TN-ITS GO D5.5
Data chain requirements

31-12-2021

TN-ITS GO
Map Update Exchange

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Author(s) – in alphabetical order		
Name	**Organisation**	**E-mail**
Frank Daems	ERTICO	f.daems@mail.ertico.com
Tom Jensen	TomTom	tom.jensen@tomtom.com
Christian Kleine	Here Technologies	christian.kleine@here.com
Suku Phull	DFT UK	suku.phull@dft.gov.uk
Stephen T'Siobbel	ERTICO	s.tsiobbel@mail.ertico.com

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Abstract

This deliverable addresses the long-term deployment activity requirements for ensuring the TN-ITS market uptake, including regions and cities. The task D5.5 identifies the data chain requirements that need to be considered, such as maintaining trust, authenticity, data channel integrity, creating recognition and visibility, to ensure differentiation between applications, using the TN-ITS authoritative data source and any other private initiative.

This action is necessary for future (CAD) automation applications and regulations.

The task has taken as a leading application ISA (Intelligent Speed Assistance) as a reference. It to aligned with leading ISA implementation cities such as Helmond (NL), Hamburg (DE).

Since most of these data sharing topics are the same for other data sharing services (such as DATEXII), alignment sessions are performed with the relevant TN-ITS existing project co-operations (DATEX II, SENSORIS, CCAM) and with the standardization community.

An assessment has been performed on how those requirements fit with the generic EU digital system infrastructure based upon NAP (National access points).

Project co-funded by the European Commission within Horizon 2000		
Dissemination level		
PU	Public	x
PP	Restricted to other programme participants (including the GSA)	
RE	Restricted to a group specified by the consortium (including the GSA)	
CO	Confidential , only for members of the consortium (including the GSA)	

1 Introduction

1.1 Content of this deliverable

This deliverable addresses the long-term deployment activity requirements for ensuring the TN-ITS market uptake, including regions and cities. The task D5.5 identifies the data chain requirements that need to be considered, such as maintaining trust, authenticity, data channel integrity, creating recognition and visibility, to ensure differentiation between applications, using the TN-ITS authoritative data source and any other private initiative. This action is necessary for future (CAD) automation applications and regulations.

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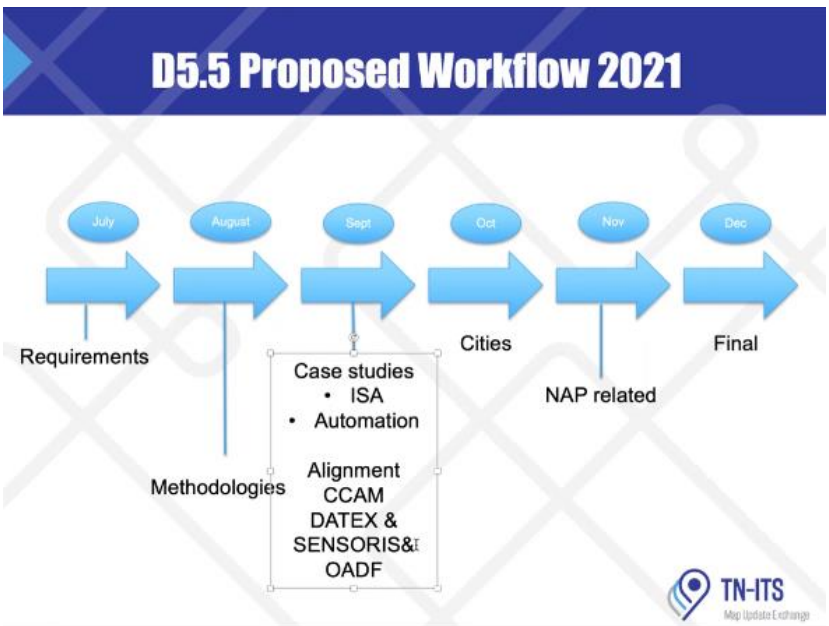
An assessment has been performed on how those requirements fit with the generic EU digital system infrastructure based upon NAP (National access points).

An early introduction on requirements was published by the TN-ITS platform in its 'Reflection paper'[1]

1.2 Workplan

The initial workplan that was put forward is illustrated by the following figure.



[1] https://tn-its.eu/storage/uploads/documents/2020/10/22/TN-ITS-Reflection-paper-22102020.pdf

Figure 1: Initial Workplan D5.5

The task initiated in June 2021 with partners ERTICO, TomTom, HERE, Flanders, UK, Finland, France and Ireland.

Due to the specific role that IGN took after September 2021 in the TN-ITS GO project[2], IGN also announced its resignation from this task. In the subsequent work, Ireland did not contribute. So, the analysis carried out by the team is based upon the insights and contributions from the other remaining partners.

Initially the idea was that each month was devoted to a certain sub task. However, due holiday, practical organisations, we detected a severe backlog of the work at the end of August. A corrective action was defined by a executing a very focussed and effective 'hybrid' meeting on September 3rd 2021 at the premisses of MOW Flanders. From that moment the task was back on track, and we concluded the inputs at the hybrid workshop In Brussels on December 1st [3]2021. This document gathers all inputs and presents the conclusions

Figure 2: The September hybrid workshop

This document outlines the results from the various task from the workplan in a synergetic way.

Starting with the identified data chain, realised by the TN-ITS Go project, identifying the building blocks and interfaces, we can analyse the requirements that apply for each of these contributing blocks. We then make an inventory of ideas on potential tools and methodologies, how the requirements can be met. Case studies for well-known target TN-ITS applications like ISA and Automation are being presented. Based upon ERTICO's city moon shot 2021

[2] IGN announced its limited role in the TN-ITS activity during the Steering committee dd 14/9/2021
[3]https://erticobe.sharepoint.com/:f:/r/sites/TN-ITS/TNITS%20GO/5.%20Meetings/2021-12-01%20D5.5%20Workshop%20Brussels/Recordings?csf=1&web=1&e=NQzcCV

[4]initiative, we also assessed the TN-ITS data share methodology and benefits with cities, such as Helmond (Nl) and Hamburg (DE).

All of these insights generate recommendations and subjects for further discussion and research, likely to be taken up in NAPCORE[5], the successor of the TN-ITS Go project.

2 Description of the data chain

2.1 Description of the data chain

2.1.1 History of the data chain: ROSATTE and eMaPS

The ROSATTE project was launched in 2008 to research a solution to the challenges map and service providers were facing to source changes of road data from a multitude of European authoritative sources with a multitude of data formats. The project aimed to support road authorities to ensure that these changes are made available, in an effective and efficient way, to applications benefiting their citizens.

The ROSATTE innovation project was funded by the EC (2008-2010, DG INFSO) and addressed the creation and maintenance of “safety attributes” in map databases via Public-Private cooperation. The project developed standard procedures to facilitate access, exchange and maintenance of European-wide road safety spatial data from public sources, to enable the multi-level national/regional/local aggregation and update of European-wide safety data, and assessed the technical & organisational feasibility of this infrastructure. Partners were road authorities (NO, SE, FR, BAY, FLA), road operators (ASFA, TfL) and private organisations as map makers and service providers (Tele Atlas and NAVTEQ). The defined and piloted Data Chain is shown in the following figure and illustrates the roles, data flow and data processes. The ROSATTE technical specifications served as a basis for later standardisation activities by CEN TC278, leading to the CEN Technical Specification 17268 published in December 2018.

[4] https://erticonetwork.com/ertico-city-moonshot-takes-off/
[5] http://napcore.eu

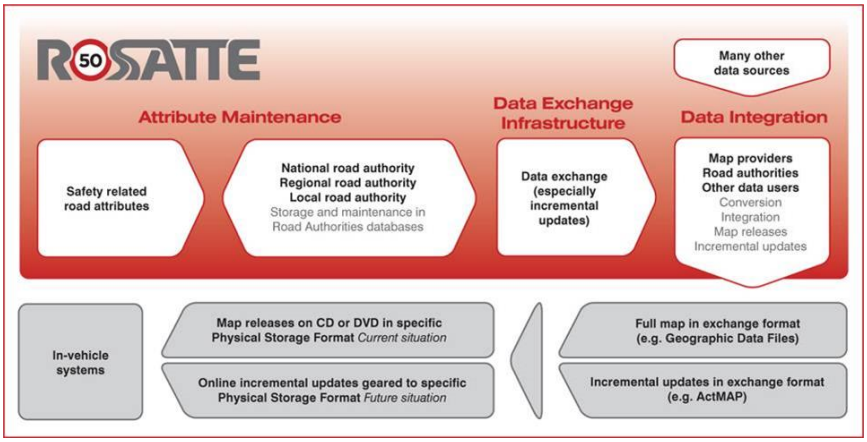


Figure 3: The ROSATTE Data Chain shown shown in the red box.

As a follow up of the ROSATTE project, the eMaPS project (FP7, eSafety Digital Maps Public Private Partnership Support, 2011-2012) was launched to establish an independent public-private implementation platform, the “ROSATTE Implementation Platform” as an enabler for implementation of actions 1.2 “Collection and provision of road data” and 1.3 “Accurate Public Data for Digital Maps” of the ITS Directive. Led by the Norwegian Public Road Administration, eMaPS used the recommendations from the ROSATTE project and kept the original ROSATTE team of experts together to support newcomers from public road sector. The ROSATTE Implementation Platform was later renamed to the “TN-ITS platform”.

2.1.2 TN-ITS data chain and its evolution

The TN-ITS data chain has undergone a significant evolution during the TN-ITS GO project.

The following picture presents the data chain as it existed at the kickoff of the TN-ITS Go project:

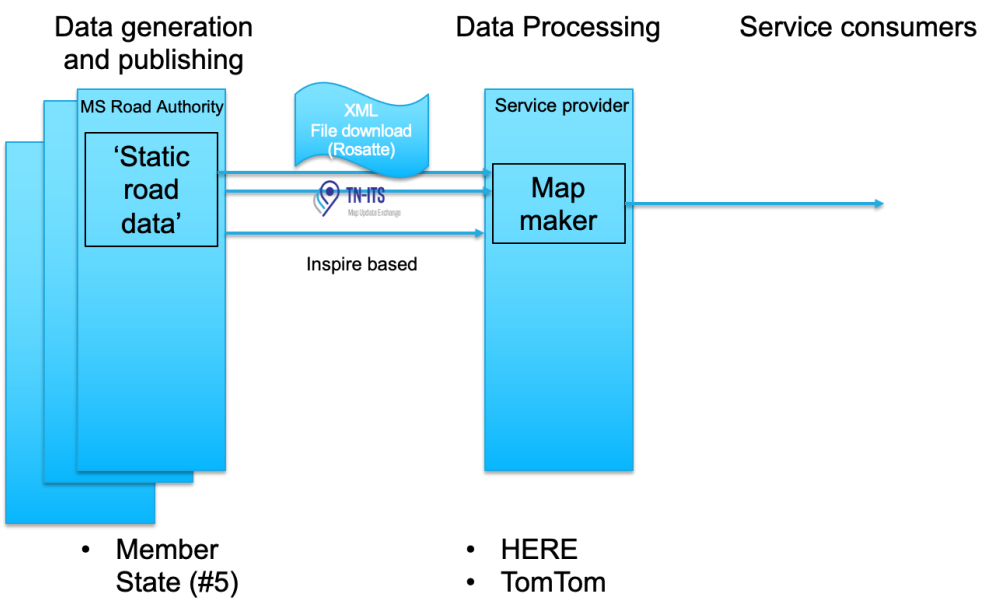


Figure 4: Initial TN-ITS data chain

This data chain is simple. Road Authorities generate the relevant infrastructure data (so called Static data[6]). The updates of this data are communicated by a simple xml file exchange over the internet to the service providers. In many cases these are digital map makers. The format of the XML is based upon ROSATTE which by itself is based upon INSPIRE[7] .

The TN-ITS Go project complemented this data chain with new functionality for automating the exchange of data via a developed API (Application programming Interface). TN-ITS GO also joined CEN TC278[8] as Liaison Organisation and moved away from the older ROSATTE specification. (see next chapter) The relationship with the well-known DATEXII data interchange methodology for traffic data became more clear. While TN-ITS focusses on 'base layer map data', DATEX II addresses the service layer, presented on top of the map base layer, using the so called 'dynamic road data'. TN-ITS Go gives proof that the exchange of data is also directly 'consumed' by parties such as other authorities, application providers and the open data community. The resulting situation is presented below:

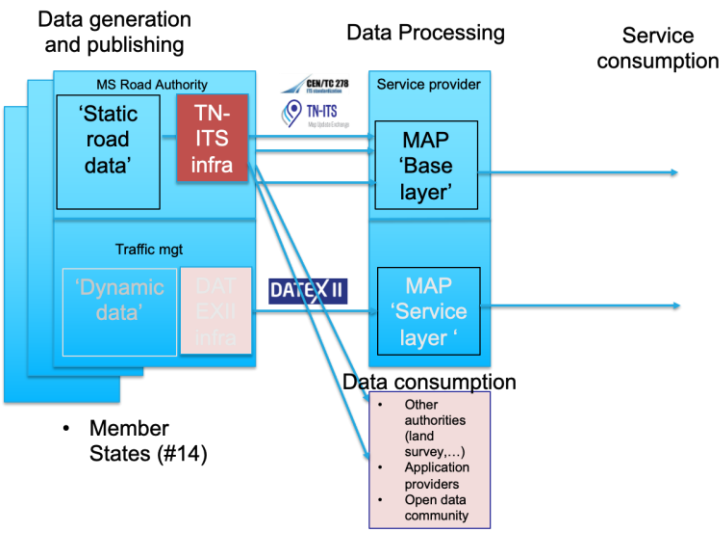


Figure 5: TN-ITS GO Data chain 2019

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[6] *The term 'Static data' refers to the EC commissions nomenclature as being applied in the RTTI delegated regulations. TN-ITS platform rather want to address this type of data as 'Base layer map data', as it is the data that enables map makers to product their digital maps , as a base layer for e.g. modern GPS equipment . (see also the webinar : How maps work: https://www.youtube.com/watch?v=-8XCrfeOFug&list=PL4LSYXNwsQOnxMckSlGJYiajh3LwWy_EH&index=6)*

[7] *The INSPIRE directive lays down a general framework for a spatial data infrastructure (SDI) for the purposes of European Community environmental policies and policies or activities which may affect the environment. The INSPIRE Directive entered into force on 15 May 2007.*

[8] *CEN/TC 278 manages the preparation of standards in the field of Intelligent Transport Systems (ITS) in Europe. It serves as a pl*atform *for European stakeholder to exchange knowledge, information, best* practices and experiences in ITS.

During the years 2019 and 2020, the role of the NAP (National Access point) as single interface for authoritative and private transport related data, being established in each member state, became more prominent, and a number of implementing Member States (TN-ITS GO partners) started publishing the availability of TN-ITS data via the NAP. At the same time the TN-ITS platform developed the TN-ITS feedback loop[9] function, a methodology to enhance the quality of the shared data and Comply with Delegated Regulation 2015/962 Article 4 Paragraph 2(d): "Road authorities, road operators, digital map producers and service providers using the static road data referred to in paragraph 1 shall collaborate in order to ensure that any inaccuracies related to static road data are signalled without delay to the road authorities and road operators from which the data originates".

At the same time, some of the member states also started developing supportive ICT tools, to enhance their own data generation in both quantity and quality. A good example of such a tool is the Flemish MOVIN tool [10]

The final result of the established data chain at the end of the TN-ITS Go project can be illustrated by the following picture:

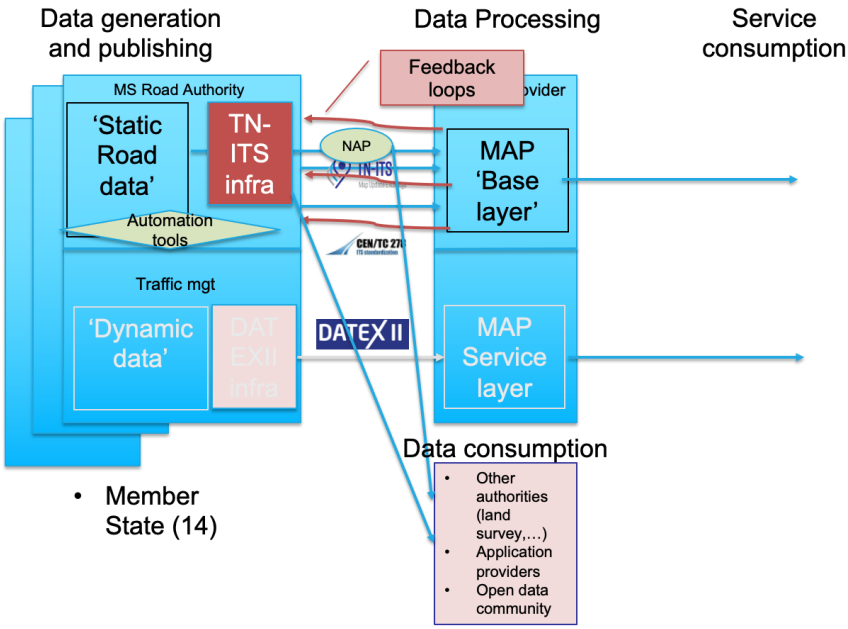


Figure 6: TN-ITS data chain at the end of TN-ITSGO project 12/2021

This schematic is the reference for further analysis in this document

2.1.3 Progress over ROSATTE

A first aspect of the progress over ROSATTE is that the scope of the content that is specified and that is made available over a standardized TN-ITS interface has widened. Whereas in the ROSATTE era the perspective was very much on the data chain for supporting road attributes

[9] *see further in this deliverable for a more in depth description of the feedback loop*

[10] https://verkeersborden.vlaanderen/MOVIN.php

which have a direct relevance for road safety – hence the use of the name “safety attributes - in TN-ITS, a broader view was adopted. Hence, TN-ITS captures the exchange of road attributes which have impact on a much broader usage in Intelligent Transportation Systems, e.g. by including information related to parking, charging, fuel types, emission classes, etc.

