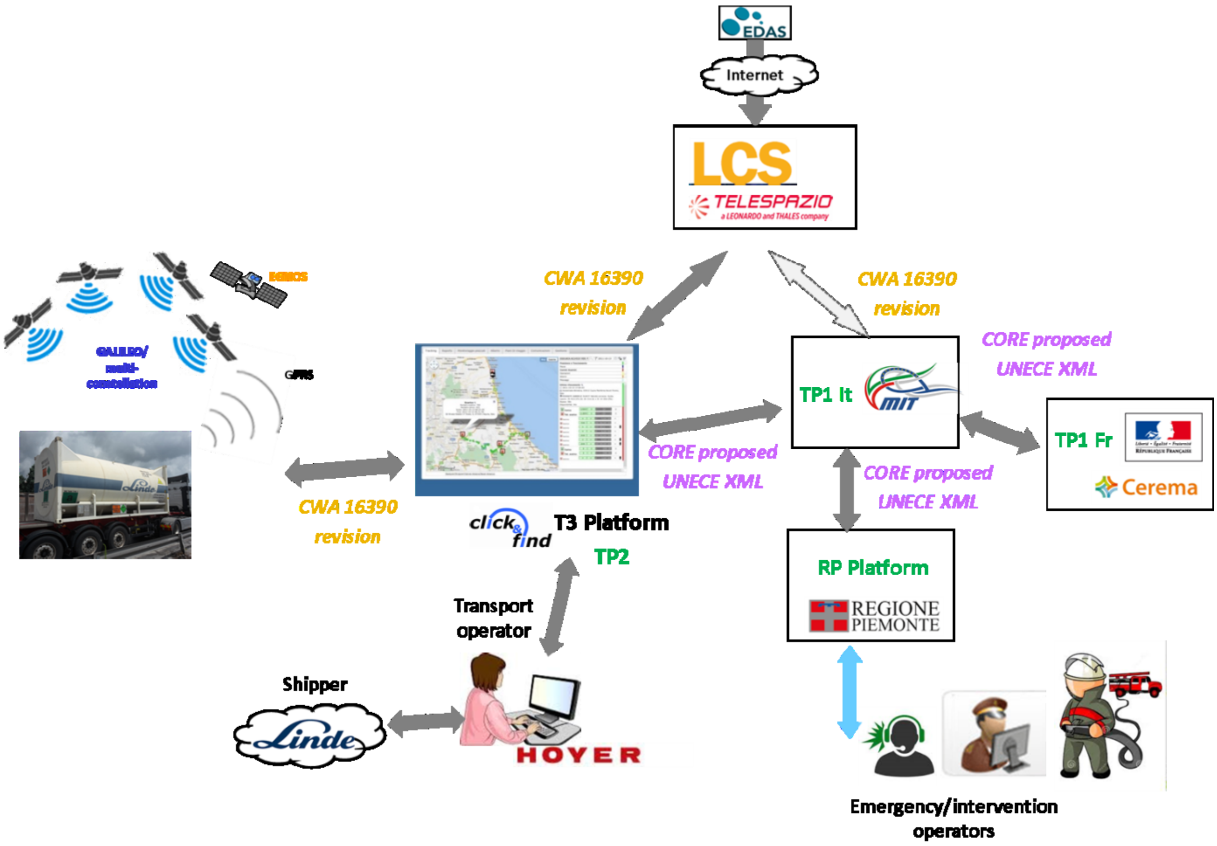

Figure 22 - Architecture and main elements of the tracking and tracing solution the CORE WP16 demonstrator

The main elements of the tracking and tracing solution have harmonised and standardised interfaces, according to:

- A CEN technical specification, CEN Workshop Agreement CWA 16390 revision that is the revised CWA 16390. The process of revision has been undertaken by CORE WP16;
- A UNECE standard based on UML/XML/XSD defined by UNECE joint WG on telematics and modifications/enhancements have been proposed by CORE WP16 to include CWA 16390 revision and additional alarms/events needed by the risk assessment functions of MIT Platform/TP1 It. Additionally, the France’s and Italy’s Ministry of Transport, representing the governmental users of CORE WP16 demonstrator, expressed the interest of formally integrating UNECE UML/XML/XSD (with the enhancements proposed by CORE WP16) in DATEX II.

One of the main concepts of CORE’s WP16 demonstrator is the use of tracking and tracing data for risk assessment functions. In particular, CORE's WP16 demonstrator has proved the values of:

- The combination, integration and processing of various types of data;
- The precise and trustable information on the position;
- The innovative model envisaging the coordination and sharing of data between national and regional platforms and authorities.

In this respect, as anticipated at the beginning of this section, the contribution of CORE's WP16 demonstrator to UNECE TP1/TP2 architecture for data exchange is to show the benefits in terms of higher efficiency, safety and security, not only for law enforcement and emergency management (i.e. during intervention and operations after an accident is occurred), but also for prevention of accidents.

MIT Platform (acting as TP1 It) and RP Platform, presently operating in Italy at national and regional level, makes use of tracking and tracing data to implement value-added services for the involved stakeholders, such as collection/transmission in real-time of the tracking and tracing data opportunely filtered/processed, monitoring and surveillance of the transport of dangerous goods, and risk assessment functions to support analysis/prevention/mitigation.

In the frame of CORE, as part of the R&D outcomes, WP16 has enhanced MIT Platform and RP Platform to include:

- The processing of tracking and tracing data and their integration and enrichment with relevant (historical and real-time) indicators and statistics, in order to elaborate risk assessment parameters and to predict potential risk scenarios;
- The dispatching of tracking and tracing data and elaborated advanced risk assessment parameters to involved stakeholders (operating at regional level in the traffic monitoring or emergency management);
- The implementation of an advanced model for risk mitigation that, based on the predicted potential risk scenarios and in the cases of difficult situations (e.g. meteorological and environmental conditions, events linked to traffic congestion and people concentration), identifies an alternative path for the transport of dangerous goods.

The use case (a real business case) considered in CORE demonstrator is related to the transport of argon in tank containers from Duisburg (Germany) to Terni (Italy).

An end-to-end demonstration has been carried out in the considered use case and involving all types of stakeholders:

- Intermodal road/rail (tank containers);
- Business stakeholders/transport operators;
- Authorities/regulators.

More specifically:

- Linde is the shipper, involved as Hoyer's customer;
- Hoyer is the tank container owner;
- Hoyer is the road and intermodal transport operator;
- Hupac is the rail transport operator and wagon keeper, having a commercial agreement with Hoyer;
- MIT, 5T (Italy) and MTES (France) are the authorities.

The demonstration has been run for more than 10 months (from the mid of May 2017 until the end of March 2018). The two tracking devices (one prototype and one pre-operational installed on board of two tank containers have been shipped in intermodal road/rail real scenarios and cross border operations.

Figure 23 - One of the two tracking devices installed on board of one of the two tank containers

The data from the tracking device (mainly GPS/EGNOS/GLONASS/Galileo positions including raw data and measurements from sensors) are sent to T3 Platform/TP2 and from here are forwarded to LCS for the relevant EGNOS processing by using EDAS. As explained in D16.2, LCS returns the positions corrected with EGNOS and the associated protection levels (Horizontal and Vertical Protection Levels HPL/VPL) providing an information on the guarantee and reliability of the positions.

The positions corrected with EGNOS, with the associated HPL/VPL, and the measurements of the sensors are, on the one hand, made available to Hoyer and, on the other hand, are forwarded to MIT Platform/TP1 It, which in turn forwards them to 5T and to TP1 Fr.

T3 Platform shows the data to Hoyer in a graphical form via Web, and Hoyer can make them available to Linde. Hoyer can access to the data visualising them on digital maps. T3 Platform also performs geo-fencing functions for the positions, and the analysis of the measurements of the sensors to check if the relevant values exceed thresholds pre-defined by Hoyer (and warnings and alarms are displayed if necessary). The functions implemented by T3 Platform have been defined by Hoyer based on the operational needs.

T3 Platform performs the analysis of the measurements of the sensors according to the requirements of MIT (for example, to check if an unexpected event or a not nominal situation have occurred) and sends the values and the events and alarms (if any) to MIT Platform/TP1 It.

During the period of demonstration, no accident has occurred on the path of the use case considered by CORE WP16. However, during this period an accident involving a tank container transporting argon occurred in Italy on a different path.

The requirements, the specification and the developments of the above listed enhancements are among the outputs of CORE WP16 demonstrator. The demonstration phase has enabled to launch the validation/fine-tuning process of the enhancements, which normally takes time (various years).

The use of tracking and tracing data for risk assessment purposes is also one of the inputs provided by CORE's WP16 demonstrator to UNECE joint WG on telematics, that are detailed in 2.2.2.1 paragraph.

2.2.1.2 FENIX project

The overall aim of FENIX (A European FEderated Network of Information eXchange in Logistics") action is to support the development, validation and deployment of digital information systems along the EU transport Core Network and notably corridors. The focus is on the implementation of "corridor information systems" according to specific objective 8: "*upon the DTLF achievements built a federated network of information exchange platforms, involving both public authorities and business stakeholders*". The compelling enablers to address these demands are technology innovations such as: Internet of Things (IoT), Big Data, Data Integration, Data Analytics, Data Products, Intelligent Transportation Systems (ITS) and new satellite navigation technologies; linked to new business models by creating opportunities to conceive, form and deploy new corridor management systems. Multimodal planners linked to execution control have been recognised as key enablers of future logistics operations. Numerous EU research projects have produced innovative solutions in demonstrator chains (among others: CORE, AEOLIX, SELIS).

The vision of FENIX is to empower logistics stakeholders, including cities and authorities, in performing collaborative planning and execution monitoring in various Corridor scenarios and contexts. This will be facilitated through the use of interoperable, interchangeable planning and optimisation tools and services utilising shared, enhanced, secure and reliable data and information resources.

FENIX central innovation imperative is brokering timely and accurate data to corridor planners who need it, by discovering the needed data at the outset and 'digesting' this data through integrated and sharable computing resources to perform adaptations and transformations.

Central to FENIX's concept is a cloud-based technology that will motivate increased horizontal collaboration, optimised routing and dynamic re-routing of freight through plug-and-play solutions for supply chain planning and operations. The end goal is a set of integrated services that exploit real-time Big Data streams for real-time awareness and visibility, delivered from the cloud as a service. These services will be based on accurate, reliable and timely information flows and events notifications based on standards and public-private governance using mainly already existing platforms. FENIX will also exploit IoT, satellite navigation and retrospective historical data, by leveraging automated processes and intelligent algorithms to identify opportunities for more enhanced streamlining of routes, customisation of cargo routing combinations, and optimisation of delivery schedules. The FENIX Pilot Sites, leveraging their own planning and optimisation tools, will utilise FENIX to develop a new generation of services with the end goal of improving or extending the capabilities of their current systems for:

1. Multimodal electronic planning, booking and route optimisation for different modes.
2. Optimisation services and algorithmic models to increase load factors and to optimise the planned delivery routes.
3. Simulation modelling tools for detailed analysis and predictions of cargo flows (per transport mode).
4. Logistics pre-planning, planning and execution, event management, data analytics and machine learning services.
5. Geolocation services and last mile routing mobile services and algorithms that consider the environment and mobility policies of authorities and reduce network traffic.
6. Time-based planning services that extend the window for delivery to secure a higher return on assets.

FENIX is based on the work and recommendation of the Digital Transport and Logistic Forum (DTLF) subgroup 2 (corridor (corridor information systems) to create available and valid federative network of platforms as enabler for Business to Administration (B2A) and Business to Business (B2B) data exchange and sharing by transport and logistics operators.

FENIX does not strive to develop a new centralised solution with its own specific functionalities and does not create another platform.

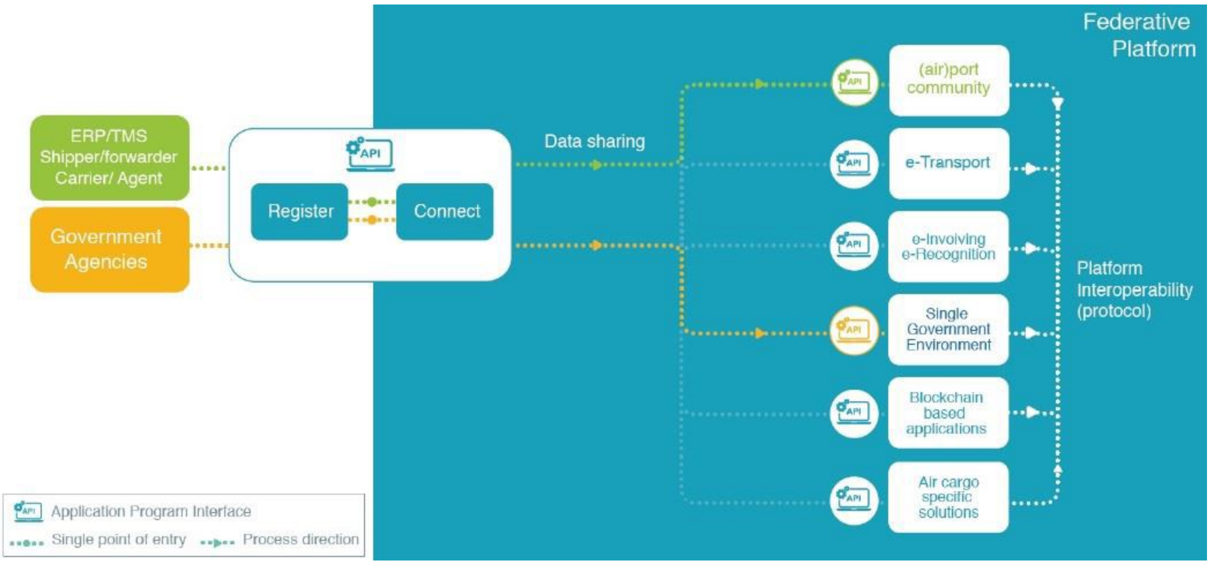

Figure 24 - FENIX architecture

FENIX is planned as non-commercial open solution, not privately owned and technologically independent.

- All the new pilot sites guarantee that they will not replicate or duplicate work conducted in AEOLIX and SELIS projects.
- The two mentioned research projects permitted the development of a PoC (TRL 5/6).
- FENIX will pre-deploy and deploy of the future pan-European innovative architectures for the management of logistics services across the TEN-T corridors.

Main project objectives are:

- Establish a federated network of transport logistics actors across Europe, enabling sharing of information and services needed to optimise TEN-T(A2&A3);
- Demonstrate the operational feasibility and benefits through the organised national pilots-focus on testing the achieved interoperability capabilities (A4);
- Set up the EU Corridor community building programme and to promote the benefits to the participants in terms of reduced costs and GHG emission (A5&A6).

FENIX Architecture will use as the first building blocks AEOLIX, SELIS analytics platforms and other platforms, data sources & services and will develop 3 pillars:

- FENIX Federated Identity Registry;
- FENIX Governance and Data sharing Federated Services;
- FENIX corridor service Registry.

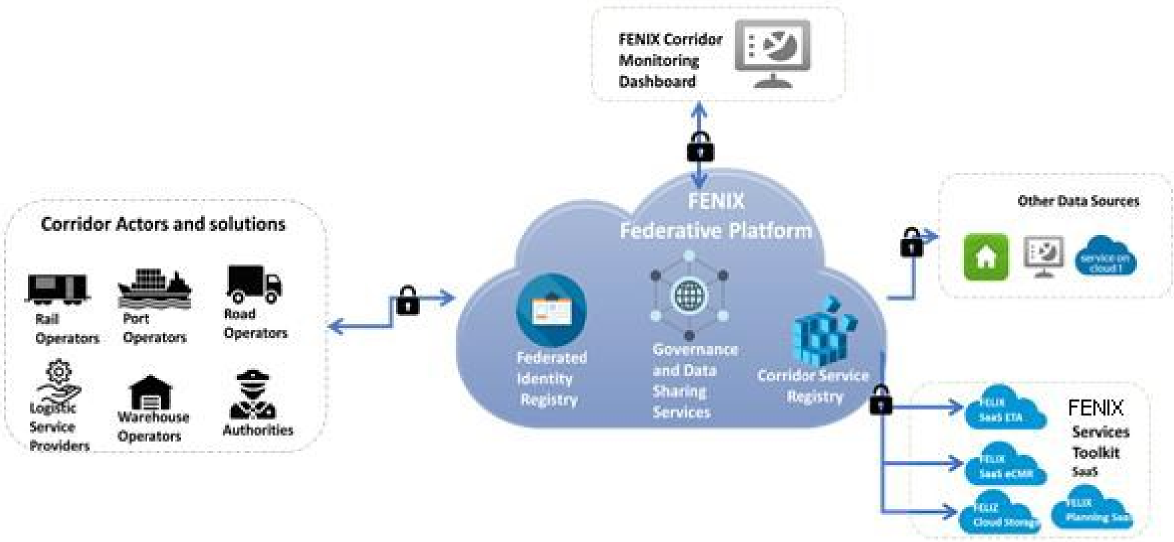

Figure 25 - FENIX scenario

Pilot Sites in Italy are:

PS IT 1 - Mediterranean and Baltic-Adriatic and the Motorway of the Sea of South South-east - Trieste

PS IT 2 - The Italian Rhine Alpine – Dynamic Synchro modal Logistic

2.2.1.2.1 PS IT1 - Trieste

Trieste is one of the main Italian ports, positioned into two EU corridors:

- Mediterranean corridor
- Baltic-Adriatic corridor

The pilot in Co-GISTICS and living lab in AEOLIX was the port of Trieste with the inland terminal and the highway; cross border issues are Slovenia (10 km), Croatia (50 km), Austria (100 km).

