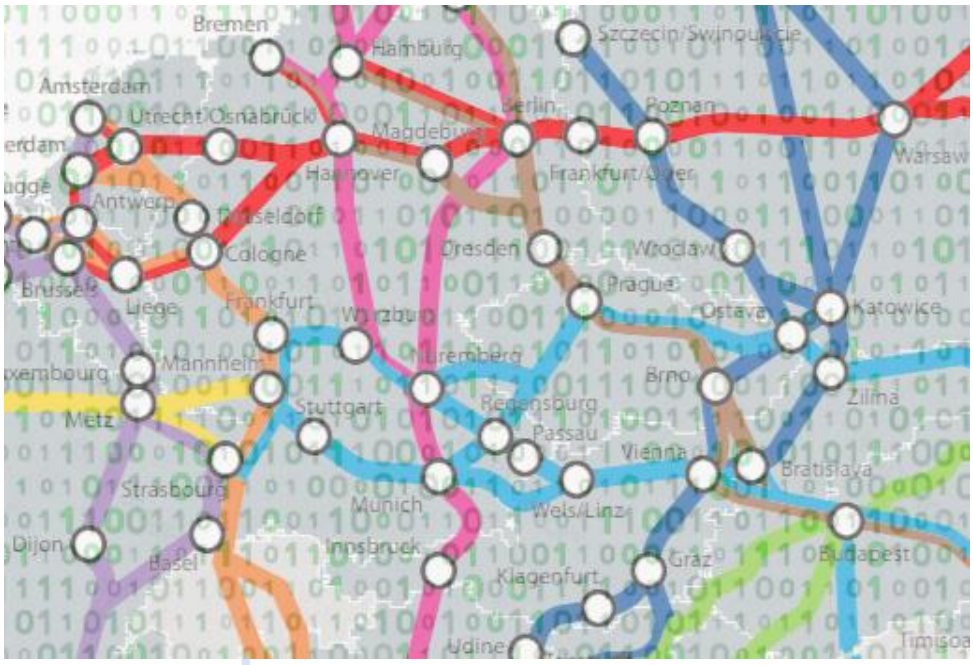
D4 Roadmap

Recommended Actions for Core Network Corridor Digitalization

Final report from EU EIP Activity 4.3 European ITS Deployment Roadmap



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2. Preface

The objective of EU EIP sub-activity 4.3 is to support the alignment of national, regional and CEF corridor ITS deployment plans to achieve higher efficiency in ITS deployment and more impact from the use of ITS.

The aim of this report is to propose ITS actions for Core Network Corridor digitalization that are not naturally accounted for in local or national programs. This means actions that are designed for and implemented on a corridor level and which will require international cooperation for their realization. Furthermore, the actions proposed are designed to be executed in a near future, before the end of 2025, and are based on the use of existing technologies.

This report has been developed by the EU EIP Sub-activity 4.3 Task Force and include the results from literature studies and workshops held 2017-2020 together with findings from earlier work on ITS Deployment Roadmaps in the framework of predecessors to EU EIP.

The work has been coordinated by Arne Lindeberg, Swedish Transport Administration.

3. Executive Summary[1]

3.1. Digitalization for European development

Through the European Strategy for Data[2] and the Strategy for Sustainable and Smart Mobility[3], the European Union has pointed at digitalization as a key element in future European development. Digitalization and data-driven innovation is expected to bring enormous benefits for citizens, not least within the mobility sector where digitalization will contribute to safer and more efficient transport with far less impact on the environment than what we currently see. Digitalization is also a prerequisite for electric and automated mobility which are important parts of the European Green Deal.

A growing economy with an increasing demand for transport of goods and people meet serious limitations to the possibility to expand the physical transport networks. In large parts of Europe investments in infrastructure are limited to elimination of bottlenecks and safety hazards. Increasing capacity by adding infrastructure has become very complicated and brings tremendous costs, while also issues about land-use and climate change can be prohibitive to building or expanding. Instead, increased capacity follows from better use of investments already made which can be achieved through further digitalization. This will also help to realise multimodal mobility and address issues of safety and climate change. In addition, the users of the transport network will experience new and better services through access to digital means. Hence digitalisation of road transport with smart traffic management as well as new services provided by road operators and other, also private, actors can make significant contributions to Europe's mayor goals.

Digitalization is a cornerstone in the build-up of Core Network Corridors (CNC) which comprise a combination of transport modes and infrastructures linking European cities and regions. When combined they offer possibilities for complex transport schemes arranged to optimize transport performance, minimize environmental impact and bring important value to users. Although the CNC´s have been identified and given a policy oriented organization[4] it is not to be expected that actual operation of a transport corridor is subject to centralized management. I.e. there will be no "operations centre" for a CNC, not even for a

[1] This Executive Summary has been issued as a Policy Brief for a webinar 4 December 2020

[2] 19 February 2020

[3] December 2020

[4] Demonstrated by the allocation of Corridor Coordinators

specific transport mode within the CNC[5]. Instead a CNC will be coordinated through cooperation between independent stakeholders through which arrangements and agreements on service design and service offers have been made on basis of harmonization.

However, experience shows that planning and budgets from a national perspective do not give a sufficiently high priority to multi-national cross-border investments to equip the European road corridors with the harmonized systems and services needed or demanded. Data driven innovation is hampered by lack of harmonization and scattered development. The European ITS Platform, EU EIP, has through a specific activity[6] investigated the challenges and opportunities to CNC digitalization, and identified key actions that should be given high priority in development work ahead. Focus is on actions primarily addressing road transport and its intermodal connections and related to border crossings (institutional as well as physical), as they to their nature require institutional cooperation since no single stakeholder is a natural driver of development. Furthermore, the actions proposed are designed to be executed in a near future, before the end of 2025, and are based on the use of existing technologies.

3.2. Three characteristics of a digital Core Network Corridor

The basis for our selected actions is that a digital CNC is characterized by three characteristics:

The driver, cargo and the vehicle experience a seamless transport system

The driver, the cargo and the vehicle systems do not experience “borders” along the transport route. Neither between geographical areas nor between transport modes. Systems and services are provided in accordance with the user needs and preferences.