Another signification area of progress is the improved discoverability of TN-ITS services. This is realized via the National Access Points programme in Europe. After the ROSATTE project, the existence and availability of operational road data exchange services, e.g. in Sweden, Finland, Flanders etc, was not very visible. As mentioned above, it took the eMaPS project to set up the TN-ITS platform to ensure that the operational TN-ITS services could be discovered more easily. With the EU EIP activity on National Access Points in the field of mobility in Europe, operational TN-ITS services are now exposed even better via web-based portals. By the end of the TN-ITS GO project, 9 TN-ITS services can be discovered on the NAPs. It is expected that this number will quickly grow so that all operational services are available via the NAPs.

Whereas in the ROSATTE era the typical data providers to share road attributes were limited to the federal or regional road authorities, in the late TN-ITS period, we see and will see even more data owners setting up TN-ITS services. Examples are city authorities and (possibly) road operators. After the TN-ITS Goes Urban session at the ITS World Congress in Hamburg, the TN-ITS management was made aware of the intentions of several cities in Europe to set up TN-ITS data sharing services.

Another area where progress can be identified is the so called “Feedback loop”. Although not shown on the figure 3, the opportunity for data receivers to provide feedback to data providers was already described in the ROSATTE technical specifications, no implementations were realized in that time. Since TN-ITS, this feedback loop has received more attention and represents an important concept for data providers to be informed about the actions and experiences of the data users. Far more important than the technical aspects, the discussion on exactly what to provide as feedback, and if/how that feedback is to be made available (including the sharing to other parties), is subject of debate between the many stakeholders. See, for example, the revision by the Commission of the Delegated Regulation on Real Time Traffic Information RTTI where an important part of that revision addresses the G2B sharing of mobility data.

The emergence of connected automation in transport, digital twins, etc. means that the TN-ITS data chain will be an essential component in an even wider ecosystem of systems and services requiring trusted base map layer information. This will be discussed in the chapters below.

2.2 Identification of the actors

List and describe all the actors involved in the data chain and the other stakeholders

Data provider	Data access enabler	Data consumer
Regulatory bodies: - National Road authorities	Main target: - NAPs for RTTI	- Map and service providers

- Regional Road Authorities - Local authorities (cities, municipalities, counties) Other: - Concessionaires (i.e. private road operators)	Other/Phasing out: - Open data platforms Future possibilities: - (private) Data marketplace (currently legal and commercial barriers to that)	- Land surveying and cadastral - App developer (start-ups) - Data brokers - Open data - Regulatory bodies and public authorities (internal consuming) - Vehicle manufactures and TIER1 suppliers

Other stakeholders, not linked to the data chain but influential in the process:

Road safety associations:

- EuroRAP
- ETSC
- VIAS

Consumer organisations:

- EURO NCAP

Platforms and partnerships:

- CCAM single platform

ICT suppliers:

- MS subcontractors
- Coding companies

2.3 Identification of data sources

Where is the data coming from?

- Currently, the data is coming from regulatory bodies (trust)

Currently the following methodologies are used to populate the databases

- Apps:
  - Like the Movin' app (FL-BE)
  - The Hungarian application on smart mobile devices
- Hand-filled database and digitalisation of maps:
  - user interface within the road authority to be used when regulation change
- People reporting information:

    - citizens in case of information mismatch (i.e. wrong speed limit on the street)
- Buying of commercial maps if possible

Other (future) possibilities:

- Sensors
- IoT devices
- ID devices

3 Data Chain Requirements

The table below gives an inventory of the top-level requirements that can be imposed to the different functions, identified in the data chain:

Stakeholder	Data chain function	Aspect	Requirement
Authority	Data (regulation data...)	Trustable	Credibility, reliability, or reputation
		Secure	Access rights, modifiction/read /write /personnel code/...
		Authenticity & Authentication	Authority by regulation?
		Quality	Correctness
			Completeness or comprehensiveness
			Consistency, coherence, or clarity
			Accuracy
			Timeliness and/or low latency (freshness)
			Validity or reasonableness
		Compliance to specification	CEN based formats
		Documented	
		Performance	Geo coverage representation
			Road attribute coverage
			Sccessibility
			Availability
			Update frequency
	MS database	Secure	Protection against attacks
		Access rights	
		Quality aspects	
		Data integrity	
		Unique identifier ?	
		Time management : beginLifeSpanVersion, endLifeSpanVersion	
	MS ICT infra	itil?	
	MS TN-ITS infra	Service compliance according TN-ITS API	
	Automation tools data/Capturing population	Accuracy	Geolocation, validity time, Time stamp
		Correctness	
		Authorised personnel	
Comms	Comms channel	Can be any	Integrity
		https? File download	Encryption
Service provider		Authorised personnel ?	
		Secure environment?	
		Perormance.when is the map ready?	

Table 1: Inventory of requirements

4 Methodologies to fulfil the requirements

The following table complements the table 1 with the insights generated by the project partners on potential tools and methodologies that could be used to fulfill data chain requirements, imposed at each function.

Stakeholder	Data chain function	Aspect	Requirement	Actual status TN-ITS GO	Potential tools and methodologies as solutions for the requirements	Details	Potential further actions	Comments	Advice Recommendations
Authority									
	Data (regulation data...)	Trustable	credibility, reliability, or reputation		Watermark/logo//based on all other aspects below.	Creation of a watermark within the TN-ITS forum, Deploying the watermark is MS -should be on feature level- marketing	To be worked out in NAPCORE		
		Secure	Access rights, modifiction/read /write /personnel code/...		Local MS to organise the security aspects and service level agrrements with subcontracts	What is the role of the NAP, Secure data piping is necessary/Cfr MDM Germany (security certificates/Who is using the data// NAP needs registration tools and authenticity tools	Should we provide guidelines?-Are their tools ?	License is open data , but data users needs registration-subcription based, authentication needed	Advice not to be encrypted data because of size ,(latency/too complicated
		Authenticity & Authentication	Authority by regulation?			See above			
		Quality	Correctness	Syntax, Symantics & fit with the reality is lacking	Feedback loop--correctness on syntax (today)--Manual process (Validation tool)-	The fit with reality is lacking ? --SENSORIS ?-payd service by the service provider-collaborative tool for citizens (Like Waze,...)	Correctness should be checked at creation level		
			Completeness or comprehensiveness	We lack the overal regulation (METR?)		See above			
			Consistency, coherence, or clarity			See above			
			Accuracy	Geolocation , validity, the right info		See above			
			Timeliness or latency (freshness)		Improve the procedure throughput time to go from the initial regulation towards publishing the related digital dataset	Provide guidelines, metadata description, last changed timestamp/ Operational excellence label		To be worked out and be concsious on time scale and resources.-- benchmarks on aggregated level? (Austria that creates regulation and immedieatly the data related to it	What tools are availble//We do have finding and inspring examples--example UK
			Validity or reasonableness			Validy time stamp is available in TN-ITS Go (occasonally)- imposed -	To be worked out in NAPCORE		
		Compliance to specification	CEN based formats		Feedback loop	Validation tools (HERE-TomTOm) available			
		Documented			MUST				
		Performance	Geo coverage representation	Scope is Ten T	% of network	Revision of RTTI delegated act says only primary roads			
			Road attribute coverage		% of the list of manadatoryattributes	RTTI delegated act revision			
			Accessibility		NAP				
			Availability						
			Update frequency		Version mgt of spec-- Related to CEN and the commissionm				

Stakeholder	Data chain function	Aspect	Requirement	Actual status TN-ITS GO	Potential tools and methodologies as solutions for the requirements	Details	Potential further actions	Comments	Advice Recommendations
Authority (continued)	MS database	Secure	protection against attacks		Should be easy for data users/Should be uniform across EU	Best practice guidance inpires by the MS--state of the art			
		Access rights							
		Quality aspects							
		Data integrity							
		Unique identifier ?	cfr Visual progress monitor						
		Time management : beginLifeSpanVersion, endLifeSpanVersion	cfr Visual progress monitor						
Authority (continued)	MS ICT infra	itil?							
	MS TN-ITS infra	Service compliance according TN-ITS API			Feedback loop				
	Automation tools data/Capturing population	Accuracy	Geolocation, validity time, Time stamp						
		Correctness							
		Authorised personnel							
Comms	Comms channel		Integrity						
		https? File download	encryption		Checksum/data catalogue /Automated end to end system				
Service provider		Authorised personnel ?							
		Secure environment?							
		Perormance.when is the map ready?			Service level agreement	Benchmarking? OEMS?			

Table 2: Tools and methodologies

The EU-EIP has published extensive analysis on Data quality tools and methodologies[11]. These will be further analysed during the SWG4.2 NAPCORE project tasks (see chapter 7)

[11] https://www.its-platform.eu/filedepot/folder/1077?_ga=2.175419234.1564374708.1639731317-1675848423.1639731317#

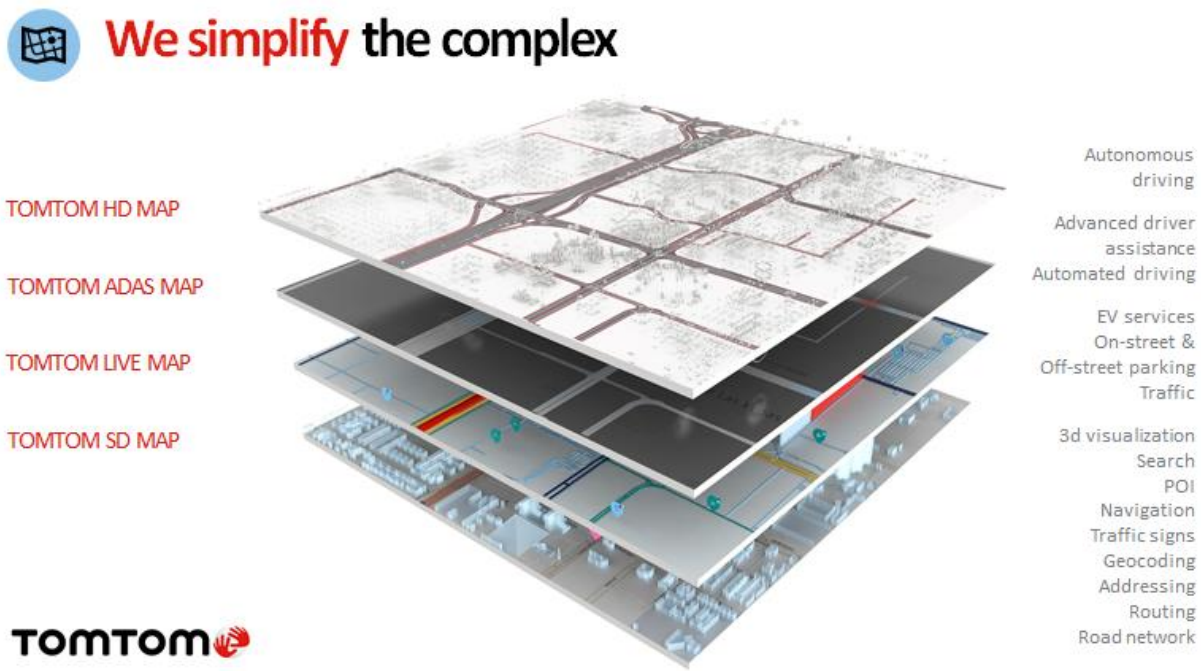
5 Case Studies (applications)

This chapter introduces a number of interesting applications, based upon TN-ITS data. A short description of the application is given. We elaborate on the relation between the application and the TN-ITS data chain.

5.1 Producing digital maps

We refer to the TN-ITS webinar on the subject: reference[12]

The structure of digital maps is based on different layers. Underlying for all services is the Standard Definition (SD) Map which provides all relevant information on Traffic Signs and Geometry relevant for Navigation Applications. All more enhanced services are built on top of the SD Map.



TomTom©

Figure 7: Map layers (Source TomTom)

5.1.1 Description

The production and updating process has several steps:

Step 1: Aware, detect, capture:

[12] https://www.youtube.com/watch?v=-8XCrfeOFug&list=PL4LSYXNwsQOnxMckSlGJYiajh3LwWy_EH&index=6

Detection and capturing of data is the first step. There are different sources which are giving input to digital maps. To get data with a high spatial accuracy, for example for High Definition / Detailed (HD) Maps, Mapping companies are actually using cars equipped with a 360 degree camera system and Lidar. Those cars are highly equipped and are used for dedicated drives to produce and update HD Maps. Below two examples of mobile mapping system from TomTom and HERE:

Figure 8: Illustation of capturing map related data (source TomTom)

The captured data from mobile mapping systems is then semiautomatic analysed to detect changes in the Road Infrastructure.

Probe, sensor data, media monitoring and governmental sources to provide near real time updates.

Probe data helps to identify changes in speed limits, driving restrictions and direction of travel.

Sensor data, especially camera sign detection is helping to detect in real time changes of road signs, this process is only in the beginning and there are still a lot of challenges in processing the data to retrieve reliable information on changes, e. g. supplemental sign text cannot yet be analyzed in an automated way. This data is also dependent on the size of the fleet, as only a large database of sensor data can give reliable information (detection and validation)

Media monitoring is the third pillar. Mapping companies are using several algorithms to capture and detect publications on Traffic Regulation Orders or new build roads. For this purpose different websites are monitored in an automated way and delivers hints to changes in the road infrastructure. This process is not fully automated and needs a lot of resources to capture and ingest the changes to digital maps. This process is of detecting changes needs a lot of efforts on the map maker side and makes it difficult to catch all changes in the time and completeness needed for several automated driving use cases.

Governmental Sources are seen as one of the most trusted data sources, because public authorities can capture the changes by digitizing their road infrastructure. When available, those sources are used and highly appreciated by producers of digital maps. The availability of governmental sources is very fragmented across Europe and sources are available on different administrative levels (from municipality to country) and data formats. TN-ITS and its

deployment in the member states plays therefore the utmost important role as the future source for map related data

The variety of different sources are the foundation of the map making process and essential for the quality of maps. The great challenge for Map Makers is managing and orchestrating all different sources to get a real-world representation of the road infrastructure.

Step 2: Extract

Next step after capturing is to extract the different sources, normalize the data to internal map specifications and features, like road signs or geometry.

Step 3: Process the data

Data is ingested and processed through a combination of automated and manual methods. Before publishing, the map edits run through several validations to ensure consistency of the database.

Step 4: Publish

Last step is updating the database to enable various services and solutions and bring the data to the road user.

See below an overview of the map making process

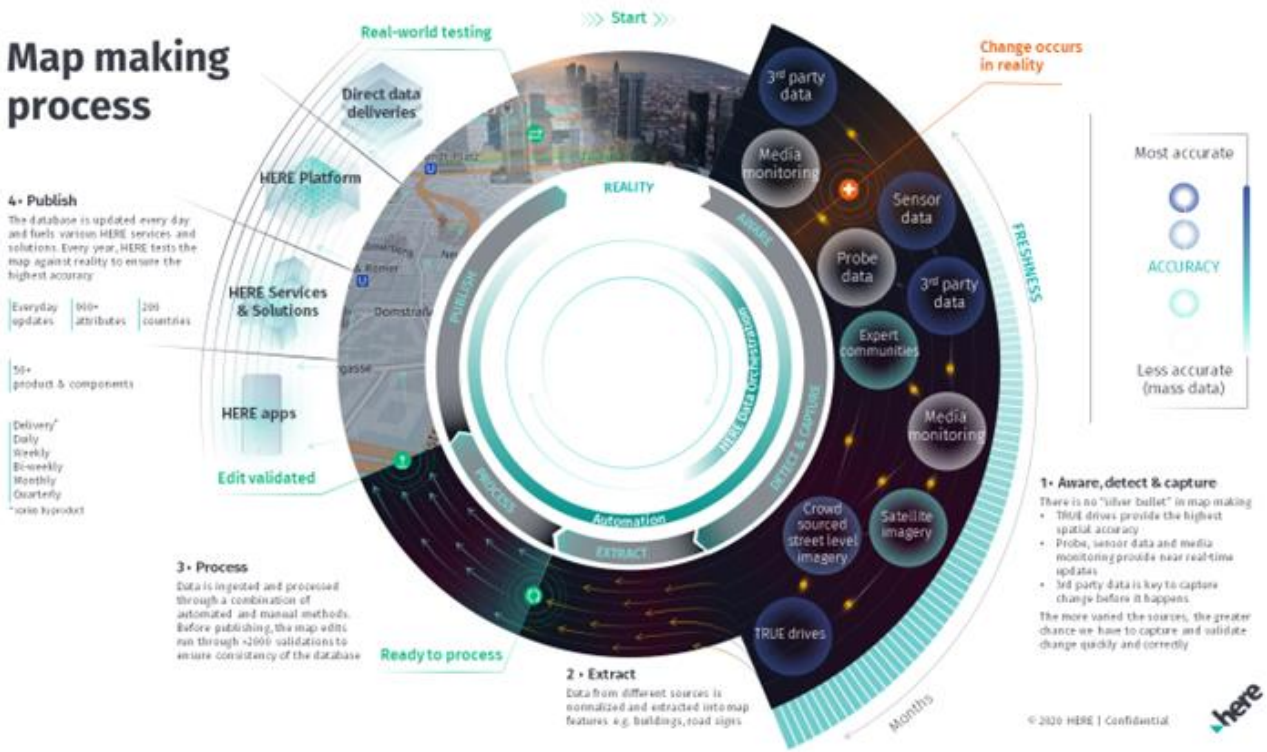


Figure 9: The complete production process (Source HERE)

5.1.2 Relevance to the TN-ITS Data chain

The digital map creation was the original driver to start up and deploy the TN-ITS. It is clear the availability of authoritative data originating from the (Member State) authority is greatly under the attention of these service providers. It will indeed reduce a lot of production cost at their side, and at the same improve the freshness, and accuracy of the map data.