Scope of the pilot is to analyze Intermodal transport tasks (vessels, trucks and rail) with customs operations and dangerous goods transportation management.

Potential local platforms to be integrated in FENIX are:

- AEOLIX
- SINFOMODAL
- OMNIA
- You Track me
- International Federative Module powered by MILOS
- My Cicero

- SINFOMAR

Figure 26 - Mediterranean and Baltic-Adriatics corridors

Main milestone in the roadmap are:

in 2020:

- Definition of FENIX technical requirements
- Coordination meeting with UC partners
- Definition of the first version of the
- Services (Guide.me app for ETA service, First draft of webservices)
- Definition of interoperability requirements
- Data set definition and data storage
- Tendering activities (PNEAES, Autovie for monitoring systems implementation)
- Updating of Services
- Defining Evaluation Criteria

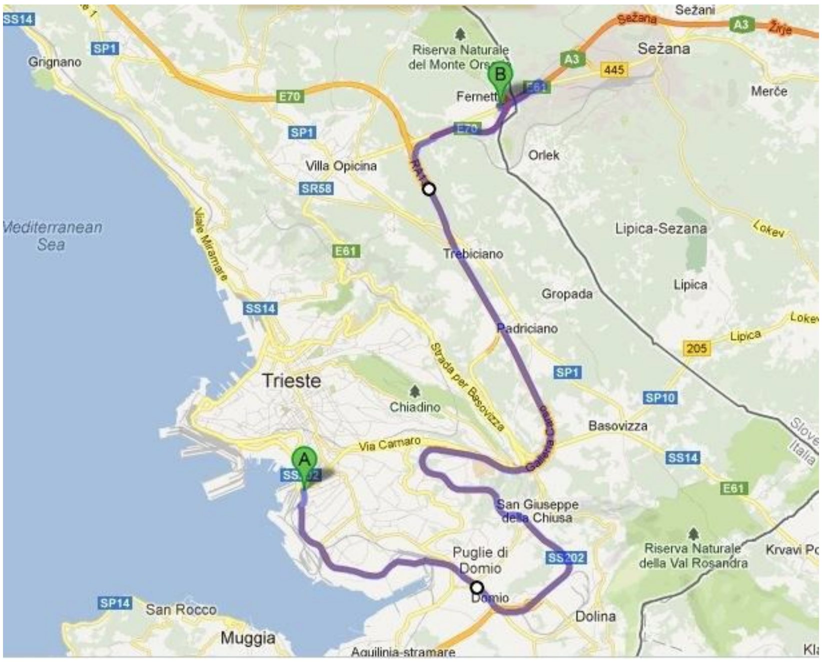

Figure 27 - Pilot site IT1, Trieste: overview

In 2021:

- Implementation of the UCs
- Testing activities
- Analysis of data
- Solution development
- Pilot roll out.

In 2022:

- Final Test and data analysis
- Definition and analysis of the results
- Test evaluation

Use cases in PS IT1 Pilot are:

- UC1: Expected time of arrival (ETA);
- UC2: Reduction of CO2 and NOx emission
- UC3: Multimodal route planning and re-routing
- UC4: Track and Trace vehicle/shipment
- UC5: TM2.0 for multimodality across the TEN-T corridors
- UC6: Parking booking service
- UC7: B2A, A2B services like Customs
- UC8: Dangerous Goods/eCall EGNOS/Galileo
- UC9: IT Tool for sustainability certification

2.2.1.2.2 PS IT2 - Italian Rhine-Alpine pilot

Figure 28 - Pilot site IT2, Genoa and Milan: overview

The purpose of Italian Rhine-Alpine pilot is to optimize the planning and the real-time operation of the maritime, aerial, logistics and transport operators of the Italian northwest regions. Two main hubs are involved:

- Genoa (and La Spezia) will focus on multimodality and synchro modality, including processes optimization and safety;
- Milan (Malpensa) will concentrate on the digitalization of import/export procedures, with a focus on the sharing and planning of the shipment information.

Turin will work on scale-up and transferability.

Figure 29 - FENIX project, pilot site IT2 routes: Genoa-Alexandria, La Spezia-Casablanca

Uses cases in PS IT2 Pilot are:

- UC1: Expected Time of arrival (ETA);
- UC2: Reduction of CO2&NOx emission;
- UC3: Dangerous goods transportation monitoring;
- UC4: B2A /A2B services like Customs;
- UC5: Safety and eCustoms;
- UC6: Digital synchro modal information dashboard
- UC7: Synchro-modality;
- UC8: Real-time Road optimisation in ports;
- UC9: Real-time Rail optimisation in ports;
- UC10: FENIX scale-up and transferability plan.

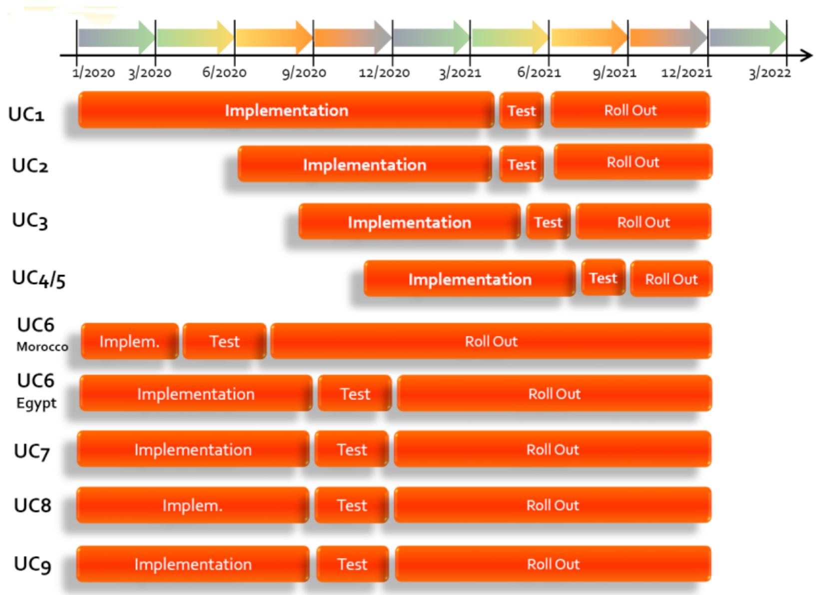

Figure 30 - Pilot site IT2, Genoa and Milan: planned timeline (before COVID emergency)

As an example of UCs, the process of digital synchro modal information dashboard (UC6) is organized through the following steps:

- A container is ready for boarding at departure terminal in Port of La Spezia;
- The container is sealed through an e-seal (eventually anticipated in an inland terminal with gate-in recognition at port terminal), it is then loaded on the ship, discharged at terminal, checked also via the e-seal. It is then sent out to the final depot (possible gate-out functions);
- During the trip, a number of systems provide information to be collectively shown to the actors involved through a personalized dashboard;
- Mobile or fixed readers for RFID connected to Terminal Operating Systems;
- Terminal Operating Systems;
- Shipping Agents;

- Customs;
- Port Community Systems.

In UC6 Pilot approach is extended to other corridors with the sub-cases La Spezia-Casablanca (Morocco) and Genoa-Alexandria (Egypt).

2.2.2 Progress since 2017

2.2.2.1 Guidelines for the use of RID/ADR/ADN 5.4.0.2

In the framework of its activities related to inputs to regulation, CORE WP16 has actively contributed to UNECE joint WG on telematics. The contribution of CORE's WP16 demonstrator to UNECE TP1/TP2 architecture for data exchange was to show the benefits in terms of higher efficiency, safety and security, not only for law enforcement and emergency management (i.e. during intervention/operations after an accident is occurred), but also for prevention of accidents.

Since various years, UNECE joint WG on telematics is addressing the adoption of telematics in ADR/RID/ADN, based on UNECE TP1/TP2 architecture This is in line with the safety/risk prevention and mitigation measures set in ADR/RID/ADN, and with the European "Directive 2008/68/EC on the inland transport of dangerous goods" that also envisages the possible introduction of tracking & tracing technologies. Moreover, it also strongly supports the digitalisation of transport documents (transport e-document).

In order to stimulate the uptake of telematics in ADR/RID/ADN, UNECE joint WG on telematics prepared, during the period May 2017-June 2019 technical guidelines (Guidelines for the use of RID/ADR/ADN 5.4.0.2) specifying legal, technical and operational details of the adoption of telematics in ADR/RID/ADN. The documents include also the requirements for TP1 and TP2, and the specification of the relevant data exchange UML/XML/XSD based.

UML/XML/XSD for the data exchange among TP1s and TP2s is an extension of DATEX II, due to the fact that it was originally conceived for road transport, and subsequently extended also to rail/inland waterways (to be applicable in inter-modality).

The guidelines are based on the outcome of the working group on telematics as agreed by the Joint Meeting in its autumn 2019 session (held in Geneva from 17–26 September 2019), but not all ADR and/or ADN Contracting Parties and/or RID Contracting States have implemented the guidelines yet. Italian Ministry of Infrastructures and Transport is participating to the informal technical working group activities with Austria, France, Germany and United Kingdom, to set up an initial TP1s network. The system architecture outlined in the guidelines is based on the concept of 2 types of service providing systems called trusted parties TP1 and TP2.

The principal elements about TP1/TP2 architecture are:

- The model envisages a number of TP1s and TP2s;
- TP2 holds the data required in accordance with section 5.4.1 of RID/ADR/ADN. A TP2 may be operated by a carrier or operated by a third party service provider for a carrier;
- TP1 provides services for sharing these data from TP2 with authorities and emergency services upon request;
- A TP1 also transmits the data from TP2 to other TP1 upon request.

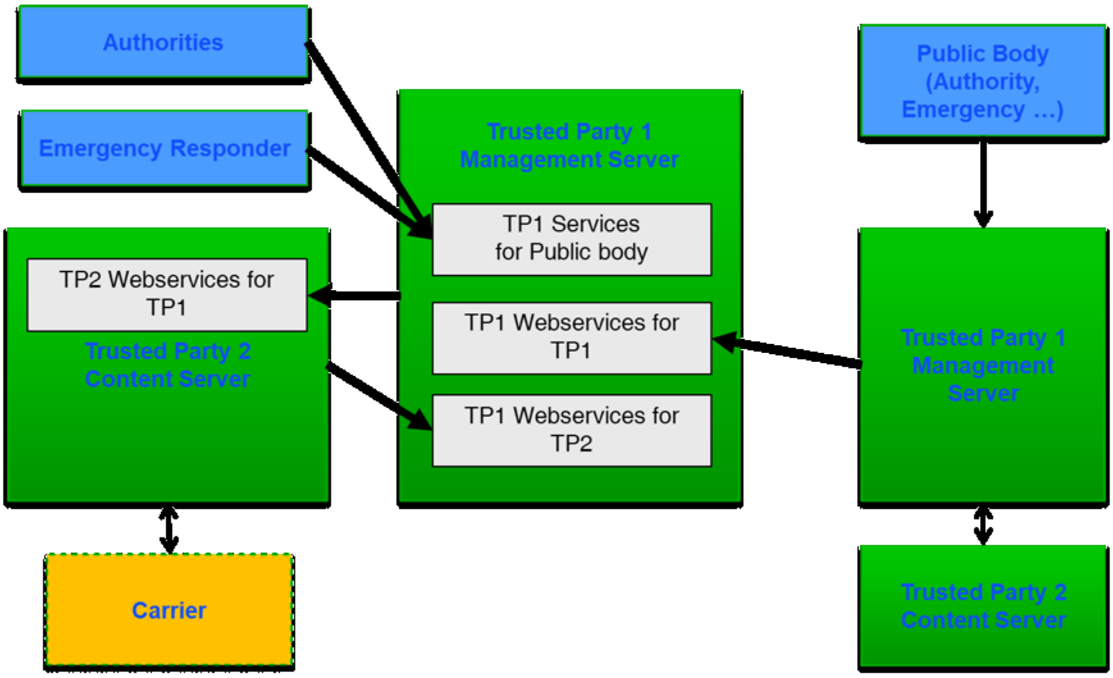

Figure 31 – TP1/TP2 architecture and webservices

The split in 3 different webservices allows better security by implementation of different access point depending the type of actors (TP1, TP2 or public bodies).

Dataset to be used between TP1s, TP2s and the authorities/emergency services are defined in the document; in particular following data set concerning every transport operation must be transmitted to a TP1:

- ADR: Country code(s) (Vienna Convention), registration number(s) and Vehicle Identification Number(s) of the towing vehicle and the trailer(s) - ADN: ENI number - RID: Unique Vehicle Number;
- BIC code for containers (if available or regulated);
- Status: beginning/end of the transport operation.

For each transport operation a TP2 must transact with only one TP1; registration of authorities and TP2s with a TP1 are defined in the guidelines.

Though the guidelines regard data exchange about electronic transport document, during

CORE project activities the entire data model UML/XML/XSD was enhanced in order to consider CWA 16390 revision above described in previous section (for the position), the additional alarms/events needed by the risk assessment functions of MIT Platform/TP1 It, and for ensuring interoperability with the rail transport (mapping with TAF-TSI of EUAR). Moreover, the analysis of the possible mapping/interoperability with e-CMR (for road transport) was conducted in cooperation with IRU.

UNECE UML/XML/XSD with the modifications/enhancements proposed by CORE WP16, is composed by mandatory data/information and optional data/information. It enables the UNECE TP1/TP2 architecture supporting various use cases:

- The transport e-document, meaning the provision of transport document according to regulations/in compliance with ADR/RID/ADN, for law enforcement/emergency management purposes (through data exchange among private operators and authorities, TP2s/TP1s);
- Other use cases by means of the other not-mandatory data/information, such as the risk assessment functions, the advanced support to emergency operations (for example re-routing and providing remote assistance to the emergency/intervention operators), statistics.

2.3 Priority area III. ITS road safety and security applications

2.3.1 Description of the national activities and projects

The transport of dangerous goods has strategic aspects in the management of safety on the whole territory; to transmit monitoring data in real time a specific platform was developed in 2015 by Italian Ministry of Infrastructures and Transport.

The platform provides for the acquisition, by MIT, of real-time tracking of vehicles used for road transport of dangerous goods for sharing data to the platforms of third parties involved in monitoring and control activities.

In the first implementation phase, the data concern the surveys of the fleet of tankers operating for ENI; these data, suitably filtered according to the area of competence, are sorted to the plants built as part of the DESTINATION and SITIP II projects.

The configuration of the SIDIRT platform provides for the possibility of extending the information with the data collected by other subjects possibly interested in integrating into it.

The system also allows for dynamic analysis by displaying the events detected on road arches on a georeferenced map, and statistical analysis, in relation to planned transport, through the production of specific reports.

The system contains the core functions of the architecture TP1/TP2 architecture for data exchange on dangerous goods transports, as described in 2.2.2.1, and is going to evolve to become Italian TP1.

2.3.2 Progress since 2017

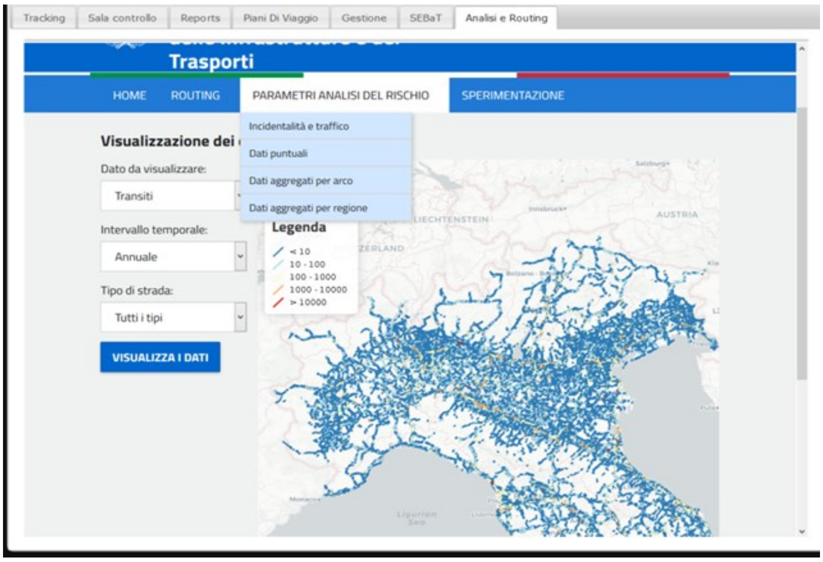

Figure 32 - Dangerous goods traffic

Among CORE project developments, MIT Platform/TP1 It was enhanced; in particular the risk assessment functions were improved, integrating with the data/events/alarms received by CORE demonstrator for the regional monitoring/risk assessment and the emergency/intervention operations (if any), and to TP1 Fr for the cross-border purposes.