Relevant stakeholders and organizations cooperate

Organizations that contribute to the development, delivery and operation of a digital CNC work together through established fora and formats where responsibilities are clearly defined and evolution is supported. As digitalization contributes to a rapid growth in economy with new actors and new services, new business models and business relations will emerge based on common interests.

[5] Whereas air transport through Eurocontrol can be seen as subject to a centralized operation

[6] SA 4.3 Actions for CNC Digitalization (ITS roadmap)

Data is always available

The key to a seamless transport system is accessibility to and availability of data. All relevant data must be available and accessible for all needs at any moment to any entity in the system, and business models for the supply and use of data shall be transparent and appropriate.

In the following, a set of actions found to be essential in order to reach these characteristics are described. It must be understood that in addition vast investments must be made in the digital infrastructure; roads with sensor systems and their digital representation, communication infrastructure, management centres, mode interchange points and vehicles. These investments must be continuous for maintenance, operation and upgrades and are essential in order to safeguard safety, fluidity and mobility on all roads at any time.

3.3. Actions for a seamless transport system

3.3.1. SERVICE HARMONIZATION

Users of the CNC shall perceive services provided as seamless in terms of content and interface.

The key element of the work will be to provide common (European) guidelines for service design regarding principles for user and vehicle interfaces (how), location (where) and provision of services (when) including quality definition and requirements. Supplementary well documented Best Practises will be a cornerstone in the work. As local adaptations will be needed, these guidelines shall function as voluntary harmonization tools.

Public / National road authorities play a central role in this development as they have the responsibility on their respective road sections and a suitable format is a platform driven development. The ITS Corridor projects and their cooperation through the EU EIP platform is a good example of a suitable organization. Development and piloting of solutions will require European financial support, e.g. through the CEF programme (this is not a research activity).

3.3.2. GEOLOCALIZATION AND GEOFENCING

European road operators / authorities need an agreed method to define Operational Design Domains (ODD) for the purpose of traffic regulation and operation. In particular considering future generations of self-driving vehicles, e.g. where certain levels of automated driving are allowed and where not, and electric mobility, e.g. where are use of fossil fuels not allowed.

Much of the needed basis seems to be available (e.g. through standards[5] and the INSPIRE directive specifications), but development of specifications are essential in order to establish operational implementations (profiles) of the standards when available. Following this, tests and pilot activities have to be carried out involving

OEM´s and Public / National Road Authorities. European institutions must engage and take a strong position in the initial phase. Possible complementary actors are CEN, CEDR, EC, ASECAP, ACEA (OEM´s). Development and piloting of solutions will require European financial support, e.g. through the CEF programme.

3.3.3. DIGITAL TRAFFIC REGULATIONS

Traffic regulations and other forms of restrictions or guidance that are needed for a driver / vehicle to perform in accordance with rules set when driving, including on road sections of the CNC, have to be available in real time in a known digital format through a known interface.

Standards are needed as a base[7] but also specifications are essential to establish operational implementations (profiles) of the standards when available. Tests and pilot activities have to be carried out involving OEM´s, national and local authorities etc. For this public / national authorities have to play a central role in the development. And as the need is European, European institutions must engage and take a strong position in the initial phase where possible actors are CEDR, EC, ASECAP, ACEA, POLIS etc. Development and piloting of solutions will require European financial support, e.g. through the CEF programme (this is not a research activity).

3.4. Actions for stakeholder cooperation

3.4.1. A COMMON UNDERSTANDING OF EFFECTS

European road authorities / operators shall have continued access to data enabling adequate assessment of costs and benefits related to ITS deployment, in particular concerning cross-border investments. To allow for benchmarking between CNC´s and to ensure that the correct data is collected, a common view on suitable KPI´s for CNC performance assessment constitute a basis.

The action is similar to what is currently carried out by the ITS Corridor projects and EU EIP, where data from assessment of ITS deployment projects are compiled in accordance with common guidelines and results are compiled and published on a European level. The work will need to account for also new KPI´s, e.g. related to a corridor perspective. Road authorities and road operators have to contribute with assessment data, and need to cooperate also on the compiled assessment. Also organizations like CEDR and ASECAP are relevant as stakeholders. This action will clearly benefit from European support, but stakeholder own interest (policy interest) is an important driver.

[7] Reference to CEN TC278 WG17 Urban ITS

3.4.2. THE ROAD CORRIDOR INFORMATION DOCUMENT (ROAD CID)

The Road CID is a structured way of describing CNC´s. It contains descriptions of the general structure of the corridor, including network overview and organisations concerned. It describes how the traffic management centres are structured and their corresponding areas, and which ITS services (with focus on services relevant for corridor operation like HGV parking) are available and where TMP´s are in operation and how they connect. Hence the Road CID provide the reader/user with an understanding of the general structure of traffic management on the corridor level. Each CNC shall develop a Road Corridor Information Document and establish an organization / solution for the continued management of this document. “Document” shall be understood as a suitable form for management and distribution of the information contained, hence it may be a website etc.

Public / National road authorities have to play a central role in the Road CID development. In particular as they will have the full responsibility to ensure completeness and correctness of information supplied. Also, European institutions through the Corridor Coordinator offices, have a strong interest and should be engaged in the work. Possible further actors are CEDR and ASECAP. Development and piloting of solutions will require European financial support, e.g. through the CEF programme. In the end, regulation may be needed to ensure that countries provide the information required in the agreed format through the agreed channels.

3.4.3. PLATFORMS AND CHAMPIONS

No single organization (beside the EC) governs the process of realizing cross border digital transport corridors. Therefore several platforms, i.e. organizations for collaboration towards common goals, have been set up, each contributing by adding pieces to the work needed. There is a growing need for this ahead. A dedicated platform (-s) committed to improve CNC performance through use of ITS applications shall be in place, and individual champions, usually twins, formal/political and informal/technical, shall have leading positions in the work within specific areas.