Today, the availability of digital map related data, sourced from the various other sources forms by far the main content of the digital maps. However, the user is fully dependent on the performance of the service provider. Differentiations in products, their performance and quality depend fully on the realised data bases at the service providers.

The availability of such third-party data is still of great value, also in relation to the TN-ITS data chain. Indeed, TN-ITS has developed the so called 'feedback loop' that feeds a quality report on the exactness of data back to the publishing authorities. Today, the feedback loop is limited to a 'simple' syntax check, checking on the right <XML> structures of the exchanged data. The obtained third party data, available at the service providers could however be a great source for a more elaborate 'semantic' check of the exchanged data by the authorities.

5.2 ISA[13]

ISA as an application is fully in focus of TN-ITS, in line with the EU vision on SAFETY and the European strategy 'Vision Zero'. [14]

This topic is extensively addressed in the webinar "How TN-ITS can support ISA: an interactive webinar", recording available.[15]

5.2.1 Description

TN-ITS is a main tool for road authorities to publish their authoritative 'trusted' data to allow applications to inform and 'impose' e.g. speed rules towards traffic users (car-drivers); speed being a major cause of accidents.

Analysing the document COMMISSION DELEGATED REGULATION (EU) 2021/1958
Of 23 June 2021 [16], the following statements relate to the use of digital maps in relation to the ISA:

---

[13] ISA: Intelligent speed assistance
[14] https://ec.europa.eu/transport/themes/strategies/news/2019-06-19-vision-zero_en

[15] https://www.youtube.com/watch?v=TG9fwmJJ9AY; https://www.tn-its.eu/news/tn-its-go/how-tn-its-can-support-isa-an-interactive-webinar

[16] CELEX 32021R1958 : https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1958&from=EN

(Statement 4) The ISA system may rely on various input methods, such as camera observation, map data and machine learning, however, the actual presence of real-world explicit numerical speed limit signs, should always take precedence over any other in-vehicle available information.

(Statement 6) The ISA systems may be faced with ambiguous speed related information due to missing, vandalised, manipulated or otherwise damaged signs, erroneous sign placement, inclement weather conditions or non-harmonised, complicated and implicit speed restrictions. For this reason, the underlying principle should be that the driver is always responsible for adhering to the relevant traffic rules and that the ISA system is a best-effort driver assistance system to alert the driver, whenever possible and appropriate.

(Statement 12) ISA systems may use map data to ensure appropriate performance during real-world driving. However, there should be no obligation to require that the map data is of such detail and quality that turn-by-turn navigation is possible, given that it could also suffice to incorporate only coordinates of urban and non-urban areas, as well as for main expressways and motorways.

(Statement 13) Member States are encouraged to facilitate the better performance of ISA systems in real-world driving by ensuring the correct placement of explicit numerical speed limit signs on streets and roads and the clear identification with start and end signs of all speed zones, expressways and motorways. In certain cases, intersections and merging streets or roads are not clearly recognisable to drivers and thus challenging to interpret for ISA technologies. For this reason, placement of explicit numerical, implicit numerical or implicit non-numerical speed limit signs at such locations is necessary to ensure consistent performance of ISA systems installed in motor vehicles circulating in the Union.

(Statement 14) It is however clear that systems employing a combination of a camera system, Global Navigation Satellite System (GNSS) and up-to-date digital maps are considered the state-of-the-art systems with the greatest real-world performance and reliability.

5.2.2 Relevance to TN-ITS data chain

In the next table we analyze the importance of the requirements of the data chain functions in relation to the statements in the regulation. The table indicates by color codes the importance of each requirement. This analysis is based upon the following deductions from the statements:

Statement 4 states that the physical sign is predominating, meaning that from a digital point of view, we can moderate the imposed requirements on the related TN-ITS data chain functions.

Statement 6 recognizes however that the physical infrastructure is not always up to date, and that finally the driver is responsible to know what rule is valid. The information on the digital map is therefore a good support to inform the driver about the momentary valid regulation. Since the driver remains the responsible, all liability relates to him and not to the supportive information systems. Therefore, the imposed requirements can be moderated. Given these statements, it is unlikely that authorities will invest a lot in ensuring to cope with the full data chain requirements when implementing TN-ITS.

Statement 12 states that map data MAY be used. It also states that the importance of correctness and completeness is not a main goal. Given these statements, it is unlikely that

authorities will invest a lot in ensuring to cope with the full data chain requirements when implementing TN-ITS. Finally, the interest of the authority to implement the TN-ITS services is determined by the demand in the market (OEM)

Statement 13 indicates that the physical environment is not complete and that additional investments are needed to ensure that ISA can work properly. These investments can be high as a lot of physical work has to be carried out. Applying this recommendation in the digital world would greatly minimize cost, introduction time, greatly improve accuracy and effectiveness. So, this statement can be the basis for a positive driver for an authority to invest in performant TN-ITS. Services.

Statement 14 recommends the use of digital maps as a complement to other systems to implement ISA as a state of the art. It is however unclear to what extend the map should support the other systems, probably depending on the interpretation and implementation by the car OEMS. This imposes a kind of uncertainty to the authority on how it should interpret the importance of accurate and up to date digital map data and therefore greatly moderates the requirements and the appetite to invest a lot in the service

As a conclusion the following table is presented on how ISA impacts the adherence to the implementation and to the further investments needed to improve on the TN-ITS data chain requirements.

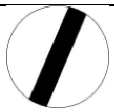
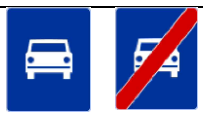
Color code:	Not important	Somewhat important	Important					
				Statements in COMMISSION DELEGATED REGULATION (EU) 2021/1958				
Stakeholder	**Data chain function**	**Aspect**	**Requirement**	**4**	**6**	**12**	**13**	**14**
Authority								
	Data (regulation data...)	Trustable	credibility, reliability, or reputation	Not important as the main trust is the physical sign	Not important as the driver is responsible	Depends on market interest		Depends on market interest
		Secure	Access rights, modifiction/read /write /personnel code/...	Not important as the main trust is the physical sign	Not important as the driver is responsible	Depends on market interest		Depends on market interest
		Authenticity & Authentication	Authority by regulation?	Not important as the main trust is the physical sign	Not important as the driver is responsible	Depends on market interest		Depends on market interest
		Quality	Correctness					
			Completeness or comprehensiveness					
			Consistency, coherence, or clarity					
			Accuracy					
			Timeliness or latency (freshness)					
			Validity or reasonableness					
		Compliance to specification	CEN based formats					
		Documented						
		Performance	Geo coverage representation					
			Road attribute coverage					
			Accessibility					
			Availability					
			Update frequency					
	MS database	Secure	protection against attacks					
		Access rights						
		Quality aspects						
		Data integrity						
		Unique identifier ?						
		Time management : beginLifeSpanVersion, endLifeSpanVersion						
	MS ICT infra	itil?					?	
	MS TN-ITS infra	Service compliance according TN-ITS API						
	Automation tools data/Capturing population	Accuracy	Geolocation, validity time, Time stamp					
		Correctness						
		Authorised personnel						
Comms	Comms channel		Integrity					
		https? File download	encryption					
Service provider		Authorised personnel ?						
		Secure environment?						
		Perormance.when is the map ready?						

Table 3: Impact of ISA regulation on the data chain requirements

The Commission Delegated Regulation (EU) 2021/1958 of 23 June 2021, laying down detailed rules concerning the specific test procedures and technical requirements for the type-approval of motor vehicles with regard to their ISA systems, includes in their Annex II a catalogue of road signs which need to be supported by camera based ISA systems for type approval. Figure

10 illustrates which traffic sign information (signs & road attributes) is supported by the technical specification of TN-ITS

Given the very recent publication of the regulation document (17-11-2021) it is unclear what the implementation status is of the data in the existing MS TN-ITS services. Today, operational and pilot TN-ITS services in Europe expose this information either via (changes of) traffic sign as point features or as (changes of) road attributes as line features. Member States have a choice what and how ISA relevant information is shared. We will address this later in the SWG4.2 NAPCORE project (Chapter 7) as part of the Member State assessment task.

ISA Delegated Regulation 2022: Speed Catalogue (Annex II)	Examples (Traffic signs)	CEN TS 17268:2018 TN-ITS Covered
Explicit numerical Speed Limit sign		Full
Variable Message Sign		Full
Implicit numerical Speed Limit sign		Full
Numerical Zone		Full
Traffic-reduced area		Yes (residential areas/pedestrian area) No (in prep.): bicycle priority street No (in prep.): bicycle zone
Motorway		Full
Expressway		Codelist extension in preparation

City Limits		Full “Built-Up area”
Not mentioned in Annex II		Full Advisory Speed (as road attribute)
Not mentioned in Annex II		Full : Compulsary Minimum Speed (road attribute)

Figure 10: TN-ITS CEN TS17268 supports the Annex 2 ISA Delegated Regulation (2022)

5.2.3 Conclusion

There is concern that ISA as an application and the ISA Delegated Regulation will drive the European road authorities to primaraly invest in the physical infrastructure and thereby will neglect further and enhanced development and deployment of TN-ITS services that should respond to the identified data chain requirements. Additionally, the revision of the ITS Directive (https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM%3A2021%3A813%3AFIN) which proposes, in their list of data types for static (and dynamic) traffic regulations in Annex III, that speed limit information should be made available for the entire road network of the EU, that is publicly accessible to motorised traffic by the end of 2028, does not significantly encourage a faster deployment of TN-ITS services by MS.

5.3 Digital twins

Digital twins are virtual representations which model the real-time digital counterpart of physical objects or processes and enable decision support systems, they assist asset management operations, they support monitoring and visualisations, and also enable new real-world constructions to be developed and operated more efficiently, saving time and money.

5.3.1 Description

Particularly relevant for TN-ITS are the digital twins that model a road infrastructure network or an urban area/environment.

Digital maps, in the form of 3D (vector) models representing the road and the roadside environment are a key component of a base layer of spatial data that constitute a digital twin for the road infrastructure. They find their use in C-ITS, traffic information and control centres, vehicles, etc and support navigation, traffic management, cooperative and connected ITS applications, etc. All of these applications require a map base layer which accurately reflects

reality (and/or some goal state to be used in simulations and predictions). TN-ITS is crucial in the maintenance of such base layer map in Europe as it supports map and service providers with a harmonized interface to authoritative, therefore trusted, changes of road attributes.

In recent years, the concept of Urban Digital Twins representing entire cities and regions has gained increasing attention. Such Urban Digital Twin are used to get insights in the current state of the physical entity as well as predict future states of the physical entity through causal data models and simulation algorithms. Hence, Urban Digital Twins are cross-domain urban decision support systems. The link from the real world city to the Digital Twin relies upon a continuous feed of data sourced with multiple data collection techniques and devices (e.g. IoT). This data allows the virtual Digital Twin to constantly learn from - and evolve along with- its physical counterpart, mirroring its lifecycle. For more information on urban digital twins see reference[17].

5.3.2 Relevance to the TN-ITS data chain

A digital map of the road network and its close environment is an essential component of a static virtual representation of a city or a transportation network, next to, e.g. building information models (BIM) and statistical information as demographic data, etc. Maps also bring the spatial framework for dynamic data (e.g. (vehicle) sensor data, IoT data, traffic information). Maps bring location awareness by supporting georeferencing and (reverse) geocoding, traffic modelling, route planning and navigation, etc and enable data dashboards, human based and automated decision support systems. Given their role as a spatial framework, their maintenance via a standardised interface with trusted authoritative data is indispensable. This is the domain of TN-ITS.

5.4 Automated Mobility

As TN-ITS moves along its roadmap[18], an important focus is on the ongoing automated mobility developments. TN-ITS updates the authoritative data, from nature issued by the authority and therefore the important requirement of 'trusted' data is already partly fulfilled, as the authority itself is the core of the trust. It is envisioned that the TN-ITS data can be used as 'regulatory data' representing the traffic regulations, imposing e.g. automated vehicles to adhere to these regulations. This subject is out of scope of TN-ITS GO but will further taken up in the NAPCORE (Chapter 7) project tasks. Still, it is interesting to list the actual actions,

[17] The Open Urban Digital Twin see paper T. Coenen, imec-EDIT, et al. 2021: https://vlocavis.z6.web.core.windows.net/Urban%20Digital%20Twins.pdf

[18] Roadmap TN-ITS : https://tn-its.eu/storage/uploads/documents/2021/12/17/TN-ITS-roadmap-2020-11-18.pdf

going on in Automated mobility and to analyse the relation with TN-ITS and the impact on the TN-ITS data chain requirements.

The chapter describes the current automated mobility platforms and actions and then summarizes the relation to TN-ITS.

5.4.1 CCAM[19]

In March 2019 the CCAM Platform an expert group on cooperative, connected, automated and autonomous mobility was launched by the European Commission (DG Move).

The mission of the CCAM is to provide advice and support to the Commission in the field of testing and pre-deployment activities for Cooperative, Connected, Automated and Autonomous Mobility (CCAM). (see reference)[20]

Four main tasks were identified:

- Assist the Commission in relation to the implementation of existing Union legislation, programmes and policies
- Coordinate with Member States, exchange of views
- Other: the group shall assist the Commission in the following CCAM related thematic areas:
    - The coordination of CCAM research, testing, piloting, and pre-deployment activities, herein collectively referred to as “testing and pre-deployment activities”, to increase efficiency and effectiveness, and to integrate existing fora at EU-level.
    - Within the scope of testing and pre-deployment activities, there are important challenges towards the deployment of CCAM that the group shall address, such as those pertaining to data access and exchange, road transport infrastructure, digital infrastructure, communication technology, cybersecurity, road safety, and legal frameworks, etc.
    - In its Communication, the European Commission also announced that it would be establishing a partnership under the next European multiannual financial framework to give a clear long-term framework to the strategic planning of research and pre-deployment programme on driverless mobility at EU
- Provides expertise to the Commission when preparing implementing measures, i.e. before the Commission submits these draft measures to a comitology committee

[19] Co-operative Connected automated mobility platform
[20] (Website of the European Commission, DG Move, Dec. 2021 https://ec.europa.eu/transparency/expert-groups-register/screen/expert-group/consult?do=groupDetail.groupDetail&groupID=3657)

The CCAM Platform was organized the work in 6 subgroups

- WG 1 - Develop an EU agenda for testing
- WG 2 - Coordination and Cooperation of R&I
- WG 3 - Physical and Digital Infrastructure
- WG 4 - Road Safety
- WG 5 - Access to and exchange of data & Cybersecurity
- WG 6 - Connectivity and Digtal Infrastructure

Mainly the WG 3 on physical and digital infrastructure is identified as relevant for TN-ITS. In June 26th, 2019 TN-ITS GO was presented to the WG3 and discussed with relevant stakeholders.

Outcome of WG 3 on physical and digital Infrastructure is a list of relevant physical and digital attributes with a prioritization and related use case.

As one important element horizontal signs have been identified and are part of the physical and digital infrastructure (PDI) attribute list.

Physical attribute (equivalent)	Digital attribute (equivalent)
Horizontal Traffic Signs, Lane markings (for human, video and lidar sensors), Special road markings for road works (Yellow), events, etc.	**Element in HD map / C-ITS message (MAP), incl. number and type of lane (e.g. bus, taxi, cyclist, etc)**

Table 4: From the final PDI Matrix of CCAM WG 3 on physical and digital infrastructure.