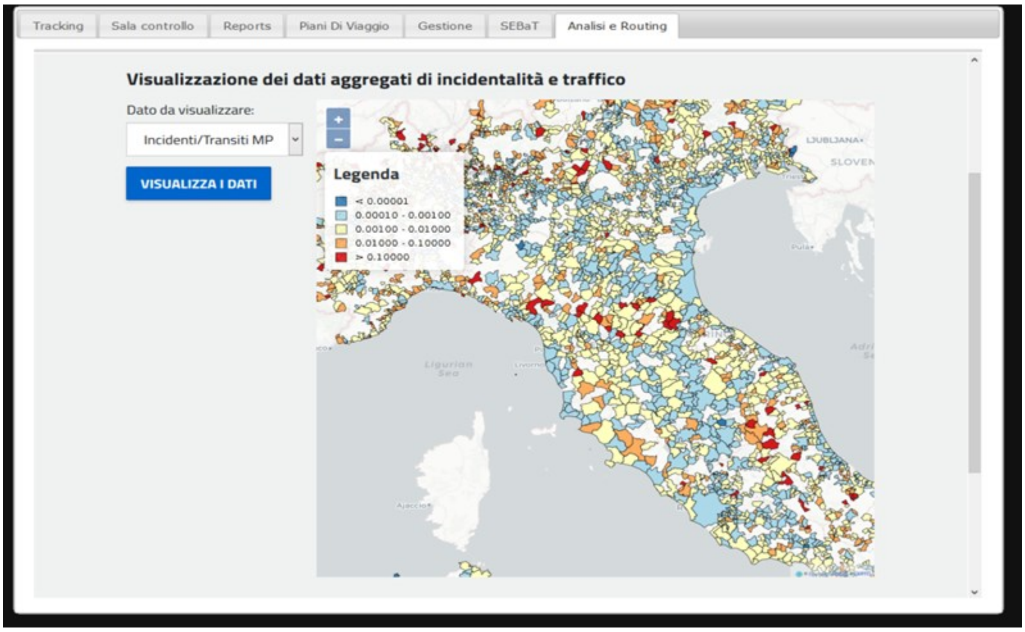

Figure 33 - Road accident

MIT Platforms developments include risk assessment functions, specifically for institutional purposes, which can be built on the availability of robust tracking and tracing, such as risk analysis/prevention/mitigation, and can support to emergency management/dispatching of tracking and tracing data integrated with related indicators, statistics.

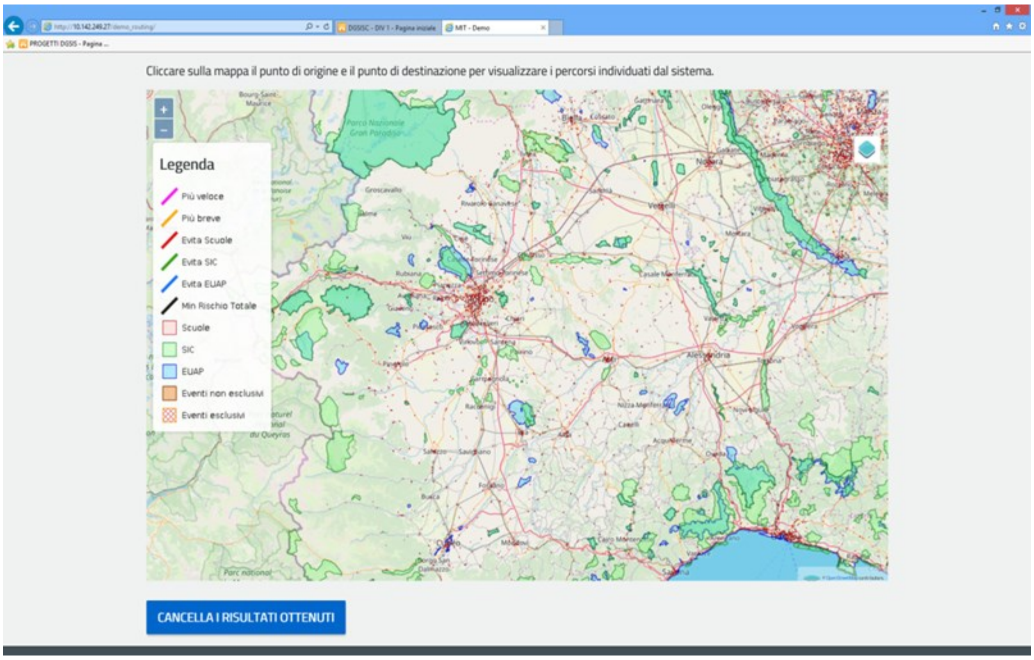

Figure 34 - Schools and protected areas

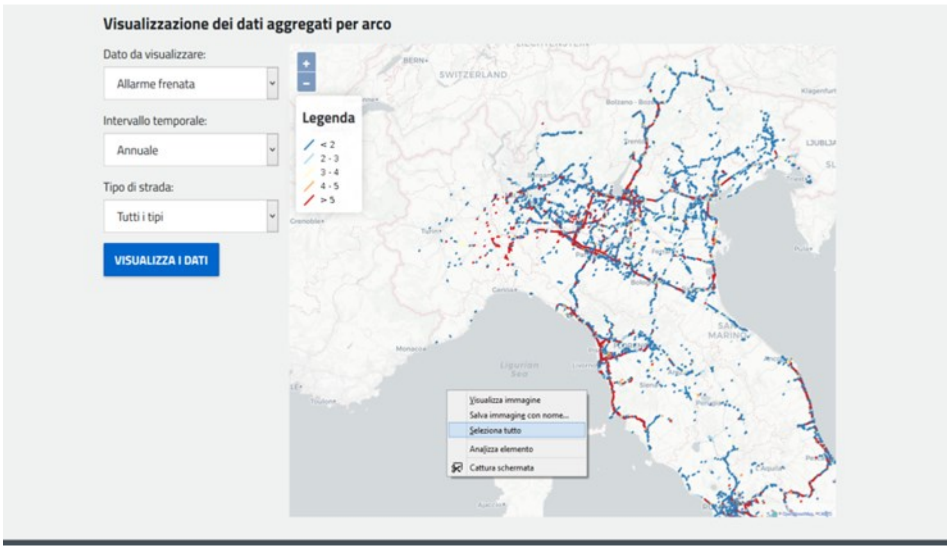

Figure 35 - Alarms and particular events in dangerous goods transport

Main risk assessment functions are:

- The processing of tracking and tracing data and integration/enrichment with relevant (historical/real-time) indicators/statistics, in order to elaborate risk assessment parameters and to predict potential risk scenarios;
- The dispatching of tracking and tracing data and elaborated advanced risk assessment parameters to involved stakeholders (operating at regional level in the traffic monitor-

ing/emergency management);

- The implementation of an advanced model for risk mitigation that, based on the predicted potential risk scenarios and in the cases of difficult situations (e.g. meteorological and environmental conditions, events linked to traffic congestion and people concentration), identifies an alternative path/transit deviation for the transport of dangerous goods.

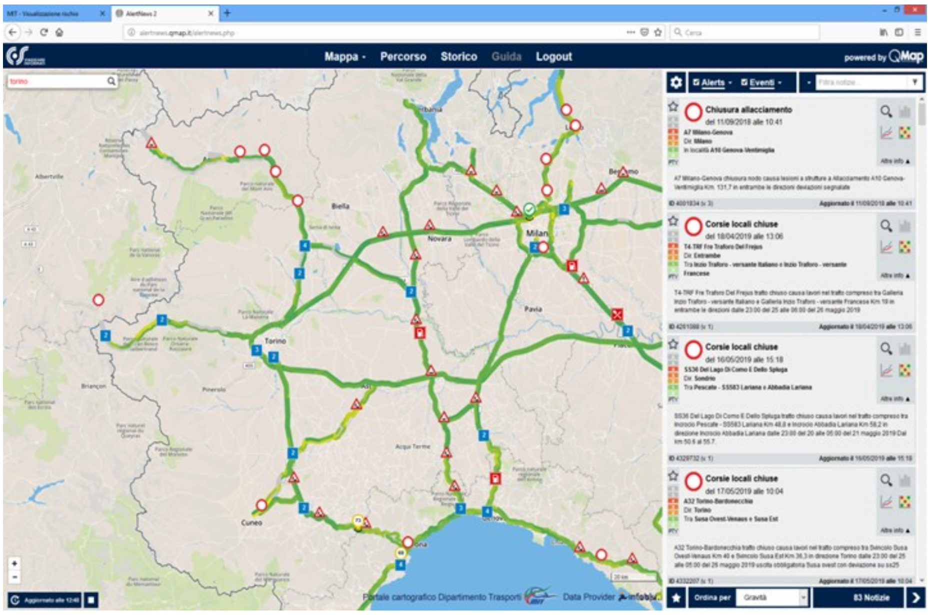

Figure 36 - Dynamic traffic information

Figure 37 - Routing model to minimize risk

In figure 32 are shown, among static data analysis implemented in MIT Platform/TP1 It, dangerous goods traffic:

- road accident;
- schools and protected areas;
- alarms and particular events in dangerous goods transport.

Overall traffic flow is monitored through CCISS platform and dynamic traffic information are received in real time in order to evaluate, together with static parameters, instant risk.

From instant risk values, it is possible to give a risk figure to each path and calculate the best route which minimizes risk.

2.3.3 112 eCall (priority action d)

After an experimental period, the enabling law No. 124 of 7 August 2015, the so-called Madia Law on the rationalization of public administrations, provided for the establishment of the Single European Emergency Number 112 (one-one-two) with operations rooms to be set up at regional level.

The service operating model identified by the legislator ensures an integrated and coordinated management and allows, by filtering the "inappropriate" calls (e.g., calls made by mistake, for information or as a joke), the emergency bodies to exclusively deal with emergency calls.

The Single European Emergency Number Service 112 (one-one-two) is implemented according to the procedures defined by the Protocols of Understanding signed by the Ministry of the Interior and the regions concerned, in conformity with what established by the Consultative Commission under article 75-bis of legislative decree No. 259/2003 (code of electronic communications).

The Italian Ministry of the Interior, in agreement with the Italian Ministry of Economic Development, is entrusted with guidance and coordination powers in order to identify and implement the initiatives for the full realization of the Single European Emergency Number (article 75-bis, code of electronic communications).

The model envisages the setting up of Public Safety Answer Points (PSAP, also known in Italy as CUR – Centrali Uniche di Risposta) where all the emergency calls converge to be then transferred to the body responsible for the management of the specific emergency situation (National Police, Carabinieri Corps, Fire Department, Emergency Medical Service).

Pending the setting up of PSAP all over the national territory, in the areas where they are not present the Single European Emergency Number 112 Service is ensured by the Carabinieri Corps operations rooms.

Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 provides for the standardized setting up throughout the European territory of an interoperable electronic service of emergency calls named e-Call.

In case of road accident the e-Call system installed on the vehicle by the car manufacturer will automatically contact the Public Safety Answer Point (CUR) and send the information on the vehicle involved, including its exact location. At the same time, the system will allow the people inside the vehicle, even if unconscious, to be automatically connected with the CUR in order to evaluate the emergency service to be provided.

The Public Safety Answer Point (CUR) of the SEE 112 (one-one-two) service operates on two levels: the first level receives the emergency calls (PSAP1, Public Safety Answer Point); the second level manages the emergency situations (PSAP2, Operations rooms of the National Police, Carabinieri Corps, Fire Department and Emergency Medical Service).

Whatever national emergency number is called (113, 112, 115 and 118), the call is received by the Public Safety Answer Point.

When the PSAP operator answers the call he/she receives the caller's telephone number and location in real time. These data are automatically stored in the "contact card".

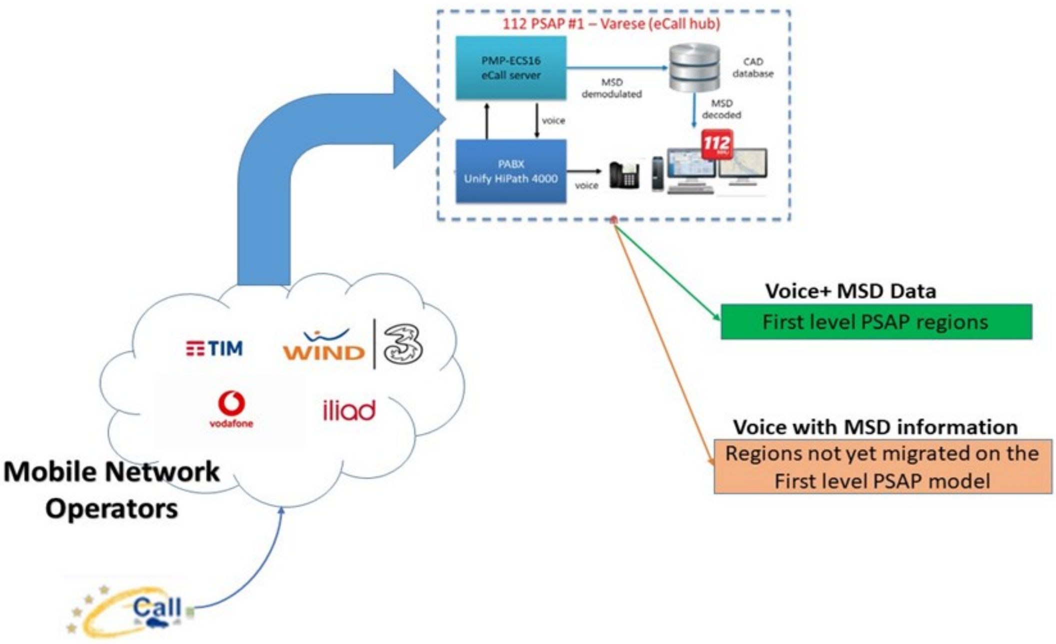

Figure 38 - IT architecture currently in use at the PSAP of Varese

The additional information on the kind of assistance to be provided is entered in the contact card, which is then transferred, along with the call, to the second level operations room responsible for the intervention (National Police, Carabinieri Corps, Fire Department and Emergency Medical Service).

Thus, it is avoided that jokes, mistakes or inappropriate calls (e.g., requests for information) reach the second level operations rooms that will exclusively receive the emergency calls.

The Public Safety Answer Point is set up by the Regions that are also responsible for staff recruitment and training. The PSAP operator acts in the capacity as "person responsible for a public service" as he/she performs his/her activity in the framework of the Public Service Single European Emergency Number 112.

Public Safety Answer Points are operative in the following Regions: Friuli-Venezia Giulia, Lazio, Liguria, Lombardia, Piemonte, eastern Sicilia, Valle d'Aosta and Trentino-Alto Adige.

The PSAP elected to provide national coverage for eCall services is the 112 emergency call centre of Varese.

The 112 emergency call centre of Varese (PSAP) was selected for a test held on 7 November 2017, concerning the exchange of eCall data with Third Party Service Providers (TPSP) within the European project I_HeERO, whose purpose was to plan, implement and coordinate the 112-eCall pilot projects in Europe.

Varese PSAP constitutes a level 1 PSAP for eCall, enabled for the reception and management of all eCalls generated throughout the whole national territory.

In order to achieve the maximum level of availability for the eCall management system as a whole, an additional level 1 PSAP eCall capable is always ready to intervene. In case of fault of Varese PSAP, all the emergency calls, including the eCalls, are automatically routed to Brescia PSAP. The Brescia PSAP is equipped in a specular way as the Varese one, and acts as a disaster recovery site for it, guaranteeing the continuity of service. Both PSAPs are in Lombardia region.

The following picture is a representation of the ICT architecture currently in use at Varese PSAP for the management and transmission of eCalls to level 2 PSAPs.

The process of receiving, managing and sorting eCalls from level 1 PSAP of Varese to level 2 PSAPs is described below:

- all the pan European eCalls are received by Varese PSAP infrastructure which, supported by the PABX software, forwards the voice call to an available PSAP agent and simultaneously to the in-band eCall modem. Then the minimum set of data (MSD) is taken in charge by the specific eCall management software module;
- the eCall management software module converts the MSD in the equivalent XML form, ready to be used by the CAD (Computer Aided Dispatching) software;
- the PSAP agent, if possible, maintains an audio connection with the vehicle by means of the on board eCall hardware;
- the audio connection is transferred to the appropriate level 2 PSAP;

- at the same time, the MSD, included in the so-called “Contact Record”, is sent to the same PSAP together with other relevant information (data are forwarded only if a data connection is available between PSAPs, if not, MSD are communicated by phone);
- the Contact Record and the MSD are stored in the DB of the level 1 PSAP, together with the complete event data.