For CNC digitalization it is recommended to combine efforts between CNC Coordinator offices and national road authorities / operators into a CNC Digitalization Platform. Prominent stakeholders are as well European institutions (that benefit from the work done in platforms) as stakeholders that might fear missing out on influencing the process. “Lobby organisations” like UITP, ASECAP, CEDR, ACEA, POLIS etc. are natural participants in ITS related platforms beside business and public partners. For the cause of CNC digitalization, key stakeholders are Road operators and authorities mainly on the national level, similar to what is seen in e.g. EU EIP. Two typical, albeit quite different, models are given by the CCAM Platform and the EU EIP project whereas the latter

includes considerable financial support (and co-funding by partners) in return for work done. Participation in the CCAM platform is driven mainly by Business and Policy interest. An interesting format concerning Champions is the assignment of Corridor Coordinators for the CNC´s, with the role of pushing work forward.

3.5. Action for data accessibility and availability

3.5.1. INTEGRATED INFORMATION MANAGEMENT

Seen from a user or service provider perspective, road transport related information for all of Europe shall be accessible through an access point of free choice. The action aims at establishing data standards (standard profiles) to ensure that data is correctly interpreted and the quality level is known. The action will also cover business aspects including information on which data is available where and on which conditions, in support of integration. Building on the framework of current and future amended ITS legislation, the action can be seen to extend the proposed initiative for a project aiming at federating NAP´s.

Stakeholders are primarily found among organizations with a strong business interest in data management and provision. Service providers like TomTom and Here, OEM´s and data warehouses are evident stakeholders. Also experts in high speed commercial data exchange like Ericsson and Vodafone are relevant. Data owners, providers, like national road authorities have an important role to play. Development and piloting of solutions will require European financial support, e.g. through a Framework Programme project.

TABLE OF CONTENTS

1. Document Information **2**

2. Preface **3**

3. Executive Summary **4**

3.1. Digitalization for European development 4

3.2. Three characteristics of a digital Core Network Corridor 5

3.3. Actions for a seamless transport system 6

3.4. Actions for stakeholder cooperation 7

3.5. Action for data accessibility and availability 9

4. Introduction **13**

4.1. A European perspective on Core Network Corridor Digitalization 13

4.2. The Work on EU EIP ITS Deployment Roadmap 14

4.3. Methods applied 15

4.4. Readers guide 16

5. Basic principles for CNC operation **17**

5.1. A CNC will not be subject to centralized management 17

5.2. Corridors are for freight, traffic take place in networks 17

5.3. Conditions will vary along a corridor – the local situation must be known 18

5.4. The CNC Coordinators view on ITS needs 19

5.5. Key driving forces behind ITS deployment 20

5.6. CNC Digital infrastructure 22

6. Assessing Corridor Performance 25

6.1. Performance indicators for transport corridors 25

6.2. Performance indicators targeting digital performance 26

6.3. Proposal for CNC KPI´s supporting multi-modality 27

7. Measures to support Core Network Corridor integration 29

7.1. CNC goal statement 29

7.2. Service harmonization 29

7.3. Organization – Champions and Platforms 31

7.4. The Road Corridor Information Document (RCID) 34

7.5. Technical development 36

7.6. Geofencing – Area definition 39

7.7. Digital Traffic Regulations 42

7.8. Integrated information management 45

7.9. Performance measurement and assessment of effects. 48

8. Drivers to make things happen 51

8.1. Drivers for CNC digitalization 51

8.2. Conditions supporting ITS deployment 51

8.3. ITS Deployment driver efficiency 52

9. Proposed actions 53

9.1. Actions to establish an organizational base 53

9.2. Actions to establish the needed technical preconditions 55

9.3. Actions for CNC performance assessment 60

10. Conclusions 62

11. References 64

12. Glossary and abbreviations 67

4. Introduction

4.1. A European perspective on Core Network Corridor Digitalization

Through the European Strategy for Data[8] and the Strategy for Sustainable and Smart Mobility[9], the European Union has pointed at digitalization as a key element in future European development. Digitalization and data-driven innovation is expected to bring enormous benefits for citizens, not least within the mobility sector where digitalization will contribute to safer and more efficient transport with far less impact on the environment than what we currently see. Digitalization is also a prerequisite for electric and automated mobility which are important parts of the European Green Deal.

A growing economy with an increasing demand for transport of goods and people meet serious limitations to the possibility to expand the physical transport networks. In large parts of Europe investments in infrastructure are limited to elimination of bottlenecks and safety hazards. Increasing capacity by adding infrastructure has become very complicated and brings tremendous costs, while also issues about land-use and climate change can be prohibitive to building or expanding. Instead, increased capacity follows from better use of investments already made which can be achieved through further digitalization. This will also help to realise multimodal mobility and address issues of safety and climate change. In addition, the users of the transport network will experience new and better services through access to digital means. Hence digitalisation of road transport with smart traffic management as well as new services provided by road operators and other, also private, actors can make significant contributions to Europe's mayor goals.

Digitalization is a cornerstone in the build-up of Core Network Corridors (CNC) which comprise a combination of transport modes and infrastructures linking European cities and regions. When combined they offer possibilities for complex transport schemes arranged to optimize transport performance, minimize environmental impact and bring important value to users. Although the CNC´s have been identified and given a policy oriented organization[10] it is not to be expected that actual operation of a transport corridor is subject to centralized management. I.e. there will be no "operations centre" for a CNC, not even for a

[8] 19 February 2020

[9] December 2020

[10] Demonstrated by the allocation of Corridor Coordinators

specific transport mode within the CNC[11]. Instead a CNC will be coordinated through cooperation between independent stakeholders through which arrangements and agreements on service design and service offers have been made on basis of harmonization.

However, experience shows that planning and budgets from a national perspective do not give a sufficiently high priority to multi-national cross-border investments to equip the European road corridors with the harmonized systems and services needed or demanded. Data driven innovation is hampered by lack of harmonization and scattered development. In EU EIP Sub-activity 4.3[12] we have investigated the challenges and opportunities to CNC digitalization, and identified key actions that should be given high priority in development work ahead.

Focus is on actions primarily addressing road transport and its intermodal connections and related to border crossings (institutional as well as physical) as they to their nature require institutional cooperation since no single stakeholder is a natural driver of development. Furthermore, the actions proposed are designed to be executed in a near future, before the end of 2025, and are based on the use of existing technologies.