5.4.2 C-ITS platform[21]

The European Commission decided early in 2014 to take a more prominent role in the deployment of connected driving by setting up a Cooperative Intelligent Transport Systems (C-ITS) Deployment Platform. The Platform was conceived as a cooperative framework including national authorities, C-ITS stakeholders and the Commission, to develop a shared vision for the interoperable deployment of C-ITS across the EU. It provides policy recommendations for the development of a roadmap and a deployment strategy for C-ITS in the EU and identifies potential solutions to some critical cross-cutting issues.

In the frame of supporting the deployment of C-ITS on European roads, there are a number of C-ITS real-life pilot projects funded under TEN-T and CEF which will create new C-ITS services for all of Europe's road users. These projects will test vehicle-to-infrastructure and vehicle-to-vehicle interactions by using both short-range and cellular communications.

[21] Source: https://erticonetwork.com/european-commission-releases-c-platform-phase-ii-final-report/

By endorsing the Final Report of the first phase of the C-ITS Platform on 21 January 2016, the C-ITS Platform achieved its first milestone towards deploying connected and automated vehicles across the EU. Based on this report, the Commission prepared the European strategy on Cooperative Intelligent Transport Systems.

The second phase of the platform (2016-2017) further develops the shared vision for the interoperable deployment of C-ITS.

This includes the progress made in defining implementation conditions for topics already discussed during the first phase. The Working Groups on Security, Data Protection, Compliance Assessment and Hybrid Communication have all worked on issues that are essential to the interoperability of C-ITS deployment and therefore relevant for the preparation of Delegated Act(s) for C-ITS.

5.4.3 C-Roads Platform

The C-Roads Platform[22] is a joint initiative of 18 European Member States and their road operators for piloting and deploying C-ITS services focusing at cross-border harmonisation and interoperability. The C-Roads Platform is an authority driven platform, bringing Member State Authorities and Road Authorities together with the aim to deploy interoperable C-ITS services across Europe. Initiated by eight Member States, the C-Roads Platform is open for other Member States as well. Austria, Belgium/Flanders, Belgium/Wallonia, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden and United Kingdom are currently represented as Core Members, with their own C-ITS pilot deployments, either in place or in preparation. Additionally, Associated Members are linked to the C-Roads Platform, liaising with the different groups within the Platform and committing themselves to use C-Roads specifications in their pilot implementations.

Common technical specifications, including the common communication profiles, are developed, shared and published on this platform. Intensive cross-tests are done and performed to verify interoperability. In addition, system tests are undertaken based on the common communication profiles by focusing on hybrid communication mix, which is a combination of ETSI ITS-G5 and operational cellular networks.

The C-Roads Platform remains open for interested authorities. The C-Roads Platform Agreement forms the basis for the cooperation for both, Core Members as well as Associated Members. The service harmonization is one of the core topics in the C-Roads Platform. On car side and on infrastructure side, all (triggering) conditions need to be harmonised. For this reason, one of the first topics is the agreement on a commonly used C-Roads infrastructure communication profile, starting with ITS-G5 and followed by hybrid communication.

[22] www.c-roads.eu

The main goals are:

- The main goal is to link C-ITS pilot deployment projects in EU Member States,
- To develop, share and publish common technical specifications (including the common communication profiles),
- To verify interoperability through cross-site testing,
- To develop system tests based on the common communication profiles by focusing on hybrid communication mix, which is a combination of ETSI ITS-G5 and existing cellular networks.
- The details of the day-to-day cooperation in the C-Roads Platform are laid down in the Terms of Reference (ToR) : https://ec.europa.eu/inea/sites/default/files/tor_c_roads_platform_final.pdf

The C-Roads Platform approach seeks cooperation at a holistic level in order to cover all of the dimensions linked to the deployment of C-ITS, such as sharing experiences and knowledge regarding deployment and implementation issues, as well as user acceptance. In order for this to work properly, a clear distinction is made between overarching platform activities and national pilots. The C-Roads Platform is managed by the C-Roads Steering Committee, which is made up of representatives from the Member States. Decisions to achieve the goal of implementing interoperable end-user services are made with the help of the Supporting Secretariat. In this context, specifications that are proposed and recommended by specific Working Groups are approved. These specifications are the basis for implementing use cases and providing services in the single pilot activities.

The success of the pilots depends on close cooperation and interdependencies between the five working groups.

ID	Name	Overarching Goal
WG1	Organisational aspects	• Analyze and describe the cooperation needed for the roll-out of C-ITS in different organisational environments in Europe. • Collect and investigate solutions to overcome known and newly identified legal barriers and obstacles (including privacy issues) related to C-ITS. • Connect to other Working Groups on strategies for attracting and involving end users. • Collect and exchange business models for the deployment of C-ITS infrastructures.
WG2	Technical aspects	*Consists of five Taskforces with the overarching goal to:*

ID	Name	Overarching Goal
		• Give recommendations on driver information through C-ITS services. • Harmonisation of current and future C-ITS services (Day 1, Day 1.5 and later). • Contribute to the definition and implementation of a harmonised communication profile for C-ITS pilot services on road infrastructures all across Europe.
WG3	Evaluation	• Transmit the achievements of the tasks completed in the other Working Groups to practical environments. • Define a methodology and performing cross-site tests all across Europe. • Assess the impact of the C-ITS services in terms of interoperability, but also regarding sustainability, safety, efficiency, and environmental aspects.
WG4	Urban C-ITS Harmonisation	• Enable a collaborative work towards strategies for the introduction of harmonised C-ITS services in urban areas. • Enable one interface with the OEMs facilitate support services delivered by city authorities.
WG5	Digital Transport Infrastructure	• Its aim is to identify and analyse the common digital transport infrastructure (DTI) elements and standards across the C-Roads Member States (MS) as well as present existing gaps which may hinder the overarching goal of C-ITS interoperability.

Table 5: C-Roads Working group's goals

WG2 – Technical Aspects – is the key WG to fulfil the harmonized functional, technical and process specifications of the C-Roads platform. This includes both specifications for procurement, operations and qualification of those parts of C-ITS for which interoperability is mandatory to realize a consistent and reliable operation of the services supported and being deployed throughout Europe.

The specifications and definitions being developed by WG2 and its Task Forces (TFs) will therefore create a secure, harmonised platform for interoperable C-ITS services across Europe. The delivery of services can only take place by specifying the requirements for the key elements of the digital/physical infrastructure for the exchange of data and C-ITS messages using available communication channels.

The TFs contain the main aspects of work within WG2 to reach the overall C-Roads objectives. Currently, within WG2, five TFs are put in place (with an option to have their tasks extended or to have further specialist groups added if required) in order to support and facilitate the technical aspects of interoperable pilot deployments. Table 6 presents the five Task Forces (TF) and their key responsibilities.

ID	Name	Responsibility
TF1	Security aspects	Define security specifications need to be considered by deploying C-ITS services to ensure secure data and service exchange between infrastructure and vehicles.
TF2	Service Harmonisation	Establish a common understanding of the functionality of Day-1-C-ITS-services, the underlying architectures and the responsibilities of all stakeholders.
TF3	Infrastructure Communication	Ensure the alignment of security specifications, different communication standards and technologies in order to ensure proper data exchange across various kinds of borders.
TF4	Hybrid Communication	Cater for long range communication and associated issues of handover between multiple communication channels.
TF5	Cross-Testing and Validation	Enable the execution of cross-testing and validation between two or more pilots.

Table 6: WG2 Task forces

Working Group 2 Task Forces

In alignment with WG2, WG5 will specify the physical and digital systems architecture needed to deliver the prescribed messages between various stakeholders over a secure communication channel. Furthermore, WG2 has formed a close alliance with the CAR-to-CAR Communication Consortium (C2C-CC) to ensure that standards are aligned between both parties to ensure consistency and interoperability.

5.4.4 Relevance to TN-ITS

The following table summarizes the combined C-Roads and CCAM use cases and their impact on TN-ITS, mainly related to the specification and data content. The analysis shows a ‘direct impact or relevance to TN-ITS, meaning that TN-ITS should (could) specify relevant data objects and attributes, as part of the specification to support the use case. The ‘indirect impact’

mentions that the feature can be supported by map information based upon ‘dynamic’ data information (Map Service layer)

Combined C-ROADS, CCAM, and Other Use Cases

	Service/Application		Use Case	Description	Communication Path	Source	TN-ITS relevant			
	Service: In-Vehicle Signage (IVS)						direct	indirect via map		remark
1			IVS - Dynamic Speed Limit Information (IVS-DSLI)	The road users receive in-vehicle speed limit notifications as they drive. The message subject is the dynamic speed limit given by the road operator.	I2V	C-Roads	1			
2			IVS - Embedded VMS "Free Text" (IVS-EVFT)	To display to the road user in-vehicle information of type "free text". The information will either reproduce what is displayed at a physical VMS (e.g. variable text panel) or display a completely new message that does not mirror a physical VMS (a virtual VMS).	I2V	C-Roads	1			
3			IVS - Dynamic Lane Management (IVS-DLM)	The use case is to inform road users of the status of the lanes (open/closed, normal, high occupancy vehicle (HOV) lane, bus lane or rush hour) of a road.	I2V	C-Roads	1			
4			IVS - Shock Wave Damping (IVS-SWD)	Providing I2V in-car information to avoid emerging or ideally even accomplish the elimination of shockwave situation in highway traffic.	I2V	C-Roads		1		
5			IVS - Other Signage Information (IVS-OSI)	To display signage information to road users other than the speed limit and free text information presented in previous use cases, e.g. bans on overtaking. The information will either reproduce what is displayed at a physical VMS (e.g. variable text panel) or display a completely new message that does not mirror a physical VMS (a virtual VMS).	I2V	C-Roads	1			
	Service: Hazardous Locations Notification (HLN)									
2			HLN - Accident Zone (HLN-AZ)	The road operator detects that an accident has happened on the network and broadcasts the information to road users who can benefit from this information.	I2V	C-Roads	1			Frequent accident location
3			HLN - Traffic Jam Ahead (HLN-TJA)	A road operator detects a traffic jam, and sends the information to the road user (mentioning the position, the length of the traffic jam and the section/ lanes concerned if the information is available).	I2V	C-Roads		1		
4			HLN - Stationary vehicle (HLN - SV)	Stationary Vehicle(s) service warn approaching drivers about stationary/broken down vehicles ahead, which may represent obstacles in the road. It is a preventive safety service, as drivers will have advanced notice and more time to prepare for the hazard.	I2V	C-Roads		1		
5			HLN - Weather Condition Warning (HLN-WCW)	Weather Conditions Warning (WCW) use case shows both static and dynamic information of weather conditions and road status in-vehicle. This service provides accurate and up-to-date local weather information. Drivers are informed about dangerous weather conditions ahead, especially where the danger is difficult to perceive visually, such as black ice or strong gusts of wind. Vehicles are sent information from roadside units warning the driver of dangerous, or changeable weather conditions. Alternatively, the messages may be transmitted via the cellular network.	I2V	C-Roads		1		
6			HLN - Temporarily slippery road (HLN-TSR)	The road operator knows that a section of a road (or a single lane or point) is temporarily slippery and sends thus information to the road user, or/and a vehicle detects that it is slipping and broadcasts an alert message to other vehicles. The combination of these two information sources within a C-ITS system makes it possible to generate much better information quality and accuracy compared to both single sources used up to now.	V2V, I2V	C-Roads		1		
7			HLN - Animal or person on the road (HLN-APR)	A road operator knows that one or several animal(s) is(are) present on the road network and broadcasts the information to road users, or a driver detects one or several animals on the road and signals that information via his HMI, broadcasting a message to road users, or both situations or warnings are combined.	V2V, I2V	C-Roads		1		
8			HLN - Obstacle on the road (HLN-OR)	A road operator knows that there is one or several obstacles on one or several lanes of his network and broadcasts the information to road users. However, traffic can still pass the obstacles (not a blockage).	I2V	C-Roads		1		
9			HLN - Emergency Vehicle Approaching (HLN-EVA)	The emergency vehicle is equipped with the necessary technology for a vehicle-to-vehicle (V2V) communication to send appropriate messages and alert the road users in advance.	V2V	C-Roads		1		
10			HLN - Emergency Vehicle in Intervention (HLN-EVI)	To warn drivers about the location (e.g. a traffic accident, rescue and recovery work) of an emergency vehicle in intervention so the drivers will be able to adjust their speed or lane position on the road. The equipped emergency vehicle is sending a warning message when the vehicle is stationary with an activated light bar and being stationary for more than the defined time period. Only the emergency vehicle equipped with the certified C-ITS unit is allowed to send the message.	V2V, I2V	C-Roads		1		
11			HLN - Railway Level Crossing (HLN-RLX)	The railway infrastructure manager or a service provider informs the driver about the presence of a railway level crossing and its type/parameters/status. This use case covers both protected level crossings along with unprotected ones. The messaging to drivers and the information provided is addressed, too.	I2V	C-Roads	1			
12			HLN - Unsecured Blockage of a Road (HLN-UBR)	An operator in the TCC gets the information that there is a blockage of a road. Till the time that operating agents arrive to the site to protect and manage it, the operator sends a warning message to road users. A blockage means that there is no traffic going through the road segment and passing it by on a single or several lanes., The complete road is blocked (not an obstacle on one or more lanes).	I2V	C-Roads		1		
13			HLN - Alert Wrong Way Driving (HLN-AWWD)	To warn a driver that he could encounter a vehicle that is driving in the wrong way. It is not the primary aim of this use case to alert the wrong-way driver that he is on the wrong way. This V2V use case could be added in the future to the warning sequence if detection quality and confirmed status of information is improved.	V2V	C-Roads	1			
14			HLN - Public Transport Vehicle Crossing (HLN-PTVC)	Vehicle is approaching a location of a high risk of collision with Public Transport vehicles. The driver is informed about this situation via in-car information and warning.	V2V	C-Roads	1			
15			HLN - Public Transport Vehicle at a Stop (HLN-PTVS)	The driver gets warned about the presence of a public transport vehicle at the stop to raise his/her attention when approaching it by providing in-car information and warnings about this situation.	V2V	C-Roads	1			

Combined C-ROADS, CCAM, and Other Use Cases

	Service/Application		Use Case	Description	Communication Path	Source	TN-ITS relevant			
							direct	indirect via map		remark
	Service: In-Vehicle Signage (IVS)									
	Service: Road Works Warning (RWW)									
16			RWW - Lane closure (and other restrictions) (RWW-LC)	The road user receives information about the closure of part of a lane, whole lane or several lanes (including hard shoulder), but without the road closure. The objective is to allow road users to anticipate the closure of lanes due to a road works site on the road ahead and to adapt their speed and lane on the road.	I2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
17			RWW - Road Closure (RWW – RC)	The road user receives information about a road closure due to a set of static road works. The closure is temporary.	I2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
18			RWW – Road Works Mobile (RWW-RM)	The road user receives information about a zone on the road that contains, at some point, the neutralization of part of a lane or a lane closure (but without road closure) due to a planned mobile work site.	I2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
19			RWW - Winter Maintenance (RWW-WM)	The winter maintenance vehicle, equipped with the necessary technology for a road operator V2V communication, sends a message signalling their activity (salting and/or snow/ice removal). The alerted road user can adapt its driving behaviour accordingly.	V2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
20			RWW - Road Operator Vehicle in Intervention (RWW-ROVI)	An operating agent in his vehicle stops in front of an accident/incident to protect the obstacles or is currently setting the equipment (lane delineation) to protect a site (in case of road works for example). The objective of this use-case is to alert a road user that an operating agent is intervening on a site so that the driver can adapt his behaviour.	V2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
21			RWW - Road Operator Vehicle Approaching (RWW-ROVA)	A road operating agent in his intervention vehicle needs to access urgently an incident area to protect it. The agent requests to road users that they facilitate the agent's way on the road, broadcasting a message.	V2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
	Service: Signalized Intersections (SI)									
22			SI - Signal Phase and Timing Information (SI-SPTI)	This service will provide information to road users approaching and passing traffic light controlled intersections, on the current phase as well as upcoming phase(s) and the moment these are expected to start and end. Road users can adapt their speed while approaching a signalised intersection, or when stopped at a red phase, they can turn off their engine.	I2V	C-Roads	1			
23			SI - Green Light Optimal Speed Advisory (SI-GLOSA)	This service will provide speed advice information to road users for a safe and efficient approach and crossing of a signalised intersection(s). Road users comply with the speed advice and adapt their speed while approaching, stopping and/or passing a signalised intersection or driving through a sequence of traffic light controlled intersections.	I2V	C-Roads	1			
24			SI - Imminent Signal Violation Warning (SI-ISVW)	This service will provide imminent signal violation warnings to road users approaching traffic light controlled intersections. Road users react to the imminent red light violation warning, stopping their vehicle in time to avoid red light violation or reducing their speed to minimise the impact of the red light violation.	I2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
25			SI - Traffic Light Prioritisation (SI-TLP)	This service will give priority to designated vehicles (e.g. public transport, heavy goods vehicles, etc.) over individual vehicles at signalized intersections for assuring on time transportation schedule (e.g. bus, tram) and/or minimise emissions.	V2I, I2V	C-Roads	1			
26			SI - Emergency Vehicle Priority (SI-EVP)	This service will actively contribute to the phase control of an equipped intersection to aid the passage of emergency vehicles. It will also provide the prioritisation status to other users approaching and passing traffic light controlled intersections. The Interaction between emergency(s) vehicle and traffic light controller(s) (either local or central) will reduce the time taken for emergency vehicles to cross signalised intersections and increase the safety of these crossings.	V2I, I2V	C-Roads		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
	Service: Probe Vehicle Data (PVD)									
27			PVD - Vehicle Data Collection (PVD-VDC)	The Probe Vehicle Data (PVD) is a service in which vehicle or road user data is collected by the road operator or service provider. The in-vehicle-system sends vehicle data collected and the road operator collects and processes data and can exchange this information with other road operators and/or service providers	V2I	C-Roads				
28			PVD - Event Data Collection (PVD-EDC)	Events (either automatically detected by the vehicle's systems or either manually reported by road users) are collected. This will allow the road operator to provide information or services to vehicles, other road users (I2V) but also to other operators (e.g. railway) to take appropriate actions.	V2I	C-Roads				
29	Safety	EEBL	Electronic Emergency Break Light Warning	This use case consists for any vehicle to signal its hard breaking to its local followers. In such case, the hard braking is corresponding to the switch on of emergency electronic brake lights.	V2V	CCAM				
30	Safety	PCSW	Pre-crash sensing warning	Prepare for imminent and unavoidable collision by exchanging vehicles attributes after unavoidable crash is detected.	V2V	CCAM				