The MSD includes information about the time of the accident, the location of the vehicle and the direction of travel, as well as additional vehicle information.

If it is possible to establish a voice connection with people involved in the accident, the PSAP operator of Varese can integrate the MSD with additional information included in the Contact Record.

The technical solution for the eCall service has been defined from ETSI/3GPP, relating to the adaptation of mobile network access (flag support "eCall"), and CEN European Standards regarding operational and application requirements.

In compliance with ETSI Recommendation, EU Regulations regarding pan-European eCall emergency service and a Ministry of Economic Development communication, which defines the routing rules for Mobile Network Operators towards the eCall enabled Operation Centres (i.e. PSAP, Public Safety Answering Points), it is identified the exclusive format of Routing Number (RgN) to be used for telephone interconnection for eCall service. The interconnection points between mobile networks, properly handling the RgN, ensure correct routing of an eCall (recognized by the mobile networks through the interpretation of the eCall flag) to the appropriate operation centre (i.e. the Varese first level PSAP), starting from the original mobile network (Originating Network), up to the network that provides services associated with non-geographic numbers (Serving Network).

The operating procedures currently in use at Varese PSAP for eCall management has been modelled upon the standard operating procedure used for all emergency calls. The latest is based on the indication provided by the operations manual (Disciplinare Tecnico Operativo) issued by the Ministry of the Interior. Hereafter a minimal description in few steps (the complete procedure is available in Italian language in the site of AREU, Agenzia Regionale Emergenza Urgenza, Regional Agency for Emergency and Urgency, Lombardy region).

For all incoming calls, the PSAP agent has to:

- answer the call as soon as possible;
- locate the position of the event;
- identify the reason of the request and, consequently, choose the level 2 PSAP that could manage the event;
- forward the call (and the Contact Record) to suitable level 2 PSAP.

The operations listed above must be carried out as soon as possible. PSAP agent should not perform any action that could delay the forwarding of the call to a suitable level 2 PSAP: the actual owner of the emergency operations.

The position location process for mobile caller is based on several information when actually available to PSAP:

- Cell-Id position, supplied by the MNO by means of a national service managed by Ministry of Interior ("Concentratore Interforze");
- Mobile App developed expressly for emergency calls (e.g. Where Are U);
- Pan European eCalls;
- Interview with the caller.

In case of Pan European eCall, the position is actually available inside the MSD and is the position used by all PSAP intervening in the emergency event.

The Contact Record, composed by the CAD of level 1 PSAP, includes several data related to the event. In case of Pan European eCall, it includes the complete MSD in XML form. In this way, involved PSAPs which receive the Contact Record are completely aware of the relevant data.

In February 2018, NavCert (a certification company for the European Electronic Toll System (EETS) based on EU-Directive 2004/52/EC) was entrusted to assess and certify the compliance of the PSAP with the requirements listed in Article 3 of Delegated Regulation 2013/305.

The Conformity Assessment, conducted by NavCert, for Varese PSAP, according to its certification mark PPP80029, consists of two parts: Components Assessment according to EN 16454 and Suitability for Use.

Currently the Varese first level PSAP receives all the eCalls originated from the whole Italian territory and is able to manage actual traffic.

PSAPs in other regions, other than Lombardia, will gradually be equipped to implement eCalls management and certified to operate.

The Italian competent authority, responsible for assessing the compliance of the PSAPs with the requirements defined in Article 3 of Delegated Regulation 2013/305, is the Ministry of Infrastructures and Transport (MIT), whose areas of competence concern:

- planning, financing, implementing and managing the infrastructure networks of national interest as well as the public works falling under State responsibility;
- urban and housing policies also concerning both city systems and metropolitan areas;
- activities related to transport, viability and logistics on the Italian territory;

Ministry of Infrastructures and Transport is supported by Ministry of the Interior, which manages Single European Emergency Number 112, and Ministry of Economic Development, whose areas of competence include communications policy.

2.3.4 Reporting obligation under Delegated Regulation (EU) 2013/885 on the provision of information services for safe and secure parking places for trucks and commercial vehicles (priority action e)

As national access point (NAP) for road safety information, the Road Safety Information Co-ordination Centre (Centro di Coordinamento Informazioni sulla Sicurezza Stradale – CCISS) collects the following data on parking and rest areas for trucks and commercial vehicles:

- number of parking and rest areas for heavy goods vehicles and commercial vehicles;
- location of parking and rest areas for heavy goods vehicles and commercial vehicles;
- capacity of parking and rest areas (whose unit of measure is the number of places available for trucks);
- name of the company responsible to manage the rest area or parking and the related contacts;
- services and security systems available at each parking and rest area;
- types of cargo allowed at each parking and rest area.

The above-mentioned information is currently collected in a database designed and operated by CCISS. The aim of this database is to provide data for the web-based platform currently used as dissemination channel for road security information. The Italian Ministry of Infrastructures and Transport, in compliance also with the national law n. 179 of 18 October 2012, aiming at “ensuring the availability of free basic information and the updating of infrastructure information and traffic data, as well as actions to encourage its development on the national territory in a coordinated, integrated and coherent way with policies and ongoing activities at national and European level”, believes that the management and dissemination of information should be as integrated as possible. In order to increase safety on the roads and fluidity of circulation, the perimeter has been then widened to the whole Italian Road Network.

The information provided related to the number of different parking spaces on the territory are summarized distinguished by:

- Safe and secure parking places in the trans-European road network in Italy;
- Safe and secure parking places in the remaining Italian road network;
- Parking areas (rest areas and parking places) in the Italian Road network.

2.3.4.1 Safe and secure parking places in the trans-European road network in Italy

Although not directly situated on the road and under direct competence of the road operators, the four following safe and secure parking places, situated in two different regions, should be considered in the Italian portion of the trans-European road network:

- three “SDAG parking areas” managed by SDAG company, in Friuli-Venezia Giulia region, allowing for 415 stalls (the area in Slovenia direction with 134 stalls, the area in Italy direction with 216 stalls, and the area “Secure park Autoporto” with 65 stalls) for the parking of heavy vehicles which are managed entirely by specialized personnel. The areas are located in strategic points along the A34 Villesse-Gorizia highway (which branches off from the A4 highway, in the direction of the H4 highway for Slovenia which connects directly with the A1 to Ljubljana). Two of the areas have been certified for safe and secure parking places by the European certification body DEKRA and the ESPORG association;
- “Autoparco Brescia Est Castenedolo”, in Lombardia, allowing for 400 stalls for the parking of heavy vehicles. The parking is located at the “Brescia Est” motorway exit and has been certified by ESPORG association.

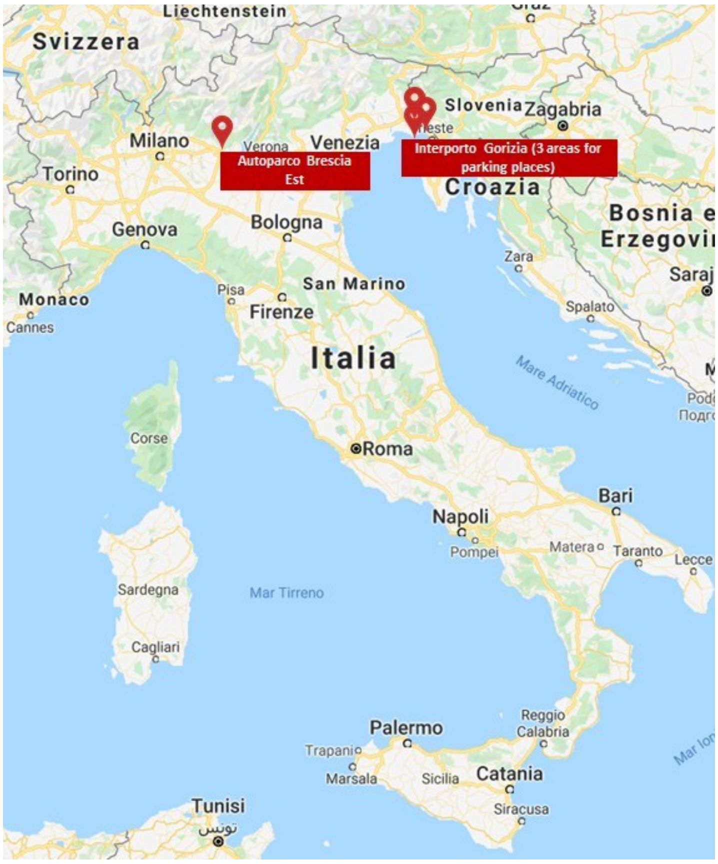

Figure 39 - Location of Safe and Secure parking place in the trans-European road network

Region	Number of parking places	Tot stalls
Campania	2	150
Emilia-Romagna	1	250
Friuli-Venezia Giulia	1	200
Lazio	1	200
Lombardia	3	270
Puglia	5	195
Total	**13**	**1,285**

Table 3 - Safe and secure parking places per region outside the trans-European road network

Figure 39 shows the location of the parking places in the Italian trans-European Road Network:

2.3.4.2 Safe and secure parking places in the Italian road network

The analysis identified 13 parking places with the aforementioned characteristics, located outside the trans-European road network.

:

Figure 40 - Location of safe and secure parking places outside the trans-European road network

2.3.4.3 Parking places in the Italian Road network

Given the importance of ensuring the availability of information on parking areas, in order to avoid improper stops for trucks and commercial vehicles' drivers, the Ministry of Infrastructures and Transport enlarged the information services to additional parking areas.

Information on additional parking places have been collected by the CCISS through:

- Direct collection from road operators;
- Consultation of the database named "Geososta", managed by ANIA foundation;
- Research on other internal or published data.

The following table reports the number of parking places and rest areas in the different Italian regions, across the entire Italian Road Network.

Region	Number of parking places	Number of rest areas
Abruzzo	-	6
Basilicata	1	1
Calabria	-	1
Campania	3	7
Emilia-Romagna	1	15
Friuli-Venezia Giulia	1	-
Lazio	3	16
Liguria	1	4
Lombardia	4	4
Marche	1	3
Molise	-	1
Piemonte	1	13
Puglia	17	2
Sicilia	4	5
Toscana	-	8
Trentino-Alto Adige	1	11
Umbria	-	3
Veneto	2	6
Total	**40**	**106**

Table 4 - Number of parking places and rest areas by region

By "parking place/car park" it is intended an area for the stops of heavy vehicles, that can be fenced and guarded, that can be equipped with adequate electronic prevention measures (anti-intrusion alarm systems, closed circuit television, etc.), as well as equipped with refuelling and refreshment services.

By “Rest Area” it is intended an area suitable for extended rest, equipped or not with users' refuelling and refreshment services.

Overall, Italy has 146 parking areas, distinguished between 40 parking places and 106 rest areas.

In addition, table 5 shows the number of places available in parking areas and rest areas.

Overall, Italy has 5,872 places in additional parking areas, distinguished between 2,222 in parking places and 3,650 in rest areas.

The information services related to the parking places mentioned above are provided to users through a document available from CCISS web site, which is continuously updated.

Region	Number of places in parking places	Number of places in rest areas
Abruzzo	-	170
Basilicata	50	30
Calabria	-	20
Campania	110	210
Emilia-Romagna	10	620
Friuli-Venezia Giulia	30	-
Lazio	180	560
Liguria	80	100
Lombardia	260	110
Marche	112	255
Molise	-	20
Piemonte	80	570
Puglia	970	100
Sicilia	170	192
Toscana	-	170
Trentino-Alto Adige	50	233
Umbria	-	60
Veneto	120	230
Total	**2,222**	**3,650**

Table 5 - Number of places per parking area and rest area by Region

Collaborations with Road Manager and Road Operators are in course of establishment to gain information directly on the CCISS platform for all parking types in the entire Italian Road Network and to shorten update time. After completion of activities to allow direct access to CCISS platform, as described below at the end of chapter 3, arrangements will be made even for those who will not be able to support standard protocols, through special software modules.

After recent developments, parking data are now available on the CCISS website (www.cciss.it) also in DATEX format, allowing automatic use by information systems.

CCISS platform acquires data through DATEX II protocol and can transmit them in the same format. Therefore, dynamic parking data, part of the Datex standard, can be managed; however, currently no dynamic data is received from any manager.

To provide a complete and high quality information service on the parking places, in compliance with Regulation 2013/885, CCISS has planned several actions.

Firstly, CCISS has undertaken actions aimed at acquiring parking dynamic information, through a collaboration with road managers and operators. This collaboration aims at acquiring information for all parking types in the entire Italian Road Network

Secondly, the information available for static and, when available, dynamic data will be tightly integrated in CCISS traffic information platform for all analysis and dissemination purposes. Information will be provided on the entire Italian Road Network for all parking types (safe and secure parking places, parking areas, rest areas). This aspect is also connected with FENIX project, which aims to build a federated network of information exchange in logistics, in the framework of CEF-Transport program, and activities are scheduled for the first quarter of 2021.

Finally, all parking operators responsible for the provision of dynamic information will be allowed direct access to CCISS platform, both in interactive mode and through web services. Data connections will normally follow DATEX II standard, but any other procedure will be considered, when needed to acquire data available in different formats. Web services for parking data, which are an extension of already active DATEX II services, are available since May 2020; interactive connection, both for data entry only and for platform use (according to software-as-a-service model), is being subjected to test and further evolution.

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

2.4.1 Description of the national activities and projects

The constant evolution and development in the technological sector makes it possible to manage the entire transport system in an "intelligent" way, taking into account various needs expressed by operators and users of public and private transport. In the coming years, the digitalization of transport is expected to take a remarkable improvement and that digital infrastructure will acquire significant importance and will greatly support connected and automated vehicles. The digital transformation of transport infrastructures represents the possibility of improving their quality, safety and use, providing data and services that can facilitate the mobility of people and goods, simplifying transport.

With these concepts in mind, ministerial decree 70/2018 (article 20) has established, within the Ministry of Infrastructures and Transport, the Technical Monitoring Centre (Osservatorio tecnico) in support of smart roads and connected self-driving vehicle with, inter alia, monitoring functions and supervision of projects and experimentation on public roads of autonomous vehicles.

In December 2018, MIT received the first trial application form of an autonomous vehicle, connected in urban environment and last mile, along public urban roads in the cities of Torino and Parma. Following the technical studies, in May 2019 the trial has been authorised with the presence of a supervisor who possesses certified expertise in safe driving with autonomous vehicles, an expertise that is regularly monitored.

The Technical Monitoring Centre is also setting trials, on public road, of those vehicles not homologated nor suitable for homologation, according to national and international current standards. During 2019, the Monitoring centre followed various projects concerning smart road and autonomous and connected vehicles.

With the advent of the experimentation of assisted and automatic driving and the increasing availability of data on mobility, innovative technologies have been developed allowing an effective exchange of data, through wireless systems, between elements and actors of the transport system, or between vehicles (V2V) and between vehicles and infrastructure (V2I); such systems are referred to as Cooperative Intelligent Transport Systems (C-ITS). They significantly improve road safety, traffic efficiency and driving comfort by helping the driver make the right decisions and adapt to the traffic situation. Also on these innovative technologies, Italy is present through several projects co-financed by the European Commission. Among the main initiatives, the following projects are highlighted:

- C-ROADS ITALY, C-ROADS ITALY 2 and C-ROADS ITALY 3, : financed with CEF funds, they are structured under the umbrella of the European platform "C-Roads Platform" in which there are 17 member states (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Portugal, Slovenia, Spain, Sweden, Holland, United Kingdom, Greece and Italy) and Norway. The objectives of the C-Roads Platform are aimed at defining functional, technical and organizational requirements to ensure the interoperability and harmonization of C-ITS services among national pilot projects across Europe. The three national projects aimed at C-ITS services are coordinated by the Ministry of Infrastructures and Transport (Territorial Development, Planning and International Projects Directorate, division 4) and they have as implementing bodies some of the managers of the trans-European network as well as the cities of Turin, Verona and Trento; in addition, vehicle manufacturers, research centres and telecommunications companies are also present. The aforementioned national projects aimed at the development and implementation of cooperative services (C-ITS) are fully part of the digital transformation advocated by ministerial decree 70 of 2018 "Smart Road".