4.2. The Work on EU EIP ITS Deployment Roadmap

The work for this report has been carried out in three phases. The work in the first two phases, reported in *ITS Vision, a scenario for ITS deployment on European road transport corridors accounting for regional preconditions*[13] concludes that with the purpose of designing a roadmap for establishing and operating ITS that aim at optimizing network/corridor performance we can see that three important prerequisites need to be fulfilled:

- There is a need for harmonization (architecture and specifications)
- Drivers, including incentives, will be required
- Stakeholder responsibilities need to be developed

The work in Phase 3 focused on the second bullet, assessing the importance and strength behind different drivers and incentives, reported in *ITS Deployment Drivers, Incentives and other mechanisms supporting ITS deployment on transport*

[11] Whereas air transport through Eurocontrol can be seen as an example of centralized operation

[12] ITS Deployment Roadmap

[13] D1 A scenario for ITS deployment on European road transport corridors accounting for regional preconditions, EU EIP SA 4.3 February 2017

corridors[14], which has led on to development of stakeholder responsibilities and needed actions. This is reported in this document, the final report from the work.

As shown in the studies presented in our previous reports, road operators primarily focus on solving local needs through local measures. To establish and operate ITS that optimize network/corridor performance, various drivers (including incentives) are needed to ensure that stakeholders also value and include the corridor perspective in their investment decisions.

This report outlines a roadmap where we combine development needs (what), stakeholder responsibilities (who), potential drivers and incentives (how) and a possible timeline (when) for delivering key initiatives that have been found to be critical for digitalization of road transport on Core Network Corridors.

4.3. Methods applied

The following methods have been used within the work:

- Literature studies (all through the process)
- Workgroup meetings (internal workshops)
- External workshops (e.g. in conjunction with ITS World and European Congresses)
- Surveys and questionnaires

Details on these are reported in annex.

The work process applied in the EU EIP ITS Deployment roadmap activity can be summarized with the following steps:

1. Identify characteristics of a corridor perspective – the target situation.
2. Clarify which systems and services that support this development and how a corridor perspective differ from a local perspective – what is the required add on? (**what**)
3. Identify and describe drivers that contribute to development and implementation of these systems and services in support of corridor performance (**how**)
4. Assess the possible impact of these drivers
5. Identify mechanisms that support the development of these drivers
6. Clarify stakeholder responsibilities (**who**)

[14] D2 ITS Deployment Drivers, Incentives and other mechanisms supporting ITS deployment on transport corridors, EU EIP SA 4.3 February 2019

7. Design a timeline for possible realization of the needed development (**when**)
8. Construct a roadmap combining the what, how, who and when

4.4. Readers guide

The main part of this document is structured in 6 sections:

Introduction and methodology (chapter 4)

Describes the background to the work and how its has been carried out.

Basic principles for CNC operation (chapter 5)

Discuss and provides a set of position statements on development and use of ITS systems on which the roadmap is based.

Assessing Corridor performance (chapter 6)

Distinguish corridor performance from local and regional networks performance. What is a relevant corridor KPI?

Measures to support Core Network Corridor integration (chapter 7)

Describes different kinds of ITS related measures in support of Core Network Corridor performance and integration.

Drivers to make things happen (chapter 8)

Discuss adequate support mechanisms for CNC development.

Catalogue of proposed actions (chapter 9 and 10)

Details a set of proposed actions, with associated stakeholders, to be included in further work planning.

The result is presented in a summary table in final chapter.

5. Basic principles for CNC operation

This report provides recommendations for actions in support of CNC digitalization. As this is a very wide concept, the preconditions need to be narrowed down to allow for more precise recommendations.

In this section a set of basic principles and findings from work in the roadmap activity are stated on which the recommendations are based.

5.1. A CNC will not be subject to centralized management

A Core Network Corridor comprise of a combination of transport modes and infrastructures linking European cities and regions. When combined they offer possibilities for complex transport schemes arranged to optimize transport performance, minimize environmental impact and bring important value to users.

Although the CNC´s have been identified and given a policy oriented organization[15] it is not to be expected that the actual operation of a transport corridor is subject to centralized management. I.e. there will be no “operations centre” for a CNC, not even for a specific transport mode within the CNC[16]. Instead a CNC will be coordinated through cooperation between independent stakeholders through which arrangements and agreements on service design and service offers have been made on basis of harmonization.

5.2. Corridors are for freight, traffic take place in networks

Even on road sections being part of a CNC, more than 90% of the traffic load constitutes of passenger cars conducting local journeys (less than 30 km[17]). The remaining 10% are HGV´s, whereof 70-80% are engaged in local transport operations[18].

This is reflected in how traffic is managed: Local or regional Traffic Centres are organized to deal with local concentrations of traffic in urban regions, with focus on alleviating congestion in bottlenecks, reducing the impact of accidents and incidents, and making sure that the road network is open in times of harsh weather

[15] Manifested by the allocation of Corridor Coordinators

[16] Whereas air transport through Eurocontrol can be seen as subject to a centralized operation

[17] The daily average is in the same order, whereas it includes more than one journey

[18] Source Eurostat

conditions. Hence, when ITS investments are made, the benefits are estimated from how different measures can contribute to improving and safeguarding the traffic flow on highly occupied road sections, in general close to urban areas.

The corresponding performance criteria for a traffic network will thus be number of accidents, average speed, time lost in congestion, emissions following from inefficient traffic etc.

The basic motivation for Core Network Corridors is not to offer safe and free flowing traffic, but to offer timely and efficient long-distance transport in order to support e.g. the European cohesion goals. One can say that transport is what you see if you look on the European road network from a satellite, while traffic is what you see through a roadside camera.

Consequently, while passenger time savings and safety constitute the major benefit following from local ITS investments, cargo “time savings and security” will constitute the major benefit from investments in transport corridors.

However, cargo time savings are different from personal time savings. A shipment that arrives earlier than planned does not necessarily bring a benefit, it may even raise costs, similar to that a shipment with critical components arriving late may cause severe problems in industrial operations. This is why quality in logistic chains is rather expressed as *Just On Time and Secure* rather than *Fast*.