Combined C-ROADS, CCAM, and Other Use Cases

	Service/Application		Use Case	Description	Communication Path	Source	TN-ITS relevant			
	Service: In-Vehicle Signage (IVS)						direct	indirect via map		remark
31	Safety	APCSW	Advanced pre-crash sesning warning	Prepare for imminent and unavoidable collision by exchanging vehicles attributes after unavoidable crash is detected. Differently from PCSW, in this case the risk of detection, as well as additional information about the imminent crash is achieved thanks to use of local sensors	V2V	CCAM				
32	Safety	SSVW	Slow Vehicle Warning	Slow-VW: This use case consists from any slow vehicle to signal its presence (vehicle type) to other vehicles.	V2V, I2V	CCAM		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
33	Safety	CGR	Co-operative glare reduction	This use case enable a capable vehicle from automatically switching from high-beams to lowbeams when detecting a vehicle arriving in the opposite direction.	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
34	Safety	ICW	Intersection Collision Warning	By exchanging information about their position and dynamics two vehicle can detect the risk of an intersection collision and warn the driver accordingly	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
35	Safety	VRUP	Vulnerable Road User Protection	Provides warning to vehicles of the presence of vulnerable road users, e.g. pedestrian or cyclist, in case of dangerous situation. For Day1 application, the infrastructure can recognize the risk and send notifications to vehicles. For day 2, vehicles and infrastructure can share information about pedestrians or cyclists detected via local sensors, and let receiving vehicles detect the occurrence of risky situations associated to VRU presence	I2V, V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
36	Safety	IVRUP	Improved Vulnerable Road User protection	A VRU is equipped with active C-ITS notification capabilities to alert other traffic road users or to let them automatically react to prevent risky situations	I2V, V2V	CCAM				
37	Efficiency	AGLOSA	Advanced Green Light Optimum Speed Advisory	Extends the GLOSA by implementing automated functions for adaptation to the speed suggested by the infrastructure or computed by the vehicle	I2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
38	Efficiency	AGLOSA+N	Automated Green Light Optimum Speed Advisory with negotiation	CAVs and/or CAVs strings communicate if the GLOSA advices can be executed by updating their own transmitted messages. This feedback can be used by the traffic light controller to further refine the traffic light phase and time algorithms (e.g. to put priority at the phases whose GLOSA advices that can be applied, e.g. ensure a long enough and stable time to green for a big string of CAVs to pass the stop line before the next red starts.	V2V, I2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
39	Efficiency, Comfort	GWI	Green Wave Information	This use case allows a traffic light to broadcast timing data associated to its current state (e.g. time remaining before switching between green, amber, red) as well as indication about available green wave in addition to GLOSA	I2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
40	Safety	MAI	Motorcycle Approaching Information	Inform the driver on approaching motorcycle in selected traffic situations. This is especially useful in case of reduced visibility.	V2V	CCAM				
41	Safety	MAW	Motorcycle Approaching warning or protection	Inform the driver about a possible collision with approaching motorcycle in selected traffic situations. In extreme cases, the vehicle can automatically react via automated braking	V2V	CCAM				
42	Efficiency	C-ACC	Cooperative - Automatic Cruise Control (ACC)	This use case is based on the use of V2X to obtain lead vehicle dynamics and general traffic ahead in order to enhance the performances of current ACC. The infrastructure can play a role in suggesting the speed to be adopted in CACC mode as well as the point from where CACC is allowed	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
43	Efficiency	C-ACC S	Cooperative ACC string	Extends the CACC by allowing multiple vehicles to organize a string of C-ACC enabled vehicles	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
44	Efficiency	AC-ACCS	Advanced Cooperative ACC string	By receiving information about non-cooperative vehicles detected by environmental sensors, vehicle can detect the risk of an intersection collision and warn the driver accordingly	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
45	Safety	OVW	Overtaking vehicle warning	An overtaking vehicle detects the risk of collision thanks to information about vehicles coming from the other direction, which are detected by other vehicles	V2V	CCAM				

Combined C-ROADS, CCAM, and Other Use Cases

	Service/Application		Use Case	Description	Communication Path	Source	TN-ITS relevant			
	Service: In-Vehicle Signage (IVS)						direct	indirect via map		remark
46	Safety	AICW	Advanced intersection collision warning	By receiving information about non-cooperative vehicles detected by environmental sensors, vehicle can detect the risk of an intersection collision and warn the driver accordingly	V2V, I2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
47	Safety	TDAR	Target Driving Area reservation	for a vehicle that is going to perform a maneuver aimed at occupying a given road section, this use case provides the possibility to notify other vehicles about the maneuver imminent occurrence	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation (dynamic data)
48	Efficiency, Comfort	OTLI	Optimized Traffic Light information with V2I	In proximity of urban signalized intersections, isolated CAVs and/or CAVs organized in CACC strings continuously transmits information describing intentions (like planned route at intersection) or vehicle/string characteristics (like desired speed, string size, etc.). By collecting this explicit probing V2I information, the traffic light controller updates its queue models and calculates more efficient traffic light phases, durations and GLOSA that are communicated to vehicles.	I2V, V2I	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
49	Efficiency, Safety	Platoon	Platooning	This use case is based on the use of V2X for trucks to operate safely as a platoon on a highway implementing longitudinal and/or lateral control depending on the level of automation supported by the interested vehicles	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
50	Efficiency, Safety	CMA	Co-operative merging assistance	This use case considers that CAVs involved in a merging negotiate together the merging process to avoid collision. The road infrastructure can in special case participate in the coordination process.	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
51	Efficiency, Safety	CLC	Co-operative lane change	This use case considers that CAVs involved in a lane change negotiate together the maneuvering process to avoid collision. The road infrastructure can in special case participate in the coordination process	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
52	Efficiency, Safety	CO	Co-operative overtaking	This use case considers that the CAVs involved in an overtaking negotiate together the maneuvering process to avoid collision.	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
53	Efficiency	CACCS M	Cooperative ACC string Management	Extends the CACC by allowing multiple vehicles to organize a string of C-ACC enabled vehicles that can dynamically administrate operation such as forming, leaving, break-up, or merging strings	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
54	Efficiency	ToCN	Transition of Control Notification	A CAV that is about to give the control back to the driver can inform other traffic participants about this possibly risky event, or about the occurrence of a minimum risk maneuver in case the driver is not reacting accordingly	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
55	Efficiency	CToC	Co-operative Transition of Control	CAVs can cooperate in organizing a transition of control such that minimizes the risks. The road infrastructure can participate in this cooperation by suggesting time or space where to safely trigger a ToC	V2V	CCAM		1		Information can (also) be on the map inidcating the geolocation where this feature applies
56			Light Signal Systems	??		Other Use cases	1			static component of data
57			Freight & Logistics			Other Use cases		1		static component of data
58			Public transport services (safety, priority)			Other Use cases		1		static component of data
59			Multi Modal Cargo Transport Optimization			Other Use cases		1		static component of data

Combined C-ROADS, CCAM, and Other Use Cases										
	Service/Application		Use Case	Description	Communication Path	Source	TN-ITS relevant			
	Service: In-Vehicle Signage (IVS)						direct	indirect via map		remark
60			Truck Parking			Other Use cases	1			static component of data
61			Tunnel Logistics			Other Use cases		1		
62			other use cases related to parking, L3 and L4 autonomous driving							
63				Autonomous Valet Parking	I2V	Other Use cases	1			static component of data
64				Off street parking information	I2V	Other Use cases	1			static component of data
65				On street parking information	I2V	Other Use cases	1			static component of data
66				Park & Ride information	I2V	Other Use cases	1			static component of data
67				Information on EV charging stations	I2V	Other Use cases	1			static component of data
68			ISA	Intelligent Speed Adaptation (ISA) is an in-vehicle system that uses information on the position of the vehicle in a network in relation to the speed limit in force at that particular location. ISA can support drivers in helping them to comply with the speed limit everywhere in the network. ISA is a collective term for various systems: The open ISA warns the driver (visibly and/or audibly) that the speed limit is being exceeded. The driver him/herself decides whether or not to slow down. This is an informative or advisory system. The half-open ISA increases the pressure on the accelerator pedal when the speed limit is exceeded (the 'active accelerator'). Maintaining the same speed is possible, but less comfortable because of the counter pressure. The closed ISA limits the speed automatically if the speed limit is exceeded. It is possible to make this system mandatory or voluntary. In the latter case, drivers may choose to switch the system on or off.		Other Use cases	1			static component of data
69			Traveller information			Other Use cases		1		static component of data

Table 7: Combined C-Roads, CCAM and other use cases -impact on TN-ITS

5.4.5 ISAD levels [23]

ISAD levels are Road infrastructure support levels, as being defined by the European H2020 project Inframix. These levels explain what kind of support can be delivered to automated drive, on the various types of roads. The following picture gives a overview of the levels and their definition

	Level	Name	Description	Digital information provided to AVs			
				Digital map with static road signs	VMS, warnings, incidents, weather	Microscopic traffic situation	Guidance: speed, gap, lane advice
Digital infrastructure	A	Cooperative driving	Based on the real-time information on vehicle movements, the infrastructure is able to guide AVs (groups of vehicles or single vehicles) in order to optimize the overall traffic flow.	X	X	X	X
	B	Cooperative perception	Infrastructure is capable of perceiving microscopic traffic situations and providing this data to AVs in real-time	X	X	X	
	C	Dynamic digital information	All dynamic and static infrastructure information is available in digital form and can be provided to AVs.	X	X		
Conventional infrastructure	D	Static digital information / Map support	Digital map data is available with static road signs. Map data could be complemented by physical reference points (landmarks signs). Traffic lights, short term road works and VMS need to be recognized by AVs.	X			
	E	Conventional infrastructure / no AV support	Conventional infrastructure without digital information. AVs need to recognise road geometry and road signs.				

Table 8: ISAD levels

Since these levels address infrastructure related capabilities, it makes sense that this can be a source of additional data and potential specification opportunity for TN-ITS, certainly if ISAD will gain regulatory aspects.

A proposal how these levels can be concretely applied to a road network is given by this reference from Finland [24]

An interesting observation is that OEMS (vehicle manufactures) also define the levels of automation capability of their vehicles, related to infrastructure in the so-called ODD descriptions (Operational Design Domain). SAE J3016[25] defines ODD as "Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics"

The geographical aspect can refer to the need to support ODD by TN-ITS related data.

ISAD can be seen as a kind of complementary initiative by the road operators to the ODD initiative by the OEM's. ISAD and ODD will meet each other at the 'service level' where the provider will need to see how ISAD related data and ODD related data can be 'coupled' together. This is illustrated by the following figure:

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[23] *<Source Inframix presentation>*

[24] https://julkaisut.vayla.fi/pdf12/vj_2021-21_automoto_web.pdf

[25] https://www.sae.org/standards/content/j3016_201806/

This ‘vision’ is explained by the next figure, based upon the TN-ITS data chain.

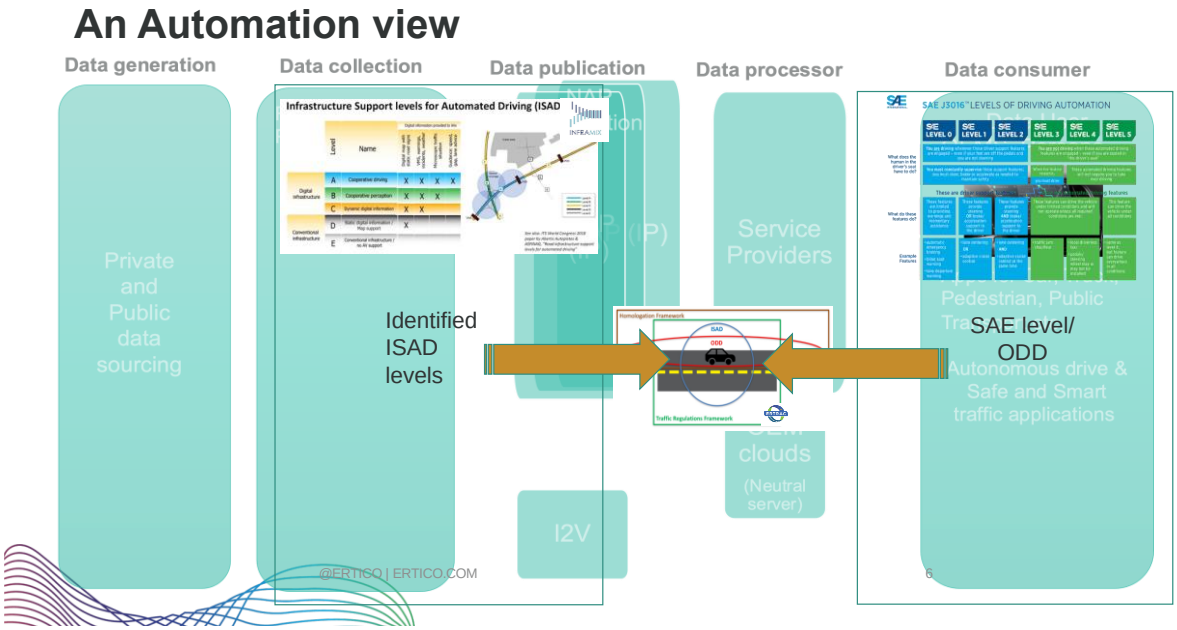


Figure 11: ISAD and ODD within the data chain

6 Consultations and alignments with other associations

6.1 DATEX II

DATEX II is mentioned in the RTTI delegated act and addresses the so called ’dynamic data, complementing TN-ITS services, identified as so called’ static data. Within the TN-ITS platform we address ‘static data ‘ as base layer map data’ and dynamic data as ‘map service layer data’ in line with the maps layering as presented in chapter 5.. DATEX II and TN-ITS are therefore very complementary. Both feeds are (will be) available via the NAP federated architecture, as being developed by the CEF NAPCORE project (chapter 7).

6.1.1 Description

The TN-ITS UML model and ontology contains a modified copy of fragments of the DATEX II model.

To ensure maximum compliance with existing and popular mobility data standards, in 2018, the TN-ITS technical specifications have incorporated data models from ISO 14823 (traffic signs) and also from DATEXII, in particular to the model periods of validity related to a road feature, vehicle characteristics, and some road feature types:

- The Validity Class specifies the periods that relate to a road feature:
  - Datatype Validy - Period Class – SpecialDay
  - Datatype Validy - Period Class – RecurringSpecialDay
  - Datatype Validy - Period Class - IntersectWithApplicableDays
  - Datatype Validy - Special Day Class - SpecialDayType
  - Datatype Validy - Public Holiday Class - PublicHoliday
  - Datatype Validy - Public Holiday Class - PublicHolidayName
- The VehicleCharacteristics Class are a collection of parameters which characterize a vehicle:
  - VehicleCharacteristic Class -YearsOfFirstRegistration
  - VehicleCharacteristic Class -Emissions
  - VehicleCharacteristic Class -EmissionsLevel
- RoadFeatureType Class:
  - ParkingSiteType Class - ParkingSite
  - ChargingPointUsageType - ChargingPoint
  - RefillPointGas

6.1.2 Relevance to TN-ITS

The TN-ITS CEN project team has converted the excerpts of the DATEX II models to the ISO/TC 211 UML Profile and performed some minor changes.

Within NAPCORE, we will further work out the complementarity between TN-ITS and DATEXII. (More details in Chapter 7)

6.2 SENSORIS

6.2.1 Context

The 4 major stakeholders: vehicle/road user; road operator, service providers and car manufacturers have standards to support their operations. For seamless services that are interoperable and consistent on the information level, the interoperability of information over the interfaces needs to be guaranteed. This brings along challenges in terms of data governance and information consistency.