- 5G CARMEN: the project aims to build a 5G enabled corridor to perform cross-border experiments and will implement a mix of 5G micro and macro cells for ubiquitous C-V2X connectivity.
- ICT 4 CART: the project will develop and provide an ICT infrastructure to allow the transition to automation of road transport, by bringing together, adapting and improving technological progress achieved by different companies, especially in the telecommunications, automotive and IT. In harmony with EU legislation, a hybrid communication approach will be adopted, where all main wireless technologies, namely mobile phones, ITS G5 and LTE / CV2X, will be integrated into a flexible network architecture.
- AUTOPILOT: The European Commission Horizon 2020 AUTOPILOT (AUTOmated driving Progressed by Internet Of Things) is aiming to exploit the IoT ecosystem to integrate connected cars and transform them in automated moving “objects”. One of the key challenges encountered in the project is to ensure the interoperability of the different components and IoT platforms serving e.g. in-vehicle and road-side devices and sensors. The adopted solution is the use of Federated IoT platforms, with the oneM2M Interoperability Platform used to ensure that all components are able to communicate with each other

2.4.1.1 C-Roads Italy (Action 2016-IT-TM-0052-S)

SCOPE

The Ministry of Infrastructures and Transport is the project coordinator, implementing bodies are: Concessioni Autostradali Venete – CAV S.p.A, A22 Autostrada del Brennero, Autovie Venete, Iveco, Fiat Research Center, Telecom Italia, Azcom Technology, Ministry of the Interior – Road Police, Codognotto Italia S.p.A, Politecnico di Milano, North Italy Communications (as project manager).

The project, introduced in response to the EC CEF 2016 call, was positively assessed by EC INEA and included in the list of projects co-financed by the EC under the C-ITS priority.

The main objective of the C-ROADS ITALY project is to implement and test, in real traffic conditions, a set of "Day 1" and "Day 1.5" services, recommended by the EC C-ITS platform and to verify and demonstrate, in line with the general harmonization objectives pursued by the C-ROADS Platform, how the cooperative systems V2V and V2I can have a positive impact on:

- Safety - showing the reduction of risks related to cooperative / automated technology in truck and passenger scenarios as well as in combined scenarios;
- Traffic fluency - showing the potential for efficient use of infrastructure with Platooning technology and Highway Chauffeur technology;
- Energy efficiency - measuring, under real conditions, fuel consumption potential and re-

lated emission reduction.

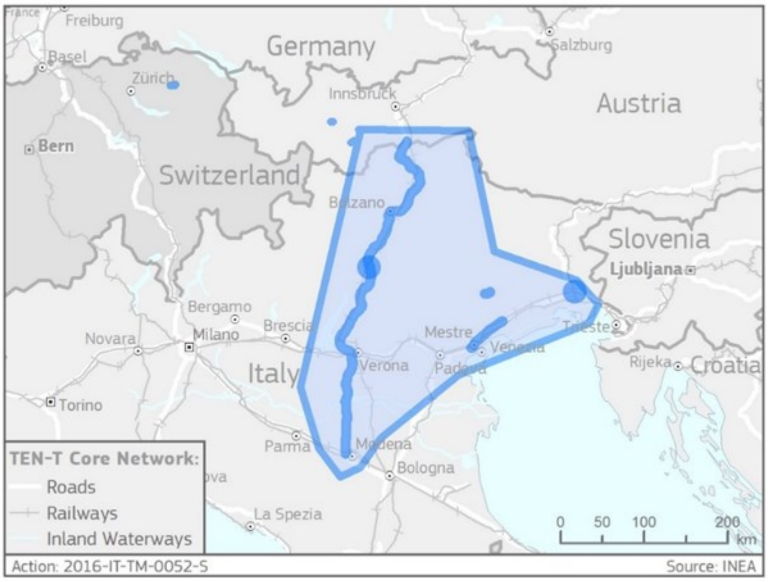

Figure 41 - C-Roads Italy project – Location

<u>SCHEDULE AND COSTS</u>

The project is eligible for costs starting from February 2017 until December 2020 (due to the Covid-19 pandemic, a 6-month extension of the project will be required, until 30/06/2021).

The overall investment of the project is € 18.6M, with 50% European co-financing.

<u>TECHNICAL ISSUES</u>

During the C-ROADS ITALY project, cooperation systems based on V2X technologies have been and will be implemented and tested in real traffic conditions for the following automation applications:

- Platooning (heavy vehicles)
- Highway Chauffeur (light vehicles)
- Combined scenarios: Platooning (heavy vehicles) and e Highway Chauffeur (light vehicles)

This involved adapting the road infrastructure and integrating V2I C-ITS and V2V information with vehicle control strategies.

The following motorway sections are involved in the project:

- Brenner motorway - A22 (entire section of 314 km),
- Concessioni Autostradali Venete – CAV S.p.A - A57 (10 km from A57 Mestre ring road)
- Autovie Venete S.p.A. – A4 Venezia Trieste (about 20 km between San Donà di Piave and Quarto d’Altino) and A28 Portogruaro Conegliano (about 5 km between Godega di

Sant'Urbano and the connection with the A27 in Conegliano).

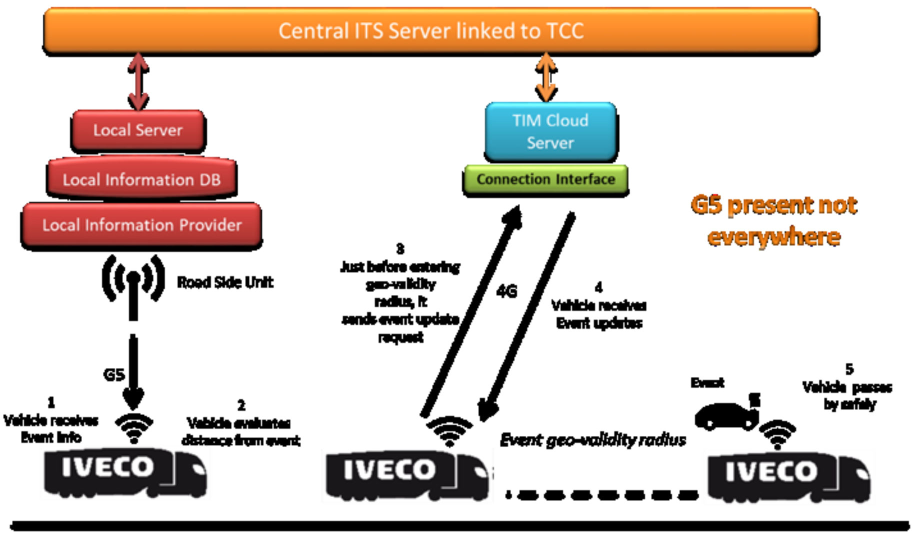

Figure 42 - C-Roads Italy project – Truck platooning

In addition, cross-border interoperability tests are planned on Austrian motorways of the ASFINAG operator.

As this is a "pilot" project, technological solutions are being tested which will provide users, once fully operational, specific information / services (Day 1) such as: traffic conditions, messages regarding accidents, queues, works in course, obstacles on the roadway, weather warnings, speed limits.

In terms of communication technologies, both DSRC ITS - G5 5.9 Ghz protocol and cellular network (4G-5G) will be used for V2I and I2V (Hybrid Communication) communication.

<u>REGULATORY ISSUES</u>

The C-ROADS ITALY project was developed with the following documents as regulatory reference:

- Directive 2010/40 / EU of the European Parliament and of the Council to support the spread of interoperable systems and provide for the continuity of services in all Member States and operators;
- Call "Multi-Annual Work Program 2016", CEF TRANSPORT 2016 - GENERAL ENVELOPE, Funding objective 3: optimize the integration and interconnection of transport modes and improve the interoperability of transport services, guaranteeing the accessibility of infrastructures Transport - 3.3.2 Intelligent Road Transport Services (ITS) priority "ITS Co-operation Services (C-ITS) and Automation".

<u>ORGANIZATIONAL AND PROCEDURAL ISSUES</u>

Project Management attends to the administrative obligations deriving from the signing of the Grant Agreement. Furthermore, it will manage all communications with the institutions involved in the EC and with the C-Roads platform (C-ROADS PLATFORM). This activity guarantees active participation in the meetings of the Platform and the supply of the requested contributions by the national Implementing Bodies.

In addition, the Project Management also deals with the dissemination of information on the activities and results of the project through various communication channels, such as the C-Roads website, workshops, brochures, technical documents, active participation in conferences of interest.

Within the Project Management there is also a specific Technical Group with the task of coordinating all the technical aspects of the pilot, with the aim of ensuring the harmonization, completion and adequate interactions of all the equipment to be installed and used. on board the vehicles involved and on the road infrastructure.

LEGAL AND PRIVACY ASPECTS

Attention was also paid to legal and organizational obstacles, including privacy issues. For this specific aspect it is extremely important to share the appropriate documentation so that other partners and stakeholders will have the opportunity to apply them to their operating environments and evaluate any critical issues or dangers.

The final objective is to identify the possible legal barriers, in order to study and finalize solutions and regulations to put in place for their overcoming in a harmonized way throughout Europe.

FURTHER DEVELOPMENT

C-ROADS ITALY project is the first pilot study carried out at national level that interacts with European C-ROADS platform, at the same time, it represents the first step towards a wide diffusion of C-ITS systems on Italian territory. From this first experience, the C-Roads Italy 2 and C-Roads Italy 3 projects were born.

In addition to the main objective of C-Roads Italy, which is to implement and test, in real traffic conditions, a set of Day 1 and Day 1.5 services, as recommended by the EC C-ITS platform, the project also includes the experimentation of “truck platooning”, concerning trucks proceeding queued, in a coordinated manner, thanks to communication via wireless technology.

Vehicles equipped with assisted driving will not only be able to receive messages but also to send them to other vehicles equipped with the same technology using wireless. Precisely it will be possible to create a "train of means" (platooning) that will communicate with each other. The first vehicle will communicate to all tracking trucks: optimal route, speed to adopt and distance to keep, increasing aerodynamic and energy efficiency and, in perspective, enabling new driving styles and drivers shift patterns for the transport of goods. In a motorway framework, this method – already tested by different European companies – could ensure smoother traffic, a cut in accidents and considerably improve exchange of commodities also regarding environmental and economic sustainability.

2.4.1.2 C-Roads Italy 2 (2018-IT-TM-0013-S)

SCOPE

The Ministry of Infrastructures and Transport is the project coordinator, implementing bodies are: Almaviva, Autostrada Brescia-Verona-Vicenza-Padova, Fiat Research Center, Turin City, Trento City, Verona City, Movalia, North Italy Communications (as project manager), Politecnico di Milano, Telecom Italia and TTS Italia.

Figure 43 - C-Roads Italy 2 project – Location

The main objective is to study and test, mainly in real urban traffic conditions (Turin, Verona and Trento cities), a set of “Day1” and “Day1.5” services, for example:

- GLOSA - Green Light Optimal Speed Advisory [C-ITS Day 1 service] (technology that allows to adjust the speed of the car in order to reach the traffic light with the green signal);
- Traffic signal priority request by designated vehicles [C-ITS Day 1 service] (Priority request for some vehicles - ambulances, police etc. - of the green traffic light signal);
- Signal violation/Intersection safety [C-ITS Day 1 service] (warning system to the driver of the vehicle when he is about to violate the red signal of the traffic light, or to alert the same driver when another vehicle is about to violate the red signal of the traffic light);
- On street parking management & information [C-ITS Day 1.5 service] (Management and information on parking places);

- Traffic Information and Smart Routing [C-ITS Day 1.5 service] (Traffic information and best route directions).

SCHEDULE AND COSTS

The project is eligible for costs starting from October 2018 until December 2023.

The overall investment of the project is € 13.7M, with 50% European co-financing.

TECHNICAL ISSUES

C-ITS services can play a significant role in helping cities to cope with the problems associated with increasing urbanization. This cooperative model, enabled by digital connectivity, is expected to significantly improve road safety and traffic efficiency, helping users make the right decisions at the right time and adapt to the traffic situation.

To test these C-ITS services, it is necessary that the infrastructures are equipped with innovative technologies and also that the vehicles are equipped with systems capable of receiving information to be provided to the driver, also with vehicle control strategies. The vehicle connected to the infrastructure expands the knowledge of the driver and the vehicle itself on the traffic scenario, increasing the safety and the efficiency of traffic itself.

Different use cases and driving conditions will be analysed, such as:

- When the vehicle is approaching equipped traffic lights: in that condition the information on the traffic lights will be used as an additional input for the Powertrain Controllers for real-time optimization based on the energy recovery strategy (conversion of kinetic energy into electrical energy).
- When the vehicle is stopped at an equipped traffic light: in that condition the information on the traffic lights will be used as an additional input for the Powertrain Controllers with the aim of minimizing emissions through advanced Stop & Start management.

The design and architecture of the C-ITS communication will be based on a hybrid solution (ITS-G5 short-range and long-range cellular communication), compliance with the definition of the hybrid profile of the C-Roads platform.

The quantitative evaluation studies of the services tested in the C-Roads Italy 2 project will be carried out on different areas of impact such as: on transport (in terms of better individual mobility and congestion reduction criteria), on the environment (in terms of emissions and energy efficiency criteria) and the economy (in terms of turnover / increase in revenues for business organizations).

2.4.1.3 C-Roads Italy 3 (2019-IT-TM-0114-W)

The project, presented after the launch by the European Commission of the CEF Transport

2019 Call (Reflow Call 2019), is linked to the two actions currently underway: C-Roads Italy and C-Roads Italy 2

SCOPE

The Ministry of Infrastructures and Transport is the project coordinator, implementing bodies are: Autostrada del Brennero, Autostrade per l'Italia, Concessioni Autostradali Venete – CAV, North Italy Communications (as project manager), Roma – Mobility Services and Autovie Venete.

The main objective of the new proposal is to extend the geographical coverage of the "Day 1" and "Day1.5" C-ITS Services defined by the EC C-ITS platform, along the main national road network, part of the European "Scandinavian-Mediterranean" and "Mediterranean" corridors, in order to maximize the impact on road safety and traffic efficiency, through the continuity of C-ITS cooperative services.

This implies that road infrastructures will have to be equipped, or updated, with innovative technologies to allow the interaction and exchange of information between infrastructures and vehicles (I2V) - (V2X).

SCHEDULE AND COSTS

The project is eligible for costs starting from July 2020 until December 2023.

The overall investment of the project is € 6.0M, with 20% European co-financing.

TECHNICAL ISSUES

The project involves equipping or upgrading the related road infrastructure with innovative technologies to allow interaction and exchange of information between the infrastructure of road operators and vehicles (I2V) - (V2X).

To allow the implementation of the planned C-ITS services, the communication design and the related architecture will be based on hybrid solutions, in particular: "ITS-G5" and "long-range cellular network", as defined in the European strategy C-ITS. The concept will be compliance to the definition of the hybrid profile of the C-Roads platform.

The development and implementation of the services will be fully interoperable with the C-ITS services already implemented under the aegis of the C-Roads platform. The design and communication architecture will always be based on a "hybrid" solution, as defined by the European Strategy C-ITS, or through ITS-G5 technologies for short range and "cellular network" for long range, applying the specifications and architectural profiles developed for the C-Roads Platform, thus ensuring the interoperability and continuity of the C-ITS services and compatibility with what has been developed in previous projects.

Figure 44 - C-Roads Italy 3 project – Location

The continuity and interoperability of the services will allow the expansion of the Italian network coverage of C-ITS services through the installation of compatible RSUs, and the connection to traffic management centres. The new use cases (eg Mobile Road Works Warning and RWW - Winter Maintenance) will be added to those used in previous projects.

2.4.1.4 5G CARMEN

5G-CARMEN project has a budget of € 18,362,373.75, with a co-financing of € 14,960,887.26 and will last from 1 November 2018 to 31 October 31 2021.

Within 5G-CARMEN project, relevant European industries, scholars and innovative SMEs work towards a worldwide impact, carrying out in-depth studies on a significant corridor (with significant passenger/freight traffic volumes), from Bologna to Munich, 600 km long, connecting three European regions (Bavaria, Tyrol and Trentino Alto Adige) in three different countries. Negotiation of the vehicle manoeuvre (at various levels of automation), infotainment and emission control into sensitive areas are the cross-border use cases targeted by 5G-CARMEN pilot projects, in order to maximize the commercial, social and environmental impact of the project.

The project will build a 5G enabled corridor to perform cross-border experiments and will implement a mix of 5G micro and macro cells for ubiquitous C-V2X connectivity. The 5G New Radio standard will be used to support services and applications with latency and/ or bandwidth problems. The project will leverage a distributed mobile edge cloud that extends from the vehicle itself to centralized cloud. The concepts of multi-tenancy and neutral hosts will be exploited in order to provide a final platform capable of enabling new business models. 5G-CARMEN will integrate C-V2X with LTE and C-ITS technologies, aiming at interoperability and exploiting a hybrid network.

Figure 45 - 5G-CARMEN project – Use cases

The four use cases considered in the project are:

- Negotiation of the vehicle manoeuvre (at different levels of automation);
- Perception, on the vehicle side, of the surrounding situation;
- Use cases of autonomous driving planned in the project;
- Emission control.

2.4.1.5 ICT4 CART

The project has a budget of € 10,218,621.25, with a co-financing of € 7,996,571.52 and will last from 1 September 2018 to 31 August 2021.

ICT4CART is providing an ICT infrastructure to enable transition towards road transport automation. To meet this high level objective, ICT4CART is bringing together, adapting and improving technological advances from different industries, mainly telecom, automotive and IT. It adopts a hybrid communication approach where all major wireless technologies, i.e. cellular, ITS G5 and LTE-V, are integrated under a flexible “sliced” network architecture.