5.3. Conditions will vary along a corridor – the local situation must be known

Local, or regional, traffic management and control is subject to uniform control mechanisms. Systems and services are integrated to allow for efficient management of traffic flows, and a “network” is in general controlled from one Traffic Management Centre with specific policies implemented.

Hence it is rational that the traffic manager communicates directly with the drivers (vehicles) and a natural way to manage traffic is then through roadside signs and panels as they provide a coherent intelligent infrastructure. This is also the design that can be found all over the world when looking at urban centres.

When looking at a transport corridor, stretching across Europe, we see something very different. Conditions will vary in many ways: the road typology will change, the traffic load will vary, the level of ITS will change, different sections will be controlled by different traffic centres etc. and the driver (vehicle) will meet different policies applied through systems and services. A road section operated as a commercial toll road will have different driving forces implemented in the control mechanisms than a public road.

This is an argument for not defining a uniform solution for a road transport corridor. The service offer will vary along a transport corridor and it is not even relevant to offer the same service levels and level of quality along a corridor.

As we conclude that, we must add the key point: The residing condition at every point along the route must be known. Not only the status, but also the quality of the status assessment made.

5.4. The CNC Coordinators view on ITS needs

5.4.1. FIVE ISSUES IDENTIFIED

The 2013 TEN-T Guidelines set a range of binding standards for infrastructure development as well as for transport services to become safer and more energy efficient. The guidelines include, for example, reinforced provisions on ITS deployment in connection with traffic management and multimodal transport solutions.

Complementary to the traditional infrastructure approach, the CEF Corridor Coordinators have together made a deeper analysis of areas which are situated at the interface between infrastructure development and service operation or where transport policy challenges must be integrated. Five issues have therefore been looked at in more detail in the Issues Paper[19]. A short summary is given below:

1. Enhancing multi-modality and freight logistics

To enhance multi-modality and efficient freight logistics, terminal infrastructure, terminal accessibility and relevant ICT infrastructure need to be developed from a reinforced corridor-wide perspective, as well as with a better integration of users' needs and demand forecasts; selected corridors shall serve as test cases for the digitalization of freight transport.

2. Promoting ITS/ Boosting investments

To boost Intelligent Transport Systems, a coordinated ITS deployment beyond the so-called ITS corridors must be promoted; building on the C-ITS Platform and the Amsterdam Declaration, investment in digital infrastructure shall be stimulated to deploy cooperative intelligent transport services by 2019; new mobility services shall be enabled by enhancing data accessibility trough national access points and by linking travel information services along corridors.

3. Boosting new technologies and innovation

To further boost new technologies and innovation in transport, the governance and cooperation structure of the corridors shall be used to the best of its possibilities to

[19] ISSUES PAPERS OF EUROPEAN COORDINATORS, 2016-05-12

deploy results of research and innovation activities in line with strategic transport policy objectives, to boost common commitment of actors (researches, industry, TEN-T stakeholders) and to create strong "flagship" cases.

4. Effectively integrating urban nodes

To better integrate urban nodes into core network corridors, it is not only important to remove bottlenecks and missing links on TEN-T infrastructure in such nodes; a stronger connection with Sustainable Urban Mobility Plans can vitally contribute to improving "last mile" connections for people and freight; urban nodes shall make best use of their exemplary roles on multi-level governance and as forerunners of innovative and low-carbon solutions.

5. Extending cooperation with third countries

Cooperation between the EU and third countries on transport infrastructure development is important in order to ensure continuity of the TEN-T and its corridors in different geographical areas and thereby to facilitate trade and international cooperation; this must also involve the common striving for coherent standards.

5.4.2. CONCLUSIONS ON ITS NEEDS

From this text the following examples of corridor actions for innovation and ITS deployment can be extracted:

- Promotion of coordinated ITS deployment, building on platforms and joint declarations
- Stimulated investment in digital infrastructure to deploy cooperative intelligent transport
- Development of test cases for digitalization of freight transport
- To build on common commitment of actors and the creation of flagship cases
- Find solutions to last mile connections for people and freight
- Remove bottlenecks and missing links
- The strive for coherent standards

5.5. Key driving forces behind ITS deployment[20]

ITS deployment activities follow in general from five main driving forces. In most cases they act in combinations and are not easily distinguished from each other:

[20] From D2 ITS Deployment Drivers, EU EIP SA4.3 2019

Perceived transport system needs: Most important are investments that are made in response to specific perceived local needs – solving problems at critical spots; measures to increase safety, reduce environmental impact from local traffic, support inter-modality and use of public transport, improve intersection and road section throughput or provide better quality of service to road users.

Transport policies put in place: ITS deployment is also made in response to policies that are not directly related to local needs; e.g. road user charging systems are put in place to drive modal shift on a general basis in support of emission reduction, reduce congestion or simply to collect money to finance investments.

Sometimes policies are expressed as legislation requiring ITS implementation. Such ITS would not have been implemented in the same manner without legislative support. Good examples are the National Access Points now under development, eCall which is compulsory from 2018, the implementation of the Digital tachograph where a new generation is introduced from 2018 and measures in response to the EETS (the EFC Directive).

Technical development: Also, technical development is in itself driving ITS deployment; new ITS are put in place simply because they have been made available, without fulfilling transport system needs or driving policies. In this category, we address in-vehicle safety systems (ADAS), cooperative ITS (C-ITS), automation (e.g. automated driving), infotainment etc.

One can argue that in-vehicle safety systems (ADAS) are implemented in response to policies on safety, we will however select to include them among technology driven ITS.

Organizational development: Digitalization and automation create opportunities for new groups of stakeholders and alliances between stakeholders. New systems and services open up for organizational and technical development. Providers of telecom and AI becomes involved in transport system development as the traditional role of infrastructure providers is changing.

They create business or policy opportunities: Several ITS are deployed on the basis that they generate better business for organizations, public as well as private: More efficient maintenance of roads, better load factor of lorries and passenger cars etc. Fleet management systems, ride-share opportunities, Mobility as a Service solutions (MaaS) etc. are examples hereof.