Related to Safe and Secure Traffic Conditions (KPIs of Commission) there is an opportunity that the co-operation between both ERTICO innovation platforms TN-ITS and SENSORIS significantly can strengthen the aim of creating reliable end user services, either serving the vehicle or the driver support system.

These systems must be able to recognise that what the driver receives from the roadside station is about same real-world incident as what is received from the service providers. Only than it can process and present this information adequate and non-disturbing for the end user.

6.2.2 Identified major opportunities

Considering the complementarity of TN-ITS and SENSORIS in the mobility data space, illustrated by the picture below, we can identify at major opportunities for both innovation platforms.

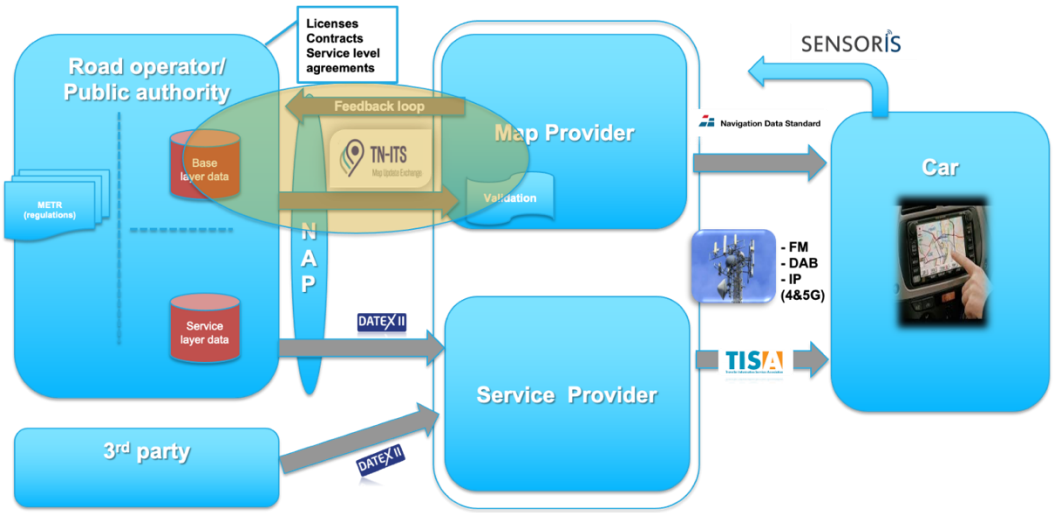


Figure 12: Mobility data space including Sensoris

6.2.2.1 Opportunities for TN-ITS

a) Increased quantity and availability of data

During the strategy meetings August 2019 there was a clear need to enlarge the set of data and data attributes that TN-ITS governs. These sets need to be gathered by the authorities' (Member states, regional or city authorities) related traffic data databases. The amount of available data is a direct success factor for the use of TN-ITS. SENSORIS , as an active data collection and sharing mechanism can play a big role in enhancing the feed of data in to the authorities' databases.

b) *Strengthen the quality and accuracy of data.*

TN-ITS already developed a so-called feedback loop as a data quality enhancing tool. It provides feedback to the authorities on the syntax of the shared TN-ITS messages. With SENSORIS we can go a n important step forward as it can provide syntax feedback. Sensors

detecting the physical reality generating data that allows comparison with the existing database content.

6.2.2.2 ***Opportunities for SENSORIS***

a. Enhance the driver's guidance by a fusion of the data obtained by the in car sensors and the Map related data provisioned by TN-ITS

b. Develop a new business model for the SENSORIS data sharing as a data resource at the basis for feeding Authoritative data bases.

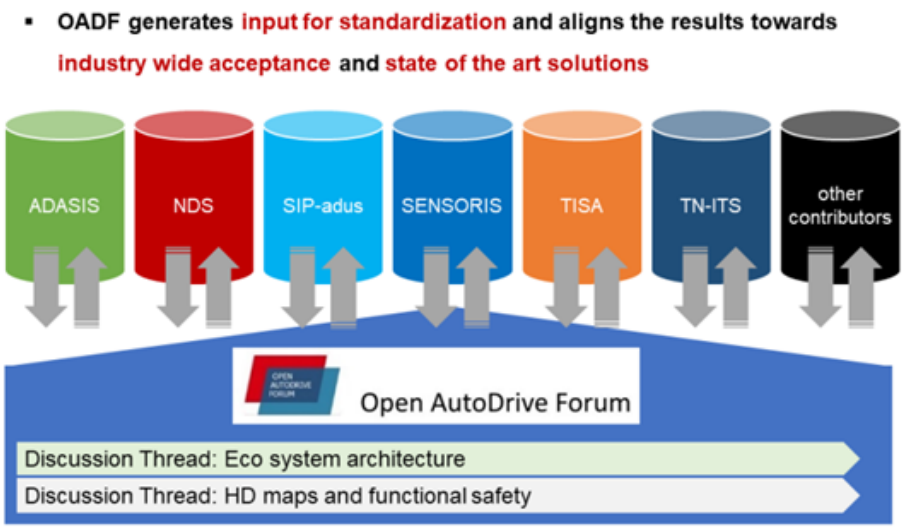
6.3 OADF

TN-ITS is since June 2019 official member of the Open Auto Drive Forum (OADF). The Open Auto Drive Forum is a cross-domain platform driving standardizations in the area of autonomous driving. Members of the OADF are the consortia ADASIS, NDS, SENSORIS, SIP-ADUS, TISA and TN-ITS.

6.3.1 Description

Goals and missions of the OADF are:

- Act as open discussion platform for cross-domain topics in the area of autonomous driving that require cooperation throughout the industry.
- Generate globally applicable, state-of-the-art solution possibilities as further input for standardization in organized bodies.
- Connect local authorities and the global industry to streamline future development efforts.
- Act as a platform to present the latest developments and achievements towards a connected world of autonomous cars.



Members are meeting monthly in the steering board and OADF has established a task force on reviewing the OADF ecosystem, idea is to incorporate external authoritative data (like TN-ITS, DATEX II) in the ecosystem.

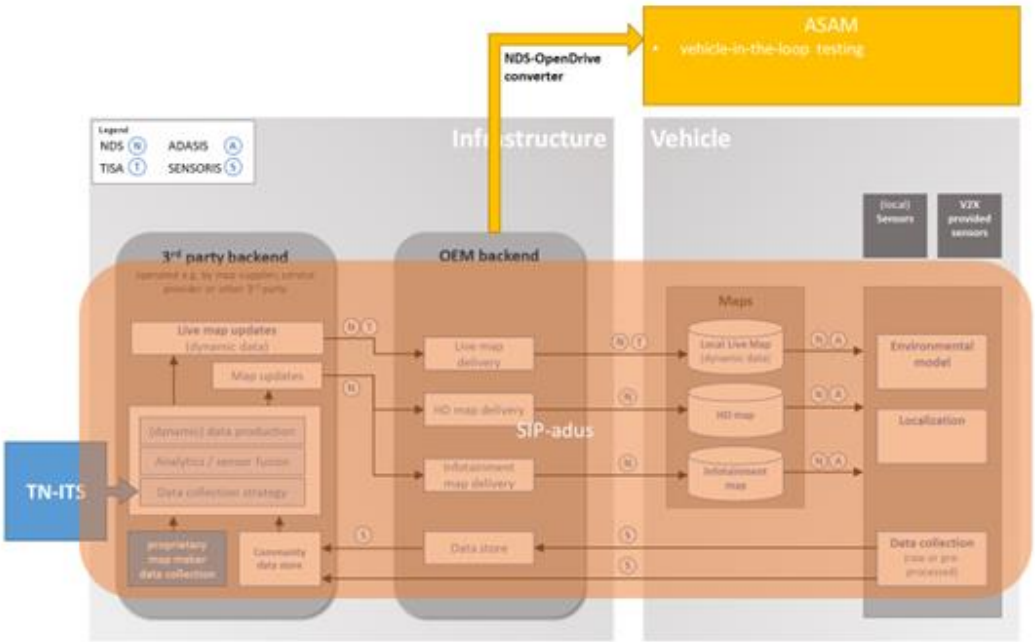
At the ITS World Congress in Hamburg, October 2021 a Special Interest Session was held with the topic

“The evolving Ecosystem of Automated Driving - Requirements and Approaches to facilitate Collaboration in Standardization”, with participation from the member consortia.

The revision of the ecosystem is ongoing and for the moment it is discussed to have an inner and external loop.

The inner loop is describing the data flow inside the industry between service provider, OEMs and system manufactures.

The external loop shows the importance of external map data to maintain highly reliable maps for Autonomous Driving. In this context a feedback loop from SENSORIS is discussed to feed public authoritative data.



Draft status of the OADF Ecosystem (2021)

6.3.1.1 Relevance to TN-ITS

OADF is a global platform to drive standards in the domain of automated driving. In order to ensure consistency between different standards like SENSORIS, NDS and TN-ITS alignment in this forum is needed. TN-ITS as the future major input for digital maps needs to work closely with the industry to understand the needs coming from future applications in the field of automated driving. One example is Intelligent Speed Assistant where TN-ITS Data could feed the speed limit information for Live NDS which is then sent out in real time to the relevant application.

The OADF ecosystem is also important to understand the data chain from the source (TN-ITS) to the end user (/NDS).

6.4 Data communities and cities

6.4.1 Data communities

6.4.1.1 Germany Mobilitats Daten Marktplatz (MDM)

TN-ITS was present at the quarterly meetings of the Mobility Data Marketplace (MDM) User Group around the National Access Point in Germany since 2018.

The members are actively committed to enhance the use of the NAP and promoting its further development. Founded in 2014, the initiative has over 20 members from business, science and public administration, including cities and regions in Germany.

The Federal Highway Research Institute (BASt) supports the work of the MDM User Group. The MDM User Group

- develops ideas and requirements
- agrees joint activities (at quarterly meetings)
- participates in events to increase awareness of MDM
- develops opinions and recommendations
- supports new and existing users with their knowledge and experience

Relevance to TN-ITS

One outcome of the involvement of TN-ITS is the position paper on static road data [26]

One recommendation in the paper is that the MDM should be extended to static road data and the suitable format should be TN-ITS:

“From the point of view of ITS, comprehensive, up-to-date and high-quality data, which are transmitted in a standardized process via a single interface, are desirable. However, this also requires electronic processes in administration, which ultimately generate machine-readable data that is up-to-date and consistent.

With the technical specification CEN / TS 17268 "Data Exchange on changes in road attributes" and the TN-ITS platform, a functioning process for the exchange of static road data already exists at European level, which was developed together with road traffic authorities and providers of digital maps” (Source in reference[27])

The user Group is also extending to neighbour countries, TN-ITS was presenting at a workshop in Bern/Switzerland in September 2021 around the Swiss NAP and discussing data requirements with public authorities. [28]

[26] https://www.mdm-portal.de/statische-strassendaten/

[27] (from https://www.mdm-portal.de/statische-strassendaten/ 2021 translated)

[28] https://www.prisma-solutions.com/de/events/vdp-ch-onboarding

6.4.1.2 Flanders

This chapter gives an overview of the use cases where the TN-ITS service can play an important role. As a case study we looked at the use cases as identified by the Flemish (BE) road authority.

In Flanders , there is the Mobilidata program, which selected a number of use cases based on a consultation process. This consultation process first focused on gathering information from public stakeholders on existing programs, projects, and tests related to C-ITS or other use cases. This resulted in a longlist of use cases where stakeholders could comment on. The program team combined the information and finally created the list of use cases for the Mobilidata program. Flanders' TN-ITS service is a data source for 5 of these use cases:

Use Case: Static and Dynamic Speed Limits

- Summary: The road users are provided with (in-vehicle) speed limit notifications as they drive. The message subject is not only static speed limits as indicated by static signage or regulation, but also the dynamic speed limits applicable on the used road segment at that time.
- Background: Inappropriate vehicle speeds are a major cause of accidents and contributor to injuries and fatalities. A higher speed increases the likelihood of an accident. Very strong relationships have been established between speed and accident risk: this general relationship holds for all speeds and all roads, but the rate of increase in accident risk varies with initial speed level and road type. Large speed differences at a road also increase the likelihood of an accident. In addition, drivers driving much faster than the average driver have a higher accident risk; it is not yet evident that this is also the case for the slower drivers. This problem can be mitigated partially, by informing the road users about the actual speed limit, so they can adapt their speed appropriately and more quickly and avoid speeding. Dynamic speed limits are (by definition) variable and road users require a reliable reminder of applicable speed limits in order to have a higher likelihood that they adhere to it.
- Objective: The aim is to provide the road users at all times with the currently valid speed limit set by regulation, static signage or by the road operator visualised on the VMS (variable message signs).

Use Case: Static Road Signs

- Summary: The aim is to provide "other" signage information to road users. In this context "Other" are the signage that is not related to legal speed limit signage or dynamic lane access information as these are covered by other use cases
- Background: Static road signs are punctual information sources that can apply to lengthy road segments. They are used to convey relevant information to road users on, e.g. right of way, dangerous situations, parking legislation. A road user that has missed/forgotten such information can unwillingly behave in an unsafe, or traffic flow disrupting manner. As an additional complicating factor, traffic regulations and its signage are becoming complex and travel mode specific. If all types of travel modes are to receive information through static road signs, this will lead to a clutter of signs.

This can lead to information overload in busy traffic situations and increased incident risk.

- Objective: The aim is to provide the road users with valid and (mode) relevant traffic regulation information, be it the original static signage, regulation or information on the text message signs should it not be covered by other Mobilidata use cases (VMS).

Use Case: Recommended Routing

- Summary: In the context of cooperative navigation, recommended-route information is the incorporation of government desired routing (recommended detour) in case of road works, events or incidents. In the same context, cut-through traffic management is mostly understood as discouraging usage of certain roads at certain times in the used navigation solution on government desired policy, without any hard traffic rules or regulations. Since most of the time, there will exist 'another' navigation solution that does not respect this policy, the effective introduction of a system where streets are virtual made inaccessible for certain vehicle types, is difficult. In this Mobilidata use case we aim to incorporate recommended routes, when available, into navigation services. Also, in order to avoid cut through traffic, we hope to enable sensibilisation of road users and thus appeal on their common sense for the usage of preferable routes and/or avoiding undesired routes.
- Background: Dealing with cut-through traffic is mainly an issue of liveability and comfort and sometimes safety on local levels. However, roads are public space and should be accessible to all allowed at all allowed times. If certain roads are not fit for use by certain road users at certain times, the road operator not always has the possibility to regulate access with fixed or dynamic traffic signs, enforce compliance and issue fines if the rules are not respected. On the other hand, in case of road works or other (un)planned events, the government indicates and/or communicates preferable detours. Again, these are recommendations in order to diminish hinderance that cannot be enforced. In both cases, the optimal use of the network relative to the community (network balance and liveability of certain environments) does not always correspond to the optimal individual route (in terms of travel time). The proper solution for preventing an undesired individual routes is to ban all unwanted traffic by rules and regulations together with enforcement. This is not always achievable, as in most cases not all traffic has to be banned, and the difference between local (allowed) and non-local (unwanted) is hard to make.
- Objective:
    - Have navigation devices and -apps to take into account recommended routes and routes to be avoided in their algorithms.
    - Give drivers the opportunity to choose the preferable route: parameter availability in navigation solutions. Allows for an educated choice.
    - Analyse usage information, keeping in mind the monitoring and evaluation of the use of recommended routes and routes to be avoided, objectivising the effect of navigation on individual street usage.
    -

Use Case: Park & Ride Facility Information

- Summary: The vehicle driver intends to make use of dedicated Park & Ride facilities. This service provides vehicle drivers with real-time information on parking spaces available at Park & Ride Facilities. This information can include information on the location of the facility; information on the availability of free parking places at the facility and information on the availability of other transport modes at the facility (e.g. public transport, shared bikes, …).
- Background: Parking place can be scarce and the unawareness of the available and/or suitable parking spaces leads to “searching” traffic, which causes unnecessary vehicle kilometres and harmful emissions. This use case focuses on providing end users with information on the location, availability, and suitability of parking places at Park & Ride Facilities. The intention is to choose (on-trip or in advance of the trip) an available parking space, causing a reduction of vehicle kilometres and emissions. A better utilisation of the available parking spaces is to be expected.
- Objective: Smarter use of available parking places at Park & Ride Facilities by providing drivers with real-time information on P&R facility parking space availability to reduce city kilometres driven and emissions.

Use Case: Active Road Users – Static Road Signs

- Summary: The aim is to provide all “other” static road sign information to active road users. The active road users in this use case document will be especially cyclist, with potentially a bigger focus on speed-pedelec drivers and the cyclists with a higher speed profile. “Other” in this context meaning the signage that is not related to legal speeds signage
- Background: Static road signs are punctual information sources, that can apply to lengthy road segments. A cyclist that has missed/forgotten such an information sign can unwillingly behave in an unsafe manner. As an additional complicating factor, traffic regulations and its signage are becoming complex and travel mode specific. This can lead to information overload in busy traffic situations.
  Objective: The aim is to provide the cyclist with valid and mode relevant traffic regulation information, be it original static signage

6.4.2 Cities

After mainly addressing major roads and highways (Ten-T corridors and beyond), road networks from more regional and city authorities are in the picture for making available their relevant data.