To achieve its objectives, ICT4CART relies on four specific high-value use cases (urban and highway) which will be demonstrated and validated under real-life conditions at test sites in Austria (highway network Asfinag), Germany (city of Ulm) and Italy (Brenner motorway and city of Verona), with cross-border testing planned between Italy and Austria.

The four selected use cases are:

- parking & IoT services;
- in-vehicle enhanced HD maps;
- intersection crossing & lane merging;
- cross-border interoperability.

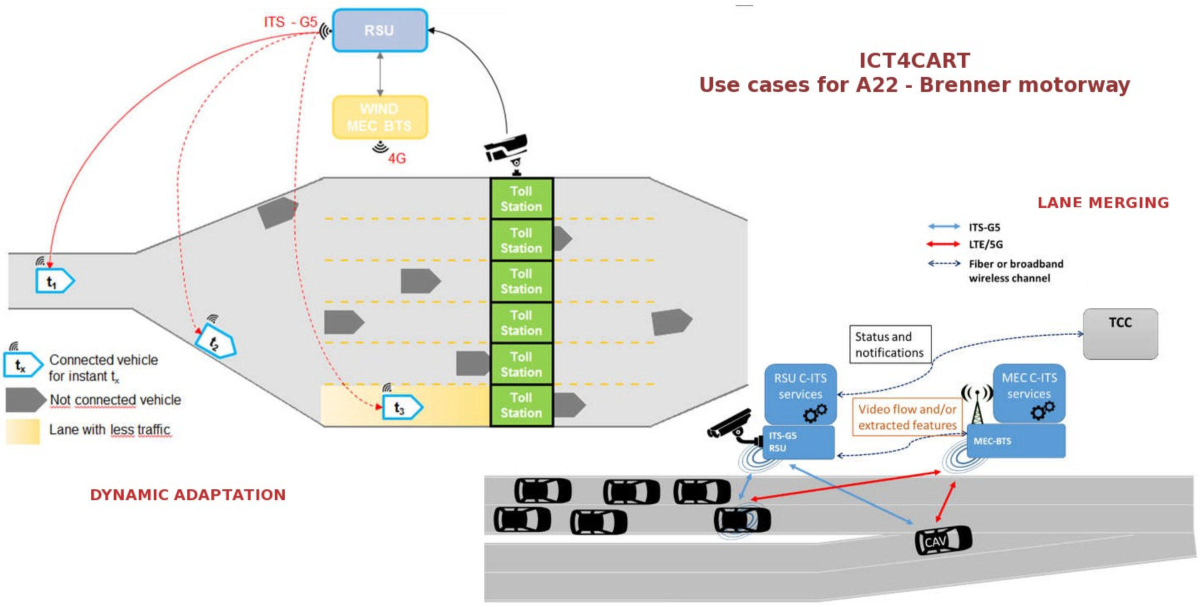

Figure 46 - ICT4-CART project – Use cases along A22 motorway

The use cases that Brenner motorway will deal with, in the project, are:

- Dynamic adjustment of driving at “Trento centro” motorway station and “Nogaredo ovest” service area: cameras capable of image processing and connected to road side units will detect oncoming vehicles and transmit their (simulated) information concerning closed, open or congestion-free tracks (“Trento centro”) or free pumps to refuel (“Nogaredo ovest” service area);
- Entering the lane from acceleration track of “Trento centro” and “Nogaredo ovest” service area: cameras capable of image processing and connected to road side units will detect vehicles arriving along the road and will communicate to connected vehicles about to enter, whether or not to proceed.

2.4.1.6 AUTOPILOT

The Livorno Large-Scale Pilot Site is located from Florence to Livorno, including a highway and an urban track inside the Livorno Sea Port. It has been adopted as “smart roads” according to the new ministerial decree that allows in Italy the experimentation of AD vehicles in real traffic conditions.

IoT devices are deployed in the car and along the roads in both the Highway and the Urban Area. In the former scenario roadside sensors and ITS-Stations managed by the Traffic Control Centre (TCC) are used to warn AD cars about hazardous situations, like heavy floods or road works. In the urban scenario “smart traffic light” and IoT sensors on the bicycles are used to enforce the safety of vulnerable road users when AD cars are approaching.

Seven JEEP Renegade prototype vehicles are used: two connected cars with AD functions and five connected cars without AD functions. A connected bicycle prototype is also used in the urban tests. The MONI.C.A.TM Port Monitoring Centre in the urban scenario and the real highway Traffic Control Centre with DATEX II node are integrated into the

ICT infrastructure of the Pilot Site. The driving modes, (notably highway and urban), the services for the car (so-called “Driver Assistant Supported by the Internet of Things”) and the monitoring and control applications are supported by the ICON oneM2M platform managed by TIM S.p.A.

The ICON OneM2M platform is provided as Platform as a Service (PaaS), with a specific tenant dedicated to the Livorno Pilot Site. The platform is oneM2M compliant, so it can interface all devices that natively adopt the oneM2M protocols. In Livorno Pilot Site most of the devices of the IoT ecosystem are oneM2M compliant, including Narrow Band- IoT (NB-IoT) sensors, Road Side Units (RSUs) and on-board units. Nevertheless, some other source of information required the development of adapters. It is the case of the DATEX II node providing real-time and verified traffic information of the highway. The adapter implementation is a SOAP-Web service that starting from the content of DATEX II messages in XML format, converts it to JSON format, without SOAP envelope (useless in the oneM2M context).

Starting from the use cases and based on ETSI C-ITS, SENSORIS and DATEX II [legacy data models, a new data model supporting IoT services for AD cars has been created. The data model has five packages: RSU, NB-IoT, DATEX II, TCC, Vehicle; each one corresponds to a content instance in the device tree of the oneM2M platform.

Urban scenario:

A road circuit inside the free public area of Livorno Sea Port has been equipped in order to test vulnerable road users warnings at traffic light intersection.

Highway scenario:

The Highway SGC Fi-Pi-Li (Florence-Pisa-Livorno) has been adapted as “smart road” in order to allow the piloting activities:

- A DATEX II node has been deployed for real-time traffic information;
- A pervasive sensing infrastructure has been deployed.

If possible the Business Model Radar[1] shall be used

Many weeks of experimentation have been executed in real traffic situation; on top, stakeholder workshops and public demo events have been performed. The purpose of those

[1] Business Model Prototyping for Intelligent Transport Systems. A Service-Dominant Approach; Eindhoven University of Technology, Technical Report · February 2015

events was to feed the evaluation tasks that investigate how IoT could offer improvements to automated driving according to: technical, business impact, quality of life, user acceptance.

Figure 47 - Business model radar

The following project partners were involved in the Livorno pilot:

- CNIT: pilot site leader and system integrator, providing also equipment (IoT-G5 RSU, NB-IoT puddle sensors, MONI.C.A.TM Port Monitoring System).
- AVR: highway traffic manager, providing the Traffic Control Center with DATEX II node, road side equipment (WiFi loggers and 6LoWPAN sensors) and three Jeeps with drivers.
- Continental; OEM providing the C-eHorizon device for the AD car and integrating the SW with the oneM2M platform.
- CRF-FCA: providing the prototype car with AD functions (speed adaptation and keep/change lane) integrated with the in-vehicle IoT platform and the HMI.
- LINKS (former ISMB): providing equipment (in-vehicle IoT platform, smart traffic light, connected bicycle, IoT pothole detector) and sw integration with the oneM2M platform.

- Thales: providing cybersecurity policy and assessment.
- TIM: management of the ICON oneM2M platform.

Many IoT platforms (often proprietary) have been developed worldwide, lacking a de facto standard solution. This situation is also found in AUTOPILOT, where several partners bring their IoT solutions with the common goal and vision that interoperability is the key for wider acceptance and adoption of IoT. The oneM2M platform is the tool chosen by the project to ensure the interoperability of the different components.

In the AUTOPILOT target IoT architecture devices, gateways, and in-vehicle and road-side IoT platforms exchange information (e.g., about detected objects, hazards, vulnerable road users, traffic lights, vehicle updates) with several distributed cloud IoT platforms.

The AUTOPILOT project shows that OneM2M compliant platforms and devices are valuable bricks of the digital infrastructure for accommodating the usage of AD cars in EU roads. The oneM2M standard offers effective tools to manage the challenge of data interoperability in the IoT ecosystem. The AUTOPILOT project developed a oneM2M interoperability platform to allow the different proprietary platforms provided by the partners to interwork successfully. The interoperability of different use cases and services is being demonstrated as the outcome of the trials in six full-scale Pilot Sites.

Further work is needed to achieve a seamless federation with the IoT infrastructure emerging from related pilot and project areas (created by the European H2020 Large-Scale Pilots Programme: IoT FA, LSPs and IoT-02-2016 CSA). This will be achieved by contributing to the standardization work groups, who are in charge of mapping the architecture, interoperability and standards approach at technical and semantic levels.

Although the evaluation activity is still ongoing, some preliminary results can be presented. Regarding the technical aspect, the analysis based on the FESTA methodology assesses that IoT data are effective in accelerating and enhancing AD manoeuvres in road hazard situations and the protection of VRUs in urban driving.

Regarding the business impact evaluation, the relevant AUTOPILOT methodology has been applied to firstly identify the business cases for the aforementioned Livorno Pilot Site Use Cases and the involved key related stakeholders and actors.

For the Livorno pilot, the following value propositions were presented to stakeholders and users involved:

- Protection of VRUs in an urban-like automated Port area;
- Automated speed adaptation and lane assistant on the highway for safety procurement;
- Integration of corporate ITS in a Traffic Control Centre;
- AVP Premium Ticketing Service.

The most important value proposition was considered to be the proposition “Protection of VRUs in an urban-like automated port area”, followed by “Automated speed adaptation and lane assistant on the highway for safety procurement”.

2.4.2 Progress since 2017

At national level

Anas, the main national road Agency, manages nearly 30,000 km of roads and is in the front line in the promotion and experimentation of technologies enabling V2X communication for the dissemination of autonomous driving and connected vehicles. In the context of the Smart Road, Anas has foreseen the realization of test-cases and POC (Proof Of Concept) on strategic itineraries in order to acquire Know How and elaborate Use Cases for the design of a Road-Map for future implementations on larger road sections through the whole national territory.

In particular, experimentations regards the following roads:

SS51 – Alemagna (Veneto), where experimentation is planned with 5G technology for the implementation of C-ITS services within the municipality of Cortina, on the occasion of the Alpine Skiing World Championships scheduled for February 2021 and of which Anas is the main player in the protection of territory and road infrastructure;

A91 – Roma-Fiumicino (Lazio), where work is currently in progress for the connectivity infrastructure between the On Board Units (OBU) installed on vehicles and the Road Side Units positioned on the roadside, for the creation of prototype solutions by adopting different communication technologies V2X, such as Wi-Fi in Motion, ITS-G5 and LTE-v.

Anas has planned to build a Smart Road infrastructure in an incremental and multi-wave manner, along a stretch of road and motorway network that already pass through various regions of the national territory in this first phase.

In particular, Anas has identified, within the scope of the first implementations covered by the Smart Road program, the following strategic itineraries:

- SS51 di Alemagna – Cortina 2021;
- E45/E55 - Orte – Mestre;
- A90 GRA e A91 Roma-Fiumicino;
- A2 – Autostrada del Mediterraneo;
- A19 - Autostrada Palermo-Catania;
- RA15 - Tangenziale di Catania.

Figure 48 - Smart roads managed by national road agency

The kind of Smart Road that Anas wants to develop is focused on users and their safety and will ensure:

- A safe trip, without difficulties, with driving assistance and/or self-driving; Safe roads, with adequate levels of maintenance;
- Timely action in emergencies and alerts from users’ mobiles; Real-time information on mobility;
- Services to users since the first installations and with possible future implementations;
- An increase in efficiency through raising existing roads’ operation factor by using modern technology;
- Intelligent monitoring, through IoT (Internet of Things) systems, of road infrastructures, traffic and goods transport, as well as environment and climate;
- Monitoring of vehicle flows with Multi-Function Smart Camera; Tunnels management and monitoring with the “Smart Tunnel” method;
- Network management and increase in infrastructure transport capacity by increasing traffic volumes through dynamic lanes; Real-time check of vehicles mass with Weigh in Motion systems (WIM);
- Full integration of existing technologies and databases on one digital platform.

Anas' Smart Road has been devised modular, that is standalone and independent; a module is a physical road or motorway segment that is operational and is served by the Green Island, energy core of the Smart Road. The Green Island is an area that contains mainly renewable energy generation and distribution systems, capable of independently powering all of Smart Roads' systems in its module, which is generally a road segment of 30 km. Another feature of the Smart Road is the creation of an infrastructure to monitor constantly and in real time all the work of arts and the state of the road. The infrastructure will be based on IoT (Internet of Things) networks, through Low Power, easily installed, Wide Area and Long Range sensors. To sum up, the Smart Road project implements enabling platforms based on the following main elements:

- Communication system;
- Energy system;
- Dynamic lane;
- Smart Tunnel method;
- Internet of Things (IoT);
- Open data and Big data.

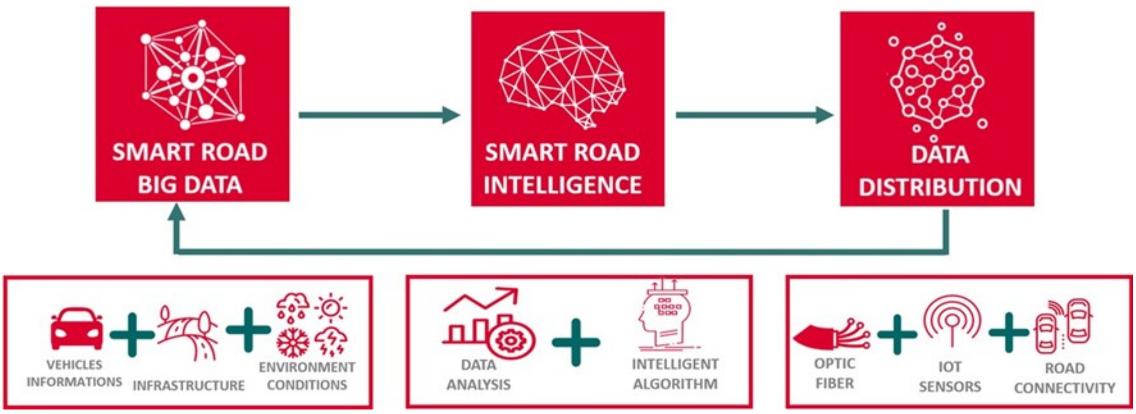

Figure 49 - National road agency Smart Road system concepts

The Road Anas Network Internet of Things (RANIoT) is the "IoT" system that Anas wants to integrate into the Smart Road project. With this system, the virtual world of information and communication technologies is closely related to the real world of things, with the purpose of monitoring, checking and transferring information and then carrying out consequent actions. Within the Smart Road, IoT systems will be used to perform both Structural Health Monitoring (SHM) activities to acquire and transmit information related to the state of the road infrastructure with its major works of art, and monitoring activities of the operating conditions related to the traffic and the transport of goods, as well as environmental conditions. In particular, quantities related to the following "objects" will be monitored:

- Road plan;

- Road barriers (Guard Rail, New Jersey and Mobile Barriers);
- Bridges / Viaducts;
- Galleries;
- Unstable slopes;
- Environment;
- Rest areas;
- Construction sites;
- Traffic.

The infrastructure of the monitoring system is generally made up of the following components:

- IoT sensors are intelligent devices, generally called "clients", which detect quantities measured and transmit/receive data and information to/from the gateway and/or concentrator;
- Gateways and/or concentrators, are a network devices that have the purpose of conveying data packets coming from the field, detected by IoT sensors of different types, and transmit them outside the local network.;
- System controller is a device that has the ability to collect, store and manage the data coming from each Gateway. Finally, this device must be integrated with the Road Management Tool (RMT) system of Anas, through the STIG system.

<u>At regional level</u>

The Turin Smart Road project is conducted in coherence with the Sustainable Urban Mobility Plan (SUMP) of the Turin City. SUMP definition is strategic for a city covering long period (10-15 years) defining guidelines-targets, actions (to reach targets) and operational measures (to verify the effectiveness).

The Turin city SUMP is divided in few Strategic Guidelines (SG).

The above SGs address overall targets of the Sustainable Urban Mobility Plan like:

- make public transport more competitive, making it accessible by everyone;
- discourage individual travel, thus, reducing congestion and improving accessibility to urban functions;
- promote an integrative system of urban transport, favoring the inter-modality between private and public transport.