The strength in these driving forces are different and varies (grows) also over time. Whereas safety related measures have been in focus through history (as well in-vehicle as roadside), an increased need for efficient infrastructure use is coming up as a key driver, supported by digitalization and automation. One important reason for this being that in-vehicle safety is now considered to be quite high. It is also important to recognize that different drivers may be present at different levels: On a national level policy related ITS measures may be in focus, while on the local level (where the real bottlenecks occur) traditional physical measures may be more

relevant. Hence a key question concerning driving forces behind ITS deployment is “where is the money?”. Is the money available on a higher policy level, or is the budget linked to the physical road network as in traditional infrastructure planning?

5.6. CNC Digital infrastructure

This roadmap for CNC digitalization is based on a set of basic characteristics describing the evolution of the road transport system in respect of the digital infrastructure in place. This will have influence on the different roles of the actors in the system and the actions needed.

The CNC´s will be covered by cellular radio

We can expect all road sections defined as part of a European Core Network Corridor to be well covered by cellular radio (4G, 5G). This coverage will be offered by (commercial) telecom operators. International roaming agreements will ensure that all vehicles with appropriate devices will be connected on the entire corridor.

Critical spots and road sections will have complementary ITS G5[21] coverage

Parts of the road network with very high usage and complex infrastructure, eventually also in association with specific ITS installations, will be equipped with roadside stations for ITS G5. We shall expect road operators to be responsible for these installations. This model can also be combined with a cloud based information management.

There are also applications where vehicles communicate directly with other vehicles through use of ITS G5. A typical example is the application of Platooning which is highly relevant on CNC´s.

Vehicles will be connected with their OEM (or associated organization)

When a Heavy Good Vehicle is delivered for use, it starts immediately to communicate with its corresponding OEM for the purpose of remote monitoring and controlling vehicle functions etc. This is linked to a growing business model where the HGV remains to be owned by the OEM (or associated org) but is operated by a fleet operator on a lease contract (or similar). The data gathered constitute an important asset for the OEM for also other purposes than the operation of the specific vehicle. Aggregated data can be used to support an extended business model where also fleet and vehicle management is part of OEM business. Communication between the vehicle and its OEM will use cellular radio of different generations (4G, 5G).

What is written above is to a large extent also valid for passenger cars.

[21] Including DSRC, 802.11p WiFi, …

New vehicles will have considerable autonomous capacity

We will for at least the next 20 years see a considerable mix of vehicles with different intelligence capacity on our roads. Vehicles with no digital capacity at all will mix with vehicles with far reaching capacities, capable of self drive.

A visible effect of this is that new vehicles get more advanced systems to monitor the situation around the vehicle. ADAS now include automatic brake, wild animal detection, 360^0 surround radar and cameras guided in all directions. Rear and side mirrors are exchanged with cameras and made intelligent etc. Vehicles monitor road markings and read roadside signs with cameras.

Hence vehicles will not be dependent on, but will benefit from, access to external information in order to function in the sense that they will always be capable of graceful degradation of operation if information supply is terminated.

Data will be collected through many sources of different character

Through history, road traffic has been operated (organized and controlled) by public authorities designated for this task. The situation has been the same for other transport modes (rail, aviation, …) whereas each mode has operated under control of its responsible authority.

In order to support the operation, the authorities have collected dynamic data to supplement infrastructure knowledge. Technology have always been present for this as speed measurements, traffic loads etc. have been subject to electro-mechanical data collection since the 1950´s. In general, the authorities continue to do this to safeguard the fulfilment of their own information needs and new technologies (e.g. ITS G5) are introduced.

But following the introduction of third-party suppliers of in-vehicle ITS equipment, private companies (notably TomTom, …) started to collect data with their introduction of navigation systems. This was picked up by application developers as the mobile telephone started to get widely in use (Google, …) and the development has continued. As the road vehicle has become more intelligent, the vehicle, through various sensors, now collect data for various purposes.

So, today we see that road traffic data is collected by a multitude of organizations for a variety of purposes, and the main part of this data is not controlled by the authorities concerned.

Data from many sources will be combined by new actors

Users, travellers or freight handlers, will have access to a large amount of applications offered by independent organizations that combine data from different sources into unique services. These applications will mainly support multi-modal solutions as their ability to combine information from different sources is their business offer.

Information exchange will use information clouds

A multitude of organizations (OEM´s, road operators, service providers of different kind) will continuously collect and process data for their own purposes but also consider that data constitute an asset if made available for other interests.

Hence we will face a situation where a multitude of organizations will need to and want to exchange data on different conditions. In bi- or multilateral arrangements. The conditions for the data exchange depend on the value of the data for the parties concerned.

There are different ways to organize such data exchange but following recent development it is reasonable to expect that cloud-based solutions will emerge as the primary way to arrange exchange of data. As we cannot expect one information cloud to cover all organizations, we will see a network of interconnected ("federated") information clouds in operation, and that Interchange operators will have a role to play similar to interconnection between telecom systems.

6. Assessing Corridor Performance

6.1. Performance indicators for transport corridors

The purpose of the CNC´s is to improve transport system efficiency by eliminating or mitigating hinders to efficient transport. In the introduction to this document it is stated that:

The characteristic of a corridor is that borders (of all kinds) are not seen, not perceived by users. That will happen if the information is seamless, if the quality of services is even, if the information is always understood. It is the information and the services that build a corridor, not the infrastructure. Hence a corridor is realized through digitalization, harmonization etc.

It is without questioning that local measures in order to safeguard mobility in urban regions and on highly occupied road sections are of immense value, also with a corridor perspective, and must be in focus for ITS deployment. But as important are measures to remove barriers from e.g. goods transport across borders[22] and to facilitate inter-modality. Following this, there is a need to find additional performance criteria for a transport corridor to reflect "the corridors performance as a corridor".

Performance indicators (KPI´s) are compilations of information that are used to measure and assess performance in terms of efficiency, effectiveness and impact, and to support benchmarking. KPIs are also used as means of communication within stakeholders to inform about constant improvement endeavors[23].