For example, if TN-ITS builds a specific registration tool, cities can use it to populate both base-layer/static data (TN-ITS) and service-layer/Dynamic data (DATEXII). Great effort was done in this sense by the UK DFT organization.[29]
One crucial task for the TN-ITS platform is to engage with local authorities, and to provide a better understanding of the benefit that TN-ITS services could bring to the city, such as improving their potential to perform digital twin operations based on the generated data. The ERTICO City Moonshot[30] can play a role in this dissemination, and so can the co-operation with big data operators in the ERTICO partnership.

6.4.2.1 Case study Hamburg

TN-ITS organized the "TN-ITS GOes Urban" event at the ITS World Congress Hamburg October 10th 2021. We had the chance to invite Dr Michael Fischer, head of real time data, City of Hamburg. He talked about the importance of data sharing and a deploying a city related 'urban data platform'. His did a market review in 80 cities. This showed that a lot of cities take likely initiatives. The Hamburg data portal is based upon existing standards in urban IT platforms and supports several services. Examples of very innovative applications, such as the ERTICO start up winner (In category 'Best product innovation 2021') is the

Dr Fischer is currently promoting the Hamburg solution to other German major cities such as Frankfurt and Berlin.

In the discussion that addressed the adoption of TN-ITS within his services, he reacted quite distantly. Hamburg claims that they already use OCG standards and considers TN-ITS yet an additional (Derived) interface to the data, that requires additional investments.

6.4.2.2 Case study Helmond

TN-ITS engaged in the project proposal 'ISA fit (Intelligent Speed Assistance retroFIT solutions for cities and region)', responding to the KIC EIT Urban mobility call 2021. Helmond (Nl) is a prominent city that wants to make progress in ISA services. The proposal formulated was to build a joint digital and physical infrastructure that could support ISA in the city.

ISA-FIT aimed to provide a solid ready-to-implement retro-fit ISA solution for urban environments. Therefore, the ISA-FIT project will:

- Test a retro-fit ISA system in different urban environments which would provide more insights and solutions to improve the robustness of the retro-fit system and identify the main city challenges for a wider deployment on e.g. data-infrastructure.
- Provide tangible outputs for the pilot cities on the potential for safety and acceptance of ISA by their citizens.

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[29] https://www.tn-its.eu/news/tn-its-go/european-tn-its-standard-for-map-updates-unifies-uk-s-digital-infrastructure-data

[30] https://erticonetwork.com/ertico-launches-the-city-moonshot-to-engage-inspire-and-empower-cities/

- Create a European sustainable implementation strategy for cities which will take into account current European C-ITS strategies, EU regulations on data exchange and lessons learned from other relevant C-ITS or CCAM projects in various urban environments.

These objectives will be established by setting up trials of 15 vehicles of different types equipped with the V-Tron ISA system in each city (Antwerp, Belgrade and Helmond) during 4 months. Skoda will perform a simulator test to evaluate the V-Tron HMI with different types of users as part of objective diver testing distraction. The ISA – system can be warning, assisting, or closed (no speeding allowed). TUE will define the evaluation focusing on the functional and user behaviour aspects. The functional evaluation (CTAG) will focus on the quality of the system in different urban uses cases: road environments, vehicles (cars, vans, trucks)), weather conditions, speed regulations, speed signage, availability of speed limit data. The behavioural evaluation will focus on the users experience and perceived benefits, HMI aspects and impact on behavioural changes. Tractebel will be project leader. The project Task 2 will first focus on the level of data-availability within the pilot cities. All city involved will provide speed limit data at their disposal. This data will be tested, completed and updated when needed on coverage, availability, accuracy, reliability, etc. by Tractebel and V-Tron to ensure the basic working of the retro-fit system in every city. Also, the geo-fencing potential will be analysed. TN-ITS Platform (ERTICO) will participate as a subcontractor for Tractebel to ensure that the data (certainly at the end of the project) is in line with EU guidelines and data standards.

The project was not granted.

6.4.2.3 Conclusions

It is not evident to engage cities in the TN-ITS data sharing initiative. Many cities have already taken some initiative towards data sharing. (See below figure, source ERTICO City Moon Shot) Today, they are not involved in the higher-level discussions on how to build the European mobility data infrastructure, like e.g. related to NAP federation, and they are hardly aware about the main data sharing methodologies like DATEXII and TN-ITS. (see next figure)

It is clear that these local initiatives do not serve the purpose as the accessibility of data is not guaranteed (who knows the city data hub URL), the risk to generate a tremendous variance and amount of data interfaces in Europe, that will prohibit service providers to economically access this data. Furthermore, the city will lack the necessary investments in tools and solutions to meet the data chain requirements (as formulated in chapter 3), and will lack on longer term the financial and human resources to ensure the data availability.

A focussed promotion of TN-ITS and the benefits given by the EU NAPCORE federation will need to be established and deployed.

Today's (proposed) changes in the Revision of Delegated Regulation No. 2015/962 EU-wide Real-Time Traffic Information Services (RTTI) text, mentions DATEX II **AND** TN-ITS as it also has been recommended before by the TN-ITS association [31]

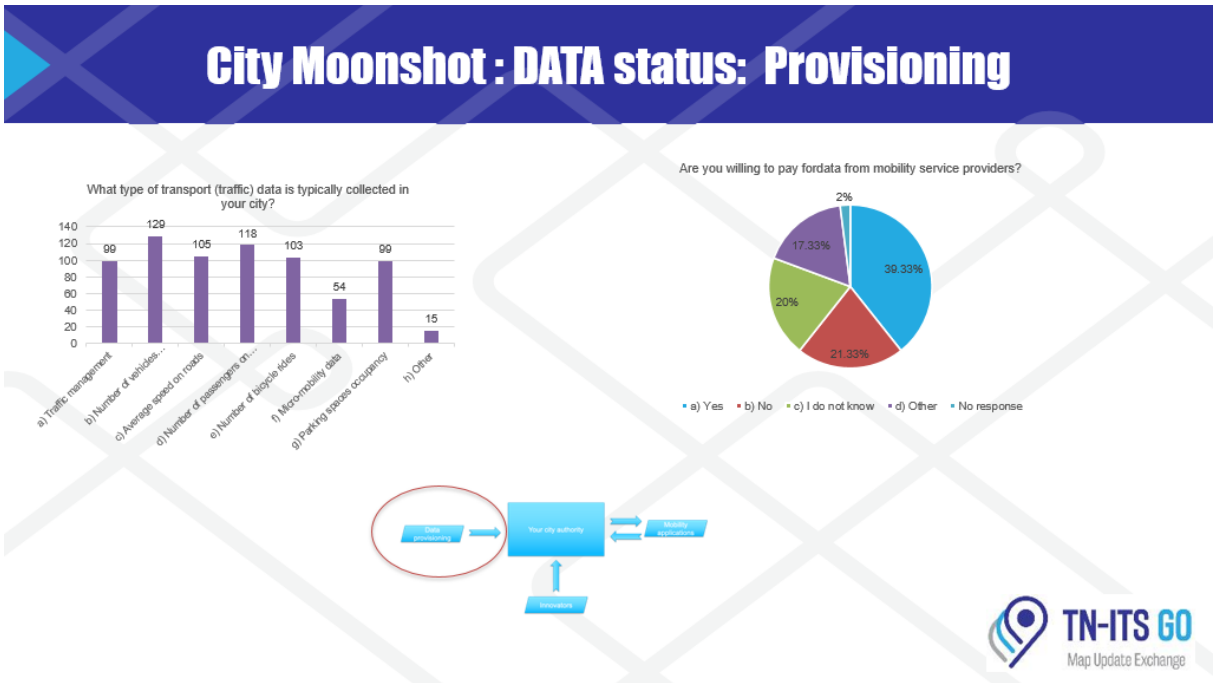

Figure 13ERTICO City Moon Shot: Data provisioning status

[31] https://tn-its.eu/storage/uploads/documents/2021/04/22/TN-ITS-viewpoints-on-the-revision-of-the-RTTI-delegated-regulation-2015-....pdf

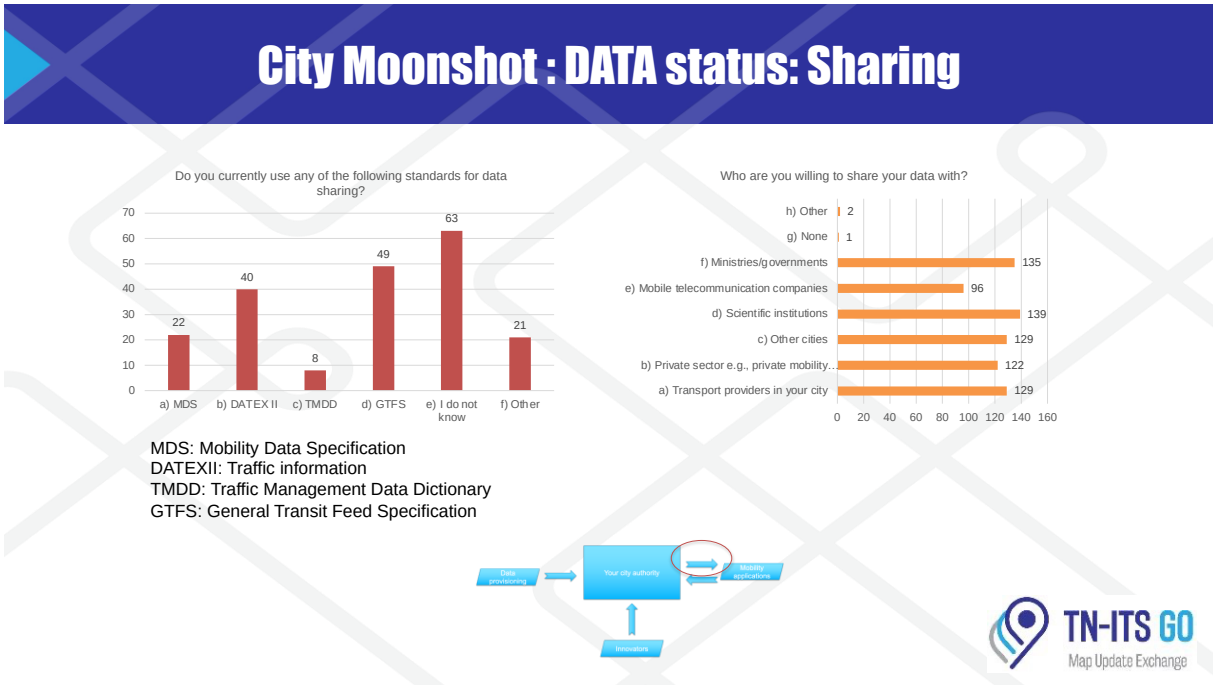

Figure 14: ERTICO City Moonshot: Status on Data sharing

Also the proposed revision of the ITS Directive, published on 14.12.2021 will support the proliferation towards TN-ITS use in cities:

The Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport describes

however, does include an important article :

"Article 1(6) provides for a new article ***requiring Member States to ensure the availability of data for the data types listed in the new Annex III and their accessibility on NAPs****, and for a new article requiring Member States to ensure the deployment of ITS services listed in the new Annex IV. "*

Annex III lists the geographical coverage and date

	Geographical coverage	Date
Types of data on regulations and restrictions (as referred to in Commission Delegated Regulation (EU) 2015/9626):		
Static and dynamic traffic regulations, where applicable, including: - access conditions for tunnels - access conditions for bridges - speed limits - freight delivery regulations - overtaking bans on heavy goods vehicles - direction of travel on reversible lanes	The trans-European network for roads, other motorways not included in that network and primary roads The entire road network of the EU that is publicly accessible to motorised traffic, with the exception of private roads	31 December 2025

6.5 Other Liaisons

6.5.1 LEX2Vehicle

The TN-ITS Association signed a letter of support for a research project in Germany, Austria and Switzerland on digitizing traffic regulations and laws, goal is to provide this information in a machine-readable format for ITS.

From the project website (https://lex2vehicle.com/en/project/):

Digitization of traffic law

A clear strategic objective can be found behind all activities in Lex2Vehicle: for every human road user, it should be as clear as possible at every point in the road network, at any time and in any situation, what they may and may not do. In a figurative sense, this also applies to any automated driving system. The goal of this research project is to explore this possibility as well as the associated limitations.

The current road traffic law certainly does not offer this crucial far-reaching clarity. The legal matters have grown over decades, still assuming that all road users are human. Simply communicating the existing regulations to automated vehicles – no matter how new the technical methods – will not have the desired effect, since automated driving systems, i.e. machines, require clear instructions and room to manoeuvre.

6.5.1.1 Relevance to TN-ITS

This results in the **following objectives** for the project at hand:

Those topics are highly relevant for TN-ITS and an alignment with several expert interviews was conducted. The results of the Lex2Vehicle study are expected to be available in June 2022.

7 Relation with the NAPs

At the time of writing, the TN-ITS platform entered the NAPCORE project and is mainly active in the Subworking group 4.2 of this project.

7.1 Introduction

7.1.1 Definition and envisioned role of a NAP (National Access Point)

Over the past years, the European Commission has published several Delegated Regulations with the aim to speed up the development of EU-wide interoperable travel and traffic services to end users, based on mainly existing digital data. As a consequence of these delegated regulations Member States have to set up National Access Points (NAP) that function as nodal points for (access to) data

<source: 25th ITS World Congress, Copenhagen, Denmark, 17-21 September 2018 ,Abstract ,Paper ID EU-TP1122 National Access Points: Challenges for Success, ***Ronald Jorna*** *Mobycon, The Netherlands* ****, Louis Hendriks*** *Rijkswaterstaat, The Netherlands,* ***Jacqueline Barr*** *IBI Group, Scotland* ***Peter Lubrich*** *BASt, Germany>*

7.1.2 NAPCORE project and TN-ITS[32]

The general objective of The NAPCORE project is to empower the National Access Points (NAPs) as the backbone for ITS digital infrastructure. Also, it will facilitate national & EU wide operational coordination for the harmonisation and implementation of the European specifications.

It has become apparent that NAPs and national bodies in each country are faced with common challenges and are looking for common solutions through working together. New challenges such as data collection activities and negotiations with private data providers and/or global players would benefit from being addressed jointly. The action « NAPCORE » was built in this spirit of consultation and cooperation. It is supported by all the Member States of the European Union as well as Norway and Switzerland as associated partners.

TN-ITS plays therefore an important role in the NAP federation architecture, as it is one of the basic data sharing services, accessible via the NAP. As the NAP experience in every country should be the same, it is important many European Member States' road authorities consider the implementation of the TN-ITS data exchange mechanism.

This SWG4.2 in general covers partly the continuation of the TN-ITS work and focuses on the integration with the standardisation activities within the scope of the NAP's. Building on the

[32] *< source final proposal NAPCORE>*

work that has been done in the previous PSA CEF project 'TN-ITS GO', where in this new NAPCORE project following priorities are set:

- Prepare extensions and enhancements of the TN-ITS stakeholder network services - both from public and private side,
- Continue to develop and promote the TN-ITS technical specifications, by safeguarding harmonisation between Member States, and in interaction with other custodians of relevant standards in the domain, with a specific focus on bidirectional data/information exchange between public and private stakeholders,
- Provide feedback on TN-ITS standardisation work to ensure uptake of findings and needs identified by NAPCORE stakeholders,
- Enhance the reliability of the TN-ITS data chain & data trust to enable new emerging applications or functional domains (in agreement of EU policies, cfr. revision of the ITS Directive), e.g. ADAS & AD systems,
- Engage the EU Member States community of experts in defining strategy & growth of the TN-ITS services and its assessment, capable of delivering required standards,
- To promote knowledge dissemination of such data sharing services and their benefits. Continue the TN-ITS support (website, documentation portal, etc.) and educate & train TN-ITS users/experts (in the different user levels and user groups within Europe, open to public and private organisations).