#	Turin SUMP strategic guidelines
1	Guarantee and improve territory accessibility
2	Guarantee and improve people accessibility
3	a. Improve air quality
	b. Improve environment quality in the urban area
4	Facilitate the public transport usage
5	Guarantee efficiency and safety of the viability in the urban area
6	Mobility governance through innovating technology usage (ITS)
7	Define the governance system of SUMP

Table 6 - Turin SUMP strategic guidelines

As far as the mobility of Turin metropolitan area is concerned, following are some dimensions of the scenario:

- 1,555,518 inhabitants:
  - 911,823 Turin city
  - 643,695 Surround area

- 2,962,000 trips/day by Turin Metropolitan Area residents:
  - 1,430,000 by car
  - 532,000 by public transport
  - 869,000 by walk
  - 131,000 other (bicycle, motorcycle, taxi, etc.)

- 2.11 daily trips/inhabitant - 1.40 trips/inhabitant with motorised means

Turin Smart Road initiative deal with ITS technologies to be deployed in the Turin road network to enable test of connected and autonomous vehicles and is related to SG#6 – Mobility Governance through innovative technology usage.

A set of Use Cases have been designed and will be evaluated:

- Vulnerable Road Warning: advising in real-time of the presence of vulnerable people to improve road safety;
- Black spot Notifications: advise in a V2X and V2V communication the presence of dangerous situation in the road infrastructure to improve road safety;
- Green Light Optimized Speed Advisor (GLOSA): to suggest speed to be maintained by vehicles to find green light and reduce stp and go and reduce pollution.

Test site has been designed starting from the definition of Use Cases involving projects partners coming from University, Research centres, Telco Utility and Automotive sectors.

Enabling technologies are:

- 5G connection;
- V2X communication;
- C-ITS usage;
- Smart Traffic Lights;
- Smart Traffic Sensors;
- Connected and Autonomous vehicles.

The test will be performed in the context of 5T Traffic Operation Centre, that has an open and flexible architecture shortly described in the following picture:

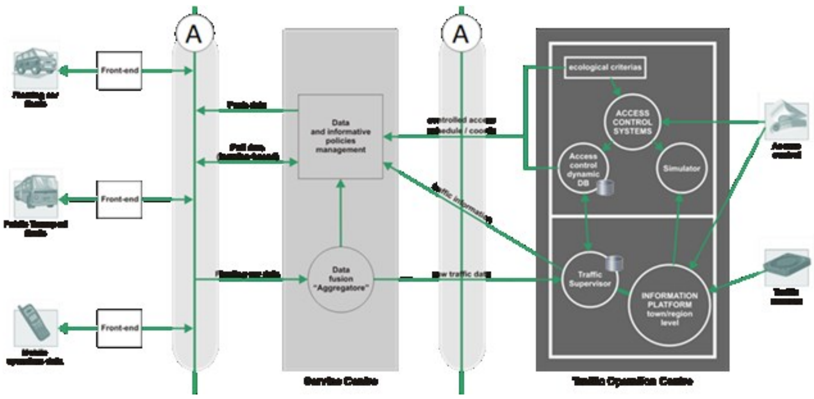

Figure 50 - 5T Traffic Operation Centre architecture

The introduction of ITS systems will be performed following a specific methodology mainly to address and resolve identified Mobility Issues and Local Authorities (LA). Identification and prioritization of Mobility Issues is typically done through a huge and shared work among all stakeholders. The Turin methodology for ITS Solutions identification and introduction is characterized by a process divided into several subsequent phases, as depicted in the following picture:

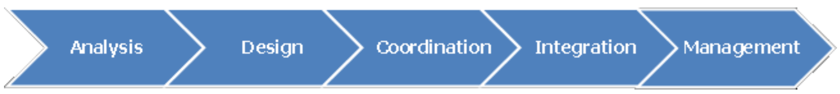

Figure 51 - Turin methodology for ITS Solutions

A 35 km long Urban Circuit has been identified where autonomous cars dedicated and non-dedicated lanes will be identified. ITS system will be deployed in a pre-competitive way integrated with legacy systems managed by Turin City Traffic Operation Centre (TOC). Important role will be covered by Urban Traffic Control (smart Traffic Lights) and 5G communication to test the autonomous vehicles.

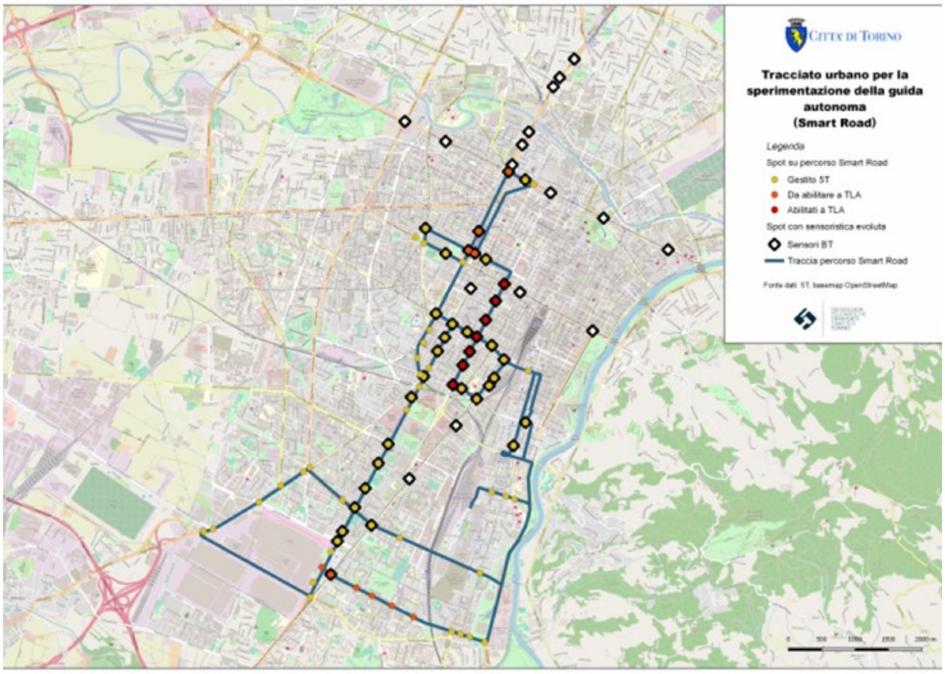

Figure 52 - Turin Urban Circuit

Following are some dimensions of the Turin city ITS deployment:

- 300 (out of 600) controlled intersections to optimize traffic signal and provide signal priority to public transport;
- over 3,000 inductive loops for real-time traffic flow measurement;
- 36 above-ground sensors;
- 71 monitoring cameras on 23 intersections;
- Integration of FCD (Floating Car Data);
- 26 above-road VMS;
- 20 parking info VMS for 26 parking lot structures;
- 18 extra-urban displays;
- 36 limited traffic zone displays;
- Web sites, smartphone apps, radio bulletin;
- speed control systems (in 2 main urban roads);
- Limited Access Area (in the city centre: 2,5 sq. km): 36 electronic gates and 36 information panels providing access information;
- UVAR: 15,000 transits per day including 4% non-authorised transits.

2.5 Other initiatives / highlights

2.5.1 Description of other national initiatives / highlights and projects not covered in priority areas 1-4:

Harmonised ITS deployment across the TEN-T and its Core Network Corridors to make mobility more safe, reliable and green, and to improve corridor performance, is the core mission of the CEF co-funded ITS Corridors – Arc Atlantique, Crocodile, MedTIS, NEXT-ITS and URSA MAJOR – and the EU ITS Platform (EU EIP). The Italian Ministry of Infrastructures and Transport, through Italian implementing bodies, is involved in ITS Corridors MedTIS, URSA MAJOR and Crocodile.

Italy is the Coordinator of the European ITS Platform. The European ITS Platform serves as a knowledge management centre by developing, providing, promoting and maintaining harmonization tools and processes with 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 implementing and advancing ITS policy and regulation as well as to relevant stakeholders and multi-stakeholder collaborations in the ITS community. Key achievements of the European ITS Platform comprise the European Reference Handbook for harmonized ITS Core Service Deployment in Europe, an improved mechanism for Cross Corridor Cooperation, KPIs for ITS deployment and benefits, the ITS toolkit and the evaluation library, the community building on National Access Points, Innovation timelines and deployment roadmaps, information services quality frameworks and assessment methods, physical and digital infrastructure attributes for automated driving, good practices how to automate road operator's own ITS and integrating C-ITS into road operators day-to-day business. The entire European ITS Platform results address all of the ITS Priority Areas I-IV (and, in doing so, have also relevance for sections 2.1 and 2.4) and contribute to the knowledge on KPIs related to ITS Corridors too. More information is available on www.its-platform.eu.

About CEF ITS corridors, this report highlights some results from ITS corridors achieved in the period since 2017 as well as results of ex-post evaluations that have been drafted after 2017.

3 Key Performance Indicators (KPIs)

At national level, so far two sets of Key Performance Indicators have been adopted to assess the technical performance and benefits of projects: *Deployment KPIs* and *Benefit KPIs, a*ccording to European harmonized procedures. At a second stage, algorithms for calculation of *Financial KPIs* will be adopted.

3.1 Deployment KPIs

<u>MedTIS Corridor</u>

Within MedTIS 2 Corridor the Italian projects focus on deploying two types of services: Traffic Management and Traveller Information. The KPI selected at the beginning of the Action to evaluate its implementation's success, and consequently of the Corridor, is the number of kilometres covered by the new systems deployed, in accordance with the DG MOVE KPI:

- TMS deployment progress: Length of TEN-T network on which TMS is deployed and enhanced;

- TIS deployment progress: Length of TEN-T network on which TIS is deployed and enhanced.

At Corridor level

MedTIS 2 Action consisted in the implementation of two types of ITS solutions, those addressing Traffic Management Services and those addressing Travel Information Services. Therefore at corridor level the DKPI are:

- MedTIS 2 has delivered 13,419 km of Traffic Management Services. The Action has reached its objective of delivering at least 6,600 km of TMS.
- MedTIS 2 has delivered 5,054 km of Traveller Information Services. The Action has reached its objective of delivering at least 2,340 km of TIS.

URSA MAJOR 2 Corridor

Within the URSA MAJOR 2 Corridor, the relevant deployment KPIs that characterise the evaluated UM projects are:

- Incident detection and incident management (EUEIP-DKPI-R1) linked to DG MOVE DKPI Incident detection (road KPI)
- Automated speed detection (EUEIP-DKPI-R2) linked to DG MOVE DKPI Information gathering infrastructures / equipment (road KPI)
- Traffic condition and travel time information service (EUEIP-DKPI-O2) linked to DG MOVE DKPI Real-time traffic information (road KPI)
- Intelligent services in accordance to delegated regulations under the ITS directive (EUEIP-DKPI-L2) linked to DG MOVE DKPI Real-time traffic information (road KPI), Dynamic travel information (multimodal KPI) and Freight information (multimodal if possible or road KPI)
- Speed limit information (EUEIP-DKPI-R3) linked to DG MOVE DKPI Traffic management and traffic control measures (road KPI)
- Variable speed limits (EUEIP-DKPI-R4) linked to DG MOVE DKPI Traffic management and traffic control measures (road KPI)
- Forecast and real-time event information (EUEIP-DKPI-O3) linked to DG MOVE DKPI Information gathering infrastructures / equipment (road KPI) and Real-time traffic information (road KPI)
- Dynamic lane management (EUEIP-DKPI-O4) linked to DG MOVE DKPI Traffic management and traffic control measures (road KPI)
- Hard shoulder running (EUEIP-DKPI-O5) linked to DG MOVE DKPI Traffic management and traffic control measures (road KPI)
- HGV overtaking ban (EUEIP-DKPI-R6) linked to DG MOVE DKPI Traffic management and traffic control measures (road KPI)
- Traffic Management Plan Service for Corridors and Networks (EUEIP-DKPI-O6) linked to

DG MOVE DKPI Traffic management and traffic control measures (road KPI)

- Dynamic information on intelligent truck parking (EUEIP-DKPI-R7) linked to DG MOVE DKPI Freight information (multimodal if possible or road KPI)
- Ramp metering (EUEIP-DKPI-O7) linked to DG MOVE DKPI Traffic management and traffic control measures (road KPI)

3.1.1 Information gathering infrastructures / equipment (road KPI)

In the entire motorways network, as well in the primary road national network, there is an integrated system of gathering infrastructures, made up by sensors, cameras, floating car data.

The 2 networks together represent a superset of comprehensive TEN-T network. Table 8 shows relevant figures.

Network type	Equipped (km)	Length (km)	%
Motorways network	7,022	7,022	100%
Primary roads national network	27,128	27,128	100%

Table 7 - Road KPI: information gathering infrastructures / equipment

3.1.2 Incident detection (road KPI)

In the framework of the above system, in the entire motorways network, as well in the primary road national network, speed can be detected by floating car data, giving evidence of slow traffic, congestion, blocked traffic and traces of accidents and other events. In this process, data from other automatic systems, sensors, cameras, toll stations, are collected and monitored, together with reports from road managers control vehicles and road police, also, in heavy traffic periods, exploiting air monitoring with planes and helicopters.

Table 8 shows relevant figures.

Network type	Equipped (km)	Length (km)	%
Motorways network	7,022	7,022	100%
Primary roads national network	27,128	27,128	100%

Table 8 - Road KPI: incident detection

3.1.2.1 MedTIS 2 Corridor

Even if data regarding MedTIS 2 Action is not available on the whole network, there are specific points or areas of the motorway network where information on one or more KPIs is available. MedTIS 2 partners have identified a list of deployment projects for which the information is indeed available. They have carried out individual evaluations of these projects, to assess both deployment and benefits.

- ITS for safety in tunnels

EVALUATION PERIOD	EVALUATION TYPE	DEPLOYMENT KPIs	BENEFIT KPIs
2014 to 2019	Ex-post	Incident detection and incident management	Change in accident numbers and severity

Table 9 - ITS for safety in tunnels

ITS Deployment status

- Description: Improving of the digitalization of roads through CCTV with AID systems, traversable cameras, Installation of information and rerouting systems and strengthening of transmission network
- Location: A6 motorway, tunnel sections between Turin and Savona, North-West of Italy
- Deployment period: project started in 2015 with minor improvements in 2017 and 2018
- Deployment KPI: the project completion rate is 100%. It covers tunnels of the A6 motorway, deploying Incident detection and incident management systems.

3.1.3 Real-time traffic information (road KPI)

As shown in section 2.1.4, a superset of TEN-T network is covered by real-time traffic information. Table 10 shows relevant figures.

Network type	Equipped (km)	Length (km)	%
Motorway network	7,022	7,022	100%
Primary roads national network	27,128	27,128	100%

Table 10 - Road KPI: real-time traffic information

3.1.4 Freight information

3.1.4.1 URSA MAJOR 2 Corridor

The table contains a list of all projects developed on the Ursa Major corridor and evaluated ex-post (or ex-ante in only one case). Within the table there are four columns: the Activity area within Ursa Major, intended as the purpose for which it was implemented, the name of the Project, the Country in which it is located and the ITS service, which represents the defined typology of the implemented system. This last field is defined on the basis of the description and impacts of each project analysed.

Italy was in charge of leading the evaluation within the Ursa Major action, but the Italian implementations are highlighted in bold.

Activity	Project	Country	ITS service
Activity 2 Enhancement of truck parking services	ParkR – app	Netherlands	Traveler information services
Activity 3 Support for truck navigation services	Avoiding rush hour	Netherlands	Other
	Network Control Rhein-Main-Ost/Mittelhessen	Germany	Dynamic rerouting
	Dynamic Rerouting A5/A6/A61/A67/A656/A659	Germany	Dynamic rerouting
	Online Traffic Information Service Hessen	Germany	Traveler information services
	Road/traffic monitoring on A4/A31-BS-PD	**Italy**	**Traffic monitoring and management**
	TCC and data exchange (DATEXII) upgrading	**Italy**	**Traffic monitoring and management**
	Traffic monitoring and control in A24/A25 – Strada dei Parchi S.p.A.	**Italy**	**Traffic monitoring and management**
	National Traffic Management Plans (TMP)	Switzerland	Dynamic rerouting
Activity 4 Remove bottleneck and congestion	Regiodesk: Improve accessibility with traffic management scenarios	Netherlands	Traffic monitoring and management
	Line control A3 Limburg	Germany	Dynamic lane management
	TMS with HSR on the A9 between Holledau and Neufahrn	Germany	Dynamic lane management
	Hard shoulder running (BAU) A1 Morges-Ecublens	Switzerland	Dynamic lane management
	Variable speed limit and danger warning system A1 VBS Lenzburg – Birrfeld	Switzerland	Variable speed limit
Activity 5 Safety improvements for freight transport on the TEN-T road	Usage of FCD to improve the traffic situation in Bavaria	Germany	Floating Car Data
	Traffic Information and Safety Campaign in Switzerland	Switzerland	Traveler information services
	Extension of motorway exits and entrances	Switzerland	Other

Table 11 - Ursa Major evaluated projects

3.2 Benefits KPIs

3.2.1 Change in travel time (road KPI)

3.2.1.1 MedTIS Corridor

MedTIS 2 Action focuses on two main objectives: reducing congestion on strategic bottlenecks of the Corridor and reducing accident number and severity. A logical consequence of congestion reduction is a reduction in fuel over-consumption and a reduction of tons of CO2 emitted, leading to a positive impact on the environment. Therefore, the three benefit KPIs chosen for MedTIS Action are:

- Safety: Change in accident number and severity - EU EIP Code: EUEIP-BKPI-S1, according to DG MOVE BKPI Change in Road Accident resulting in death or injuries numbers (road KPI)
- The Environment: Change in CO2 emissions - EU EIP Code: EUEIP-BKPI-E1, according to DG MOVE BKPI Change in traffic-CO2 emissions (road KPI)
- Congestion: Change in bottleneck congestion EU EIP Code: EUEIP-BKPI-N3, linked to DG MOVE BKPI Change in travel time (road KPI)

Given the time constraints that require evaluation results to be delivered at the end of the project, road operators have developed an ex-ante evaluation method. This method tries to respond to the commitment of verifying, by a socio-economic analysis, that MedTIS program fully meets the objectives assigned in terms of congestion reduction, environmental impact, and safety improvement; and with a good level of economic balance of investments. The results must be significant and meaningful for decision-makers and stakeholders.