The application of KPI´s and the possibility to understand and to translate impact from measures into costs and benefits in a monetary sense is essential. Effects from ITS investments must be described and compared to other investments on a socio-economic basis. What is needed, is to define which indicators that are best suited to describe performance of a transport corridor and can be used to benchmark against other transport corridors. This would also require that the same monetary values are applied to the performance criteria used.

On Core Network Corridors, that include sections in several countries, we face currently a situation where the value of effects (fatalities, emissions, time lost in congestion, …) differ a lot between different sections of the corridor depending on country or region. This makes it truly difficult to assess costs and benefits from ITS measures on a corridor basis in a way that allow for benchmarking by using the same criteria as is used for local measures. We need also to find performance

[22] This is discussed in e.g. Issues Paper 1, 2 and 5.

[23] Vukomanovic et al., 2010

criteria that reflect the corridors performance as a corridor, and not only as an aggregation of road sections.

6.2. Performance indicators targeting digital performance

There are a series of potential KPI´s that reflect the impact of the transports concerned: Emissions, safety etc. In order to contain such impact into a corridor KPI, it has to be related to differences in corridor length, availability of alternative transport modes etc. Also, as concluded in section 7.9 below, ITS measures very often have large spill-over impact to a wider transport network and other transport modes which make them difficult to assess. Similarly, ITS actions on the transport system outside the corridor may have big impact on the corridor performance, in particular at nodes and bottlenecks.

Whereas these KPI´s do not specifically relate to the "digital performance" of the CNC concerned, we do not further the discussion of these KPI´s in this work. They are however very important.

6.2.1. EU EIP AND EC ITS KPI´S FOR CORRIDORS

In Issues Paper 2[24] performance indicators are pointed at as follows:

To increase the efficiency of the TEN-T Core Network Corridors, interoperability and continuity of intelligent transport services must be discussed, designed, tested and finally deployed on the basis of the evolution of technology, standards, specifications and open interfaces. Moreover, to assess their effectiveness, a wide range of indicators related to deployment and benefits have been developed and could be considered as true key performance indicators.

An in-depth analysis on KPI´s made by EU EIP identifies a set of relevant Deployment and Benefit KPI´s for the ITS Corridor projects and put these in relation to the corresponding DG MOVE Deployment and Benefit KPI´s[25][26]. When taking into account the specific role of the CNC and the discussion above concerning the specific needs of freight transport, the EU EIP Deployment KPI "Change in road traffic journey time variability"[27] is the KPI that comes closest to the aim of estimating the assessing corridor performance as such.

[24] Reference Issues Paper 2 on ITS, Pat Cox et al 2015

[25] EU EIP Activity 5 ITS Deployment and Benefit KPI definitions, Technical reference 2017

[26] Key Performance Indicators for Intelligent Transport Systems, AECOM 2015

[27] With reference EU EIP BKPI-N2

However, as it is expressed in the EU EIP reference document[28] it is measured as the absolute and % difference in journey time on a certain road section following a specific ITS implementation.

As an ETA calculation is far more dependent on availability of information (data), and the precision and reliability of this information, concerning the entire length of the planned transport, probably the EU EIP Deployment KPI´s “Traffic Condition and Travel Time Information Service”[29] and “Forecast and Real Time Event Information"[30] are better reflecting the possibility to contribute to prediction of high quality ETA´s.

6.3. Proposal for CNC KPI´s supporting multi-modality

If a transport planner has “good insight” (through use of various information sources) in the traffic situation along a planned long distance route and can make a precise prediction of the resulting transport time, the cost of a local congestion (which is known to the planner) or time consuming border control is limited as the transport will arrive Just On Time anyhow. This “good insight” will also allow the transport planner to make the best decisions possible concerning use of transport modes, including multi-modal combinations, selected route etc.

Following the discussion above, a KPI for CNC need to:

- Allow for benchmarking between corridors
- Allow for transport planners to estimate the precision in ETA calculations for different transport modes
- Allow for transport planners to estimate the cost associated with different transport modes

This would mean a shift in focus from the travel time as such to the predictability of travel time and the quality of this predictability.

A KPI that meet these requirements would be:

Variation (or precision) in Estimated Time of Arrival Calculations on a CNC

[28] Absolute and % difference for Corresponding timeframes before and after ITS implementation (where applicable).

[29] EUEIP-DKPI-O2

[30] EUEIP-DKPI-O3

The basic input for calculating this KPI will be level of availability to information (data) along the transport route and the reliability and precision of this information, in particular in terms of forecasting capacity.

The precise definition of corridor KPI´s including a method that allows for (simple) estimation and description of corridor performance is regarded as an important possible EU initiative.

7. Measures to support Core Network Corridor integration

7.1. CNC goal statement

This roadmap proposes a set of digitalization actions for improved Core Network Corridor performance that are not naturally accounted for in local or national programs. This means actions that are designed and implemented on a corridor level which will require international cooperation for their realization.

A common purpose of the actions proposed is to realize measures that contribute to the elimination of perceived borders along road sections of the CNC´s. This is done through provision of seamless information to road users (and their operators) with known quality that will allow for (very) high quality in ETA calculations for long distance and cross-border transports, in particular carrying goods.

These measures are complementary to and dependant on measures carried out in order to mitigate local and regional traffic problems. They need to be put in place in order to eliminate bottlenecks and safeguard road safety while also providing necessary data.

This section provides an overview of and motivation for measures needed. Proposals for specific implementation of these measures, i.e. actions, is provided in section 9 below.

7.2. Service harmonization

7.2.1. BACKGROUND

Service harmonization does not specifically relate to Transport Corridors, but to the road network in general. In a door to door journey the driver and the vehicle will meet different parts of the road network, and it is a prerequisite that service provision is seamless and service design is road operator independent. The driver and the vehicle shall meet similar conditions on what is perceived as a “continuous road without borders”.

Already in 2007[31] in the preparation for the ITS Directive the EC concluded that lack of harmonization was a major obstacle to ITS deployment. The challenge was

[31] ITS Roadmap Outline, October 2007

picked up by the EasyWay[32] initiative which in 2012 delivered 18 Deployment Guidelines providing a basis for European ITS service harmonization[33].

The EasyWay initiative was based on cooperation between European Road Operators who decided to focus the DG development on aspects related to the end user needs and service perception. “Common look and feel” and “Quality assurance” where typical design requirements. EasyWay also took further the work initiated by the EU TELTEN initiative[34] where a framework for road network classification was established as a basis for the definition of service needs in relation to network characteristics (referred to as Operating Environments). In parallel to the Deployment Guidelines, EasyWay took also the initiative to systematic collection and distribution of Best Practise experience from European road operators.

The EasyWay initiative have continued with the European ITS Platform initiative[35] and the work continues with harmonization needs related to the extension of the ITS service framework into C-ITS and also accounting for needs related to multi modality, urban traffic etc. EasyWay and EU EIP have also played a paramount role in the creation of a harmonized solution to the evaluation of effects (costs and benefits) following from ITS investments.

7.2.2. CURRENT STATUS

The Deployment Guidelines, and their supporting tools including the evaluation framework and the Operating Environments, are subject to continuous updating and improvements through the EU EIP project. New services and their needs are brought into the work, e.g. C-ITS Day 1 and Day 2 services, as the scope of ITS is expanding. EU EIP (and its predecessors) have also increased the work on data interfaces (DATEX II etc.) and the integration and harmonisation of National Access Points (NAP´s). In recent years work in the C-ITS domain have been picked up by the C-Roads initiative (with focus on C-ITS service specifications) adding an additional level of detail to the work. The EC has also taken additional initiatives through establishing CEF Programme Support Actions (PSA´s) e.g. FRAME-NET on architecture, on DATEX II and is currently preparing a PSA on integrating National Access Points.

7.2.2.1. LOOKING AHEAD

[32] 2007-2012

[33] Guidelines are available at https://dg.its-platform.eu/DGs2012

[34] Delivered in 1996

[35] Currently in the EU EIP Project supported by the CEF Program

We can see that further initiatives are taken by the EC with the aim of driving harmonization through as well additional PSA´s as through standardization mandates given to e.g. CEN and ETSI. European Road operators are also expanding their network and work to cover additional service domains. The need for continued service harmonization is clearly there.

7.2.3. ACTION NEEDED

As systems and services are continuously improved and refined, and new systems and services are brought in to be used, there is a continuous need to work on harmonization with the end user in focus.

The continued goal must be that the driver, and in the future the vehicles, on European transport corridors shall meet continuous and harmonized services of adequate quality in relation to the local conditions. And as services are developed and new services are brought in, initiatives aiming at service harmonization, involving a multitude of stakeholders, are needed.

7.3. Organization – Champions and Platforms

7.3.1. BACKGROUND

Road transport corridors interconnect the geographical domains of different road operators. CEF corridors, defined as multi-modal, also require that different modalities are interfaced. Since it is the core task of each road operator to take care of their own domain, as it is for other modal operators, the question is what mechanisms can help realise the interfaces and cooperation to realise cross-border corridors within and across transport modes.

The infrastructure world today is very much organised in a modal way. Each operator is focusing on their own technical and geographical domain, where they are doing a great job managing traffic, taking care of safety and providing information to both service providers and end users. At the same time both construction and operation of the infrastructure are increasingly considering the reduction of impact on the environment and resilience against climate change.

The use of infrastructures is at the same time becoming more multimodal, most clearly in freight transport, but passenger transport following where new systems and services, sometimes referred to as disrupted, are introduced not always easy to classify in traditional ways. In freight transport we see that the market very much is organizing itself, but in support of inter-modality transfer points, parking places, traffic management, incident management, information on traffic and on restrictions, etc. are needed.

European policy is working under the banner of achieving the Single European Transport Area, which includes the realisation of the multi-modal Trans European Core Network by 2030, the comprehensive TEN-T network by 2050 as well as a

number of initiatives to improve urban transport and multi-modality while addressing safety, resilience and climate change. European policy is also focusing on development in line with the EU Digital Agenda, and in February 2020, the Commission adopted the European Strategy for data[36] where Mobility data, and in essence ITS applications, are core ingredients. Hence the CEF initiative aims to combine these two areas in order to create “digital transport corridors”.

The CEF programme covers realisation and implementation of the TEN-T, including hubs and digital systems and services such as SESAR (air), ERTMS (rail), RIS (IWW) and ITS (Road) thus combining (at least) two policy areas. ITS is defined as for roads and interfaces to other modes. 9 multimodal CEF corridors have been defined on the TEN-T core network of Europe, e.g. ScanMed, North Sea - Baltic, North Sea- Mediterranean etc. Their work plans consume 90+ % of CEF budget (24 B€) and are almost completely focused on realising national hard infrastructure. In order to cater for its use and promote aspects of European added value, in 2016 the so-called issue papers have been published covering horizontal issues, e.g. ITS and multimodality[37].

7.3.2. CURRENT STATUS

No single organization (beside the EC) governs the process of realizing cross border digital transport corridors. Therefore several platforms, i.e. organizations for collaboration towards common goals, have been set up, each contributing by adding pieces to the work needed.

Existing platforms cover a wide range, some organised as European projects with a final date, typically 2020 or 2021, others of a permanent nature. Here under some of them e.g.:

Cooperative, Connected, Automated and Autonomous Mobility (CCAM)

Most recent, established in 2019, is the Cooperative, Connected, Automated and Autonomous Mobility (CCAM) Single Platform. The CCAM Single Platform is a joint initiative between several EC DG´s with the aim to advise and support the EC in the area of open road testing and making the link to pre-deployment activities.

EU EIP

Knowledge centre, established in its first version in 2012 as a successor to the EasyWay project. Cooperation of Road Operators, -authorities and other stakeholders for the Europe-wide exchange of knowledge, agreeing harmonised approaches and quality levels. EU EIP is closely related to the ITS Corridor projects, 5 international CEF projects where national and local ITS projects along

[36] Brussels, 19.2.2020 COM(2020) 66 final

[37] See section 5.4

the TEN-T are being implemented, with some horizontal activities. Closely associated to EU EIP.

C-ITS Platform

When co-creating an ecosystem, a viable way forward is that a legitimate actor provides a platform where stakeholders can adhere to. The C-ITS Platform can be named as a successful example for sounding the common vision and the recommended steps how to enable C