7.2 The EU NAP as a part of the TN-ITS data chain.

7.2.1 Current status

According to the recent Steering board dd 2/12/2021 information given by TN-ITS GO partners, the following member states have introduced TN-ITS services, exposed and accessible via their NAP. (info Visual progress monitor)

- Cyprus
- Finland
- Flanders
- Greece
- HU
- NL
- Norway
- Slovenia
- Spain
- Sweden

7.2.2 Envisioned TN-ITS future data chain

Chapter 2.2 figure 6 reveals the current TN-ITS data chain, achieved at the end of the TN-ITS Go project. (31/12/2021). This situation is not ideal because of the following major reasons

1) The feedback loop is established between the service providers and the Member state road operator. This interface is currently a direct interface between the two stakeholders. If TN-ITS will proliferate towards all Member states, cities, and private road operators, then, this architecture will require a multitude of interfaces for each service provider. Furthermore, the member state will be confronted with a variety of 'opinions' on data quality where it is hard for them to choose the right appropriate data quality improvement action.
2) It is not up to the service provider to act as the 'quality maintenance and feedback' function within the data chain, as this stakeholder is not recognised as a 'neutral party', nor can it obtain such status by e.g. regulatory means. Therefore, it is advisable the data quality control function is taken by another party. Potentially this could be a role for a NPA provider. Within NAPCORE, WG5 will address the issue of compliance and will probably form the right forum to discuss this topic.
3) Today the road authority fulfils two tasks in the TN-ITS data chain. The first task is to create (generate) the data, the second task is to publish the data. At this moment, the process of creating data is mainly a legacy action, by digitizing all existing physical infrastructure in the reference digital map (acting as a digital twin). This process is slow and hampers a fast market uptake of the TN-ITS service. Even tools like the Flanders Movin tool is not (yet) used as a digitalisation tool, but merely used as a kind of feedback loop to check if the (manually) entered data is right. The slow digitalisation process gives a lot of competitive force to private data providers to provide (non-regulatory and non-trusted) work arounds for providing RTTI information. We could imagine that the role of the road authority is exactly to provide the (Regulatory) trust on the published data, leaving the opportunity for any data provider to offer its data as a consideration towards the authority to 'accept it' and label it as 'trusted'. The current vast amounts of available data at private data providers can be an enormous driver for quicker deploy TN-ITS services . Potentially there is a also a lot of cot to gain for the involved road authority.

These considerations lead to the modification of the TN-ITS data chain picture towards the following figure:

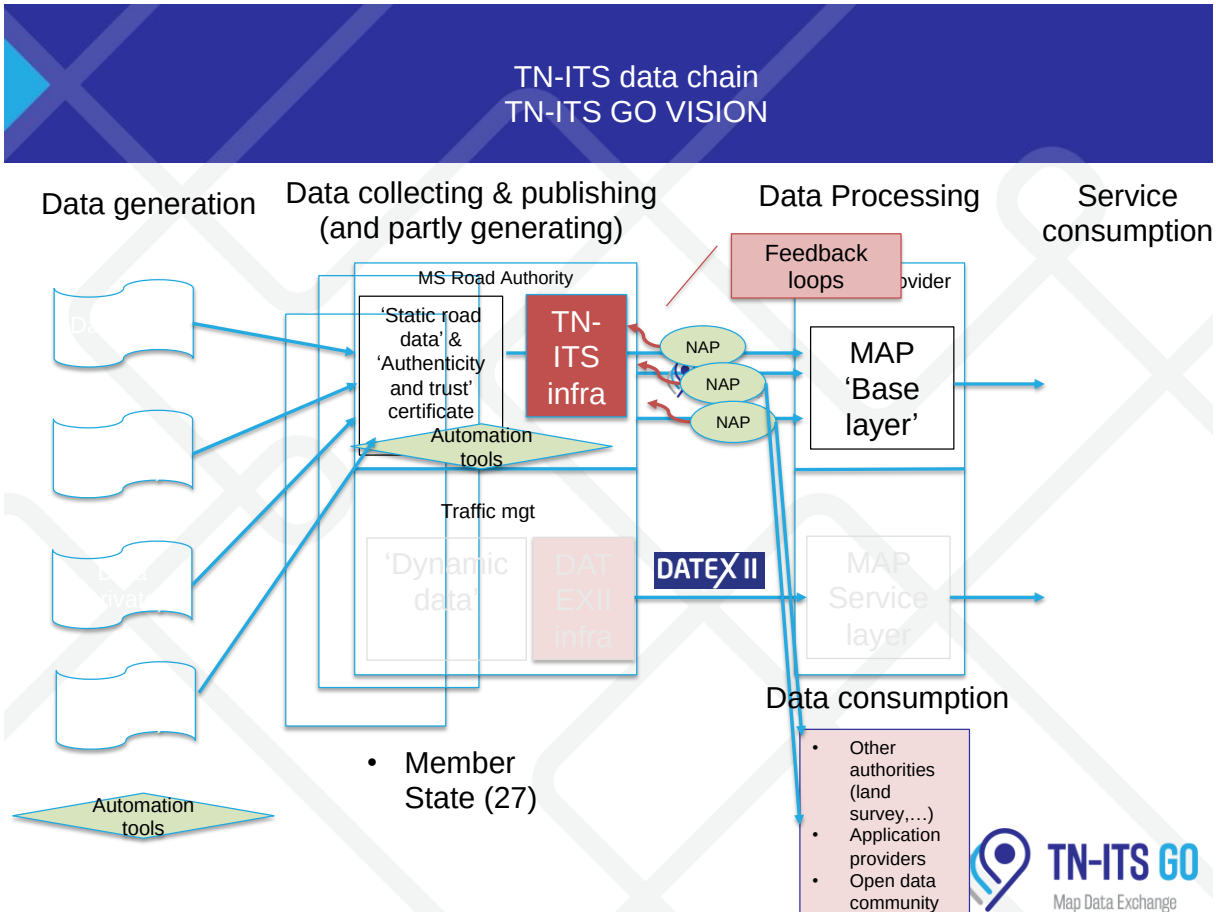

Figure 15: Envisioned TN-ITS data chain

7.2.3 Potential solutions and tools that NAP could provide to the TN-ITS data chain.

In the previous paragraph we discussed the potential role of NAP in the 'future' TN-ITS data chain. In this chapter we analyse again the requirements (Chapter 3) and potential roles that the NAP could take to improve on the various aspects of the TN-ITS data sharing mechanism.

The following are priority discussion points within NAPCORE WG3 and 5:

- Data Quality aspects – from NAPCORE Project WG 3 and the EU-EIP
- The path towards trusted regulatory data
- Ho to create and deploy the 'Trust Logo'
- Discussion on the "Compliance" in WG 5.5 NAPCORE group– Definition align with NAPCORE
- NAPCORE and SLA between NAPCORE & data providers
- Supply chain aspects
- Cross boarder service

Stakeholder	Data chain function	Aspect	Requirement	potential tools and methodologies as solutions for requirements	Details	NAP Potential
Authority						
	Data (regulation data...)	Trustable	Credibility, reliability, or reputation	Watermark/logo//based on all other aspects below.	Creation of watermark is TN-ITS forum, Deployin the watermark is MS -should be on feature level-marketing	NAP potential (although real trust should remain at the authority level)
		Secure	Access rights, modifiction/read /write /personnel code/...	Local MS to organise the security aspects and service level agrrements with subcontracts	ROLE OF NAP? SECURE PIPING NECESSARY/Cfr MDM Germany (security certificates/Who is using the data// NAP needs registration tools and authenticity tools	NAP attention point
		Authenticity & Authentication	Authority by regulation?		see above	
		Quality	Correctness	Feedback loop--correctness on syntax (today)--Manual process (Validation tool)-	fit with reality? --SENSORIS ?-payd service by the service provider-collaborative tool for citizens (Like Waze,...)	NAP can interface feedback loops
			completeness or comprehensiveness	we lack the overal regulation (METR?)	see above	Monitoring function?
			consistency, coherence, or clarity		see above	Monitoring function?
			accuracy		see above	
			timeliness or latency (freshness)	from regulation to dataset	guidelines, metadata description, last changed timestamp/ Operational excellence label	Attention point for NAP
			validity or reasonableness		validy time stamp is available in tTN-ITS Go (occasonally)-e imposed -	Metadata within NAP
		Compliance to specification	CEN based formats	feedback loop	validation tools (HERE-TomTOm) available	Potential function
		Documented		MUST		Attention point for NAP (Log functions?)

Stakeholder	Data chain function	Aspect	Requirement	potential tools and methodologies as solutions for requirements	Details	NAP Potential
Authority (C'tnd)						
		Performance	Geo coverage representation	% of network	revision of RTTI delegated act says only primary roads	Metadata within NAP, SLA needed with publishing Road authority
			Road attribute coverage	% of the list of manadatoryattributes	RTTI delegated act revision	Metadata within NAP, SLA needed with publishing Road authority
			Accessibility	NAP		Metadata within NAP, SLA needed with publishing Road authority
			Availability			Metadata within NAP, SLA needed with publishing Road authority
			Update frequency	Version mgt of spec--Related to CEN and the commissionm		Metadata within NAP, SLA needed with publishing Road authority
	MS database	Secure	protection against attacks	should be easy for data users/Should be uniform across EU	best practice guidance inpires by the MS--state of the art	Attention point for NAP
		Access rights				Attention point for NAP
		Quality aspects				
		Data integrity				Attention point for NAP
		Unique identifier ?	cfr Visual progress monitor			Attention point for NAP
		Time management : beginLifeSpanVersion, endLifeSpanVersion	cfr Visual progress monitor			Attention point for NAP
	MS ICT infra	itil?				Attention point for NAP
	MS TN-ITS infra	Service compliance according TN-ITS API		feedback loop		
	Automation tools data/Capturing population	Accuracy	Geolocation, validity time, Time stamp			
		Correctness				
		Authorised personnel				
Comms	Comms channel		Integrity			Attention point for NAP
		https? File download	encryption			Attention point for NAP

Table 9: Potential roles for NAP in relation to TN-ITS data

7.2.4 Potential role for Gaia-X in the TN-ITS data chain

Gaia-X[33] is a project initiated in 2019 by Europe for Europe and beyond. Representatives from business, politics, and science from Europe and around the globe are working together to create a federated and secure data infrastructure. Companies and citizens will collate and share data – in such a way that they keep control over them. They should decide what happens to their data, where it is stored, and always retain data sovereignty.

TN-ITS did not yet study in detail the role of Gaia-X in the TN-ITS data chain and will probably be taken up in the NAPCORE activities. The first insight is that Gaia-X is a basis for a new data related ICT infrastructure. This infrastructure could enhance the interchange of data between data providers and the road authorities (figure 14). Of special relevance is their use case Mobility - Data Interoperability and Data Sovereignty, focusing on intermodal solutions in transport. In the near future, TN-ITS will connect to the Brussels based Gaia-X non profit organisation.

7.3 TN-ITS and its cooperation with NAPCORE

In previous paragraphs, we discussed potential roles to potentially take up by NAP within the TN-ITS data chain.

These paragraphs reveal the structure of NAPCORE working groups and how TN-ITS is embedded and interface to the complete work content of NAPCORE. It lines out the Paragraphs on:

<Source: NAPCORE Final proposal>

7.3.1 NAPCORE Project structure

Without detailing the complete figure below, giving the overview of the complete NAPCORE project structure, we identify the Sub working group 4.2 where further work on TN-ITS is planned and how it will be carried out, especially for its task T4.2.1 about alignment and harmonisation of data standards.

[33] https://www.data-infrastructure.eu/GAIAX/Navigation/EN/Home/home.html

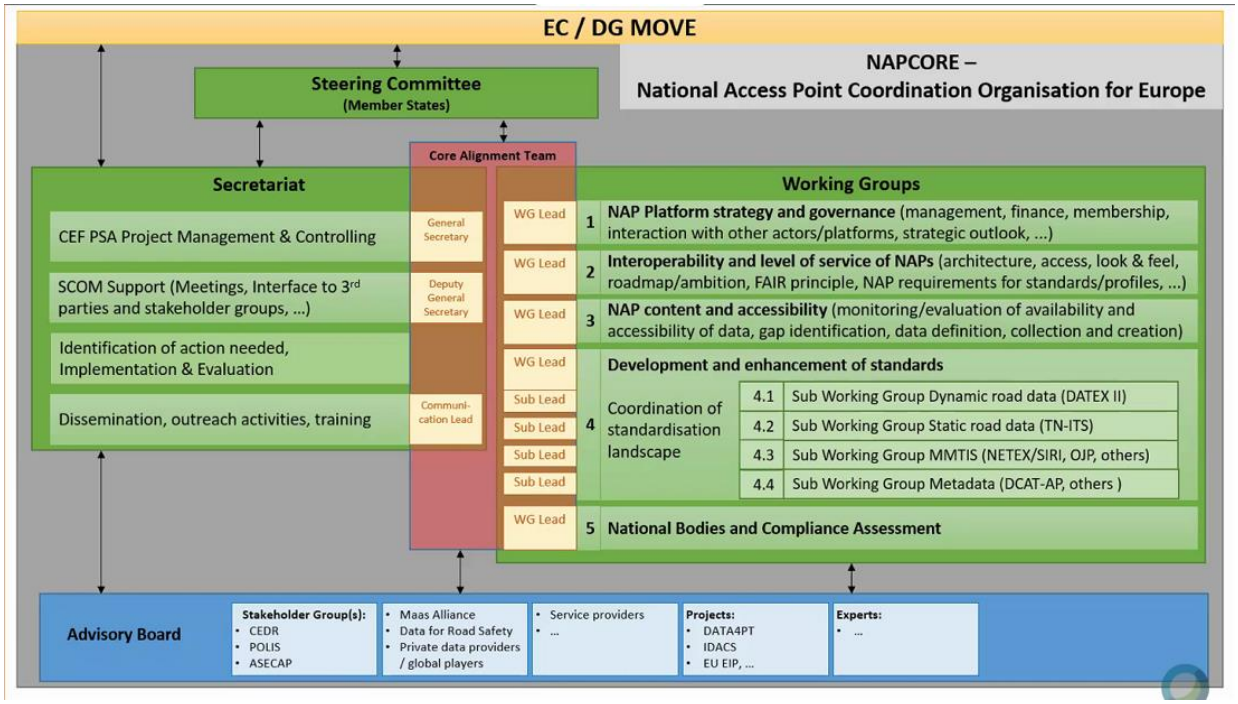

Figure 16: NAPCORE project structure

7.3.2 TN-ITS and NAPCORE

The interaction between the TN-ITS ERTICO innovation platform and the NAPCORE related Subworking group 4.2 is illustrated by the following picture

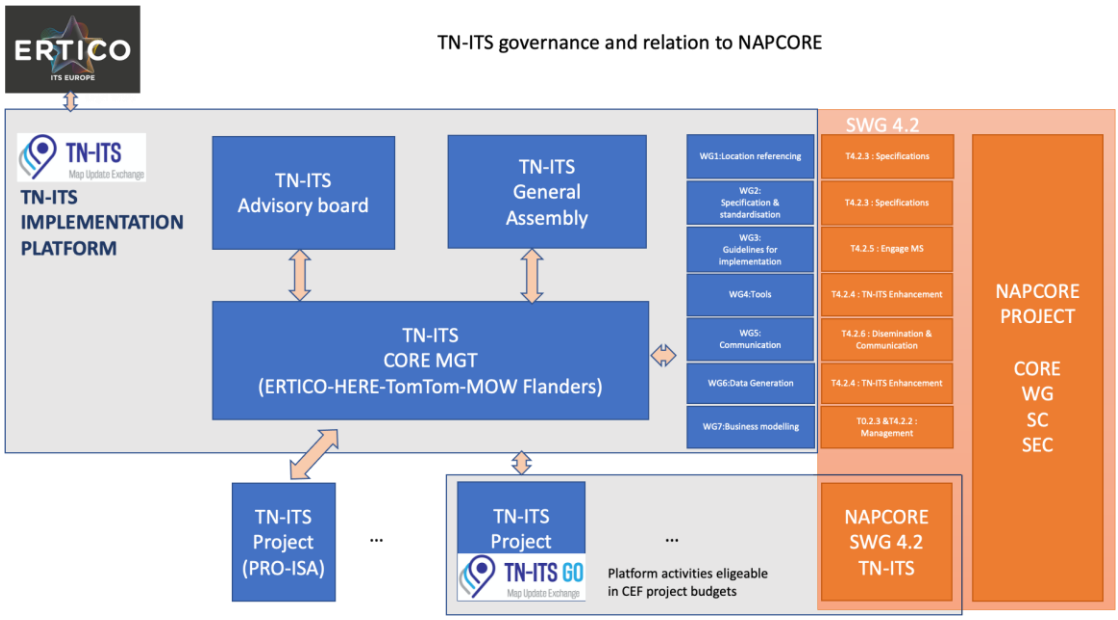

Figure 17: TN-ITS and NAPCORE relation

Besides this interaction between the TN-ITS existing workgroups and the NAPCORE tasks within SWG4.2 , TN-ITS is also active in WG3 and follows closely WG5.

Especially Work Group 3 is interesting to clear out topics as ‘overlap’ between some of the data objects and their attributes that exist today between e.g. DATEX II and TN-ITS. This subject is out of scope for this deliverable.

8 Conclusions

This document has described in detail the current TN-ITS data chain, its functionalities, their requirements, and the involved actors. We also touched upon relationships with other existing platforms, associations, and potential new stakeholders like cities and how they can influence the data chain and TN-ITS in particular. We analysed detailed case studies like ISA and Automation and their influence and relationship with TN-ITS.

The results achieved by the TN-ITS Go project are beyond the simple implementation of the services into 14 member states, mainly focussed to the TEN-T network. The project revealed a lot of insights on today's specification, the actors, the data chain requirements. Vast insights on the experiences that member state road authorities have gained by solving their particular road blocks are generated. This knowledge and insights will help the TN-ITS to perform their further tasks in SWG4.2 of NAPCORE, and in addressing the assessments and recommendations task related to Member state and other road authorities. NAPCORE will boost the dissemination power of TN-ITS and ensure its essential complementary role, next to DATEX II and public transport data' in the EU federated NAP infrastructure.