Moreover, the methodology should rely on as most individual deployments as possible, and allow the measurement of impacts common to all of them and significant for the entire program.

Considering individual deployments of MedTIS Action, more than 75% of them aim to:

- Better and Faster detection (CCTV, incident detection system …);
- Better and Faster information (VMS, on board information …);
- Better and Faster intervention (on site protection).

In fact and to summarize, the operational goal sought by the operators in deploying these projects is to improve the alert time and the response time in case of incident or accident, and thus reduce the occurrence of secondary accidents (by alerting drivers approaching the primary accident, so they are more prepared to avoid a secondary accident).

3.2.1.2 URSA MAJOR Corridor

Within the URSA MAJOR Corridor, the relevant Benefit KPIs investigated in the evaluated UM projects are:

- Change in traffic flow (EUEIP-BKPI-N1), linked to DG MOVE BKPI Change in travel time (road KPI)
- Change in road traffic journey time variability (EUEIP-BKPI-N2), according to DG MOVE

BKPI Change in Travel Time (road KPI)

- Change in bottleneck congestion (EUEIP-BKPI-N3), linked to DG MOVE BKPI Change in travel time (road KPI)
- Change in journey time (EUEIP-BKPI-N4), according to DG MOVE BKPI Change in Travel Time (road KPI)
- Change in accident numbers and severity (EUEIP-BKPI-S1), according to DG MOVE BKPI Change in Road Accident resulting in death or injuries numbers (road KPI)
- Change in CO2 emissions (EUEIP-BKPI-E1) according to DG MOVE BKPI Change in traffic-CO2 emissions (road KPI)

The evaluation of URSA MAJOR is performed with ex-post results, since the time schedule allowed to collect enough real data for this kind of assessment. The ex-post evaluation is based on the comparison of Key Performance Indicators (KPI) before the implementation of ITS and after the system is in operation or by the measurement of KPIs with the system switched on and the system switched off.

3.2.2 Change in road accident resulting in death or injuries numbers (road KPI) and Change in traffic-CO2 emissions (road KPI)

3.2.2.1 MedTIS Corridor

At Corridor level

Impact on safety

The impact on safety is estimated by calculating the possible reduction of secondary accidents, which can be avoided by reducing alert and intervention times.

To estimate the impact of the reduction of the alert time on the secondary accidents, and taking into account that a secondary accident can occur within 4 to 5 min after the first accident, the method analyzes different realistic scenarios of reduction of alert times on different types of network and deduces the realistic percentages of potential reduction in the number of secondary-accidents.

On the basis of existing accident data, which show that the share of secondary-accidents varies from 4% to 12% of total accidents according to the type of traffic (low traffic, medium traffic or high traffic), the analysis below presents the different impacts of reducing the warning time on the number of accidents.

<u>About elasticity of the theoretical accident reduction rate</u>

Road and traffic configuration	Secondary accidents/total accidents number observed	Average delay of occurrence of a secondary accident after the first accident (in sec)	Time savings due to quicker alert (due to the program) (in sec)	Time savings rate	Accident number potential reduction
A	B	C	D	E = D/C	F = B*E
Low traffic motorway	4 %	240	30	12.5 %	0.50 %
Average traffic motorway	6.5 %				0.81 %
High traffic motorway	12 %				1.50 %
Low traffic motorway	4 %		60	25 %	1.00 %
Average traffic motorway	6.5 %				1.63 %
High traffic motorway	12%				3.00 %
Low traffic motorway	4 %	300	30	10 %	0.40 %
Average traffic motorway	6.5 %				0.65 %
High traffic motorway	12 %				1.20 %
Low traffic motorway	4 %		60	20 %	0,80%
Average traffic motorway	6.5 %				1.30 %
High traffic motorway	12 %				2.40 %

Table 12 - Potential Accident number reduction due to program - Various hypothesis

According of the different scenarios, and after eliminating the four cases regarding low traffic motorways (not present on MedTIS network), the theoretical range of potential accident reduction rate figures is between 0.65% and 3%.

After discussions, road operators decided to take the average of these different figures as the right potential reduction rate of accident numbers on MedTIS network linked to alert time reduction.

Thus, the potential reduction rate of accident numbers linked to alert time reduction on MedTIS network is calculated at 1.6 % for the evaluation study.

Using that first result of 1.6% reduction rate, the methodology developed below allows to estimate the potential savings on safety due to MedTIS program implementation (Benefit KPI: change in accident number and severity).

Impact on congestion

One assumes that there is a straight relation between congestion volumes and accidents.

One assumes that inter-urban highway congestion is mainly related to accidents that occur there: a potential reduction of 1.6% in the number of accidents leads to a potential reduction of 1.6% in congestion volumes[2].

That hypothesis leads to a congestion reduction volume calculation to be considered as a minima result. In practice, the congestion volume reduction should be more favourable. Thus, this hypothesis should be rather conservative.

According to that hypothesis and using that same reduction rate of 1.6%, the methodology developed below allows to estimate the potential savings on congestion volumes due to MedTIS program implementation (Benefit KPI: change in bottleneck congestion).

Impact on CO2 emissions

One assumes that there is a straight relation between congestion volumes (expressed in lost hours) and fuel over-consumption (expressed in fuel liters) and therefore CO2 over-emissions (expressed in CO2 Tons).

The table below makes it possible to calculate the relation between a volume of congestion lasting 1 hour on 1 km, on a lane, and the volumes of over-consumption of fuel and therefore of corresponding CO2 over-emissions.

The calculation is made on the following basis corresponding to inter-urban motorways:

- Average speed in the congestion is 50 km/h (instead of 110 km/h in fluid traffic situation);
- Maximum traffic flow for an inter-urban motorway is 1,750 veh/h for 1 lane, of which 1,575 light vehicles and 175 heavy goods vehicles;
- It was furthermore estimated that under these conditions:

[2] This figure is consistent with the objective of reducing the congestion observed on the main bottlenecks of medtis by 5%. Indeed it applies to the entire network and not to its critical spots; so the global figure is necessarily inferior to 5%.

- light vehicles consume an extra 0.035 L/km of fuel and HGV consume an extra 0.16 L/km of fuel;
- CO2 emissions per litre of fuel is 2.7 kg.

	Characteristics of fluid traffic flow	Characteristics of congested traffic flow (for 1 HKM)
Traffic/hour (veh/h/km)	1750 (1575 LV + 175 HGV)	**1750** (1575 LV + 175 HGV)
Average speed (km/h)	110	**50**
Fuel consumption (L/km)	LV: 0.07 HGV: 0.32	LV: **0.105** (+ 0.035) HGV: **0.48** (+ 0.16)
Fuel over-consumption (L/km)		0.035*1575 + 0.16*175 = **83.125**
CO2 over-emissions (T/km)		83.125*2.7/1000 = **0.224**

Table 13 - Estimation of fuel over-consumption for 1 HKM

To summarize that calculation: 1 km congested traffic for 1 hour on 1 lane, running at 50 km/h in average, equals about 20 lost hours ; 83,125 l of fuel over-consumption; and 0.224 t of CO2 over-emissions.

By using the accident figures and congestion volumes for the year 2013, used as reference year before deployment, the methodology makes it possible to estimate, from the coefficient of improvement of 1.6%, the potential gains due to the project. These are expressed in savings on accidents' number, congestion volumes, and therefore in volume of fuel over-consumption and CO2 over-emissions.

Social costs in different countries from reference year (2013) to year 2018 and beyond are as follows.

Accidents (source: Handbook of external costs of transport):

- Slight injured: from 13,800€ to 21,600€
- Seriously injured: from 201,100€ to 289,200€
- Fatality: from 1,505,000€ to 2,070,000€

Congestion

- Hour lost: from 7.87€ to 22.54€ (source: DOT of beneficiaries)
- Fuel liter: 0.7€(out of tax) (source: market price)
- CO2 Ton: 30€ (source: market price)

Applying the social costs, used in the different beneficiaries networks, related to each of the savings, and summing those savings, it is possible to monetize the gains of the whole project (from 2013 to 2018).

Congestion volume for year 2013 (All MedTIS Beneficiaries)	
Hours lost number	8,022,240.00
Congestion volume reduction due to project (-1.6%)	
Hours lost number reduction	128,355.84
Fuel over-consumption reduction (liters)	533,478.96
CO_2 over-emissions reduction (tons)	1,437.59
Accident for year 2013 (All MedTIS Beneficiares	
Accident number year 2013	3,181
Slightly injured	3,468
Seriously injured	665
Fatalities	102
Slightly injured per accident	1.09
Seriously injured per accident	0.21
Fatalities per accident	0.03
Accident number reduction due to project (-1.6%)	50.90
Slightly injured number reduction	55.49
Seriously injured number reduction	10.64
Fatalities number reduction	1.63
Social costs savings	
Hours lost savings	2,156,811.83
Fuel over-consumption reduction savings	373,435.27
CO_2 over-emissions reduction savings	43,127.56
Slightly injured savings	1,033,078.40
Seriously injured savings	2,676,497.60
Fatalities savings	3,134,480.00
Total savings	9,417,430.67

Table 14 - Potential savings on MedTIS 2 main network

This table therefore makes it possible to draw the following overall potential results per year after MedTIS2 implementation:

- Safety potential reduction: about 51 accidents, 66 injured, 2 fatalities
- Congestion potential reduction: about 130,000 hours
- Environment potential reduction: about 535,000 fuel litres, 1,450 CO2 emissions tons

These savings account for a total of roughly 9.5 million € per year.

Comparing this with MedTIS deployment cost of about 43 million €, the return on investment of the whole Action is less than 5 years.

Insofar as the hypotheses retained are very conservative, as indicated above, these results, to be considered as minimal, are therefore very positive and well demonstrate the impact of the MedTIS implementation.

At national level

This section presents, for each individual deployment assessed, the main results of the evaluation regarding Benefit KPIs.

It is important to notice that these evaluations do not necessarily cover the whole deployment perimeter of projects, as they are often composed of different solutions. And, as for the Corridor level evaluation, the analysis was made for certain situations only (secondary accidents for projects addressing road safety). Therefore, the benefits calculated in these reports can be considered as minimal; each project has the potential of having a greater impact when taking into account all the solutions deployed and all situations addressed.

Evaluation period	Evaluation type	Deployment KPIs	Benefit KPIs
2014 to 2019	Ex-post	Incident detection and incident management	Change in accident numbers and severity

Table 15 - Deployment of ITS for safety in tunnels

Impact on Traffic Flow

The new equipment, permits to monitor the traffic flow. The data is directly sent to the Traffic Control Centre that can identify, analyse and process it for a better management of traffic flow, dispatching user information through all possible channels and information devices.

Impact on Safety

Through the implementation of new CCTV stations in most of A6 tunnels, it is possible to monitor and cover the whole tunnel length, in terms of incident detection and hazardous situations. With the aid of traffic sensors and the Traffic Control Centre it is possible to prevent or activate procedures in case of alert in order to improve safety for the users and for the road workers. The project has thus contributed to potentially avoiding 45 accidents from 2016 to 2019.

Impact on Environment

Thanks to the new equipment, it is possible to monitor the traffic flow and in case of alert, incidents, or queues, to give information to users and reroute vehicles, reducing the emissions and the impact on environment.

Cost-Benefit Analysis

The deployment costs are 1.391.311 €, and the benefits are estimated at 1, 5 M€ for 2016-2019 period, which means a ROI of about 4 years.

3.2.2.2 URSA MAJOR Corridor

At Corridor level

In this paragraph the impacts of ITS services are summarized using tables, one for each field of impact (traffic efficiency, safety, environment and other results), subdivided by indicator and by ITS service. Table 16 contains results obtained from the ex-post evaluation of Ursa Major corridor implementations.

Key Performance Indicators	ITS services				
	TIS	DR	DLM	TMM	VSL
Traffic flow			+17%/+23%	+1,5%/+7%	+5%/+7,5%
Travel time		-770.000 hours per year	-8%/-50%	-3%/-4%	
VHL		-2,5%		-48%/-86% for 4 events	
Number of traffic jams			-24%		
Congestion costs		-26 M€ per year		-6.000€/-55.000€ for 4 events	
Number of rerouted users		10%/43%			
Travel speed					Improved
Capacity			+26%/+34%		

Table 16 - Impacts on traffic efficiency of the evaluated UM projects

The impacts on road safety generated by Ursa Major projects are summarized in table 17.

Table 18 shows the impacts on the environment described in the Ursa Major project's evaluation.

Results related to Ursa Major implementations that can be considered additional to the fields described above are called "Other results" and are provided and summarized in table 19:

Key Performance Indicators	ITS services				
	TIS	DR	DLM	TMM	VSL
Number of accidents					-67% in 1 month
N. of accident/changes in flow				-7%	
Headway			Low increase		
Acceptance of safety campaign	91% of satisfied users				

Table 17 - Impacts on safety of the evaluated UM projects

Key Performance Indicators	ITS services				
	TIS	DR	DLM	TMM	VSL
Fuel consumption		Reduction	-28%/-55%		
CO2 emissions		-3.650 tons per year	-40%		
NOX emissions			-40%		
Fine particles			-75%		
VOC			-13%		

Table 18 - Impacts on environment of evaluated UM projects

The overall impact of Ursa Major (UM) is based on a combination of the results of UM evaluated ITS implementations and impact data available in literature (and similar to ITS realized in UM), in order to have more solid statistical basis.

The results are expressed through the Key Performance Indicators defined by DG MOVE, using only those applicable and pertinent to UM implementations.

The first step is the calculation of KPIs for each type of ITS service, using combined data from the UM evaluation studies and from literature.

After that, the impact results are extended to the whole UM corridor using a weighted average of the indicators over the number of implemented projects for each ITS service type.

Key Performance Indicators	ITS services				
	TIS	DR	DLM	TMM	VSL
User acceptance	90%/95% satisfied users		78% satisfied users		
User behaviour			Better compliance with VMS gaps of 1,5 km		
Page views (website)	36.500 per month				
Event detection time				-93%/-97%	
General benefits				44 M€, with benefit-cost ratio of 7	

Table 19 - Other results of evaluated UM projects

The following table represents the assessed average impact along routes where the ITS systems included in the Ursa Major Project have been implemented.

Impact area	Benefit KPI along routes where UM-ITS has been implemented	Value
Traffic efficiency	Change in journey time	-13%
	Change in traffic flow	+9%
Safety	Change in number of accidents	-34%
Environment	Change in annual CO_2 emissions	-22%

Table 20 - Assessed average impact along routes where the ITS systems included in the Ursa Major Project have been implemented.

<u>5 year estimated minimum benefit</u>

The estimation model applied only to the Italian and German Projects allows to estimate the following annual savings:

- less 71 accidents with victims;
- less 79 slightly injured people;
- less 22 seriously injured people;
- less 2 fatalities.

By transforming these benefits into economic value, it can be estimated a gain of 11,5 M€. For the estimation of the ROI the following basic calculation can be applied: Project Investment (€) / Annual savings (€) = Number of Years

ROI = 45,878 M€ / 11,5 = 4 years

For the only Italian UM network the result is:

Congestion Volume reference Year (2013) to 2018	
Accident Number Year 2013	1,277
Sligtly injured number	1,713
Seriously injured	524
Fatalities	32
Sligtly injured number per accident	1.34
Seriously injured per accident	0.41
Fatalities per accident	0.03
Accident Number reduction due to project (-1,6 %)	20.43
Sligtly injured number reduction	27.41
Seriously injured number reduction	8.38
Fatalities number reduction	0.51
Social costs savings	
CO_2 over-emissions savings (€)	0.00
1 slightly injured cost (€)	18,800.00
Sligthly injured savings (€)	515,270.40
1 seriously injured cost (€)	246,200.00
Seriously injured savings(€)	2,064,140.80
1 fatality cost (€)	1,916,000.00
fatalities savings(€)	980,992.00
Total savings	3,560,403.20

Table 21 - Congestion volume reference year (2013) to 2018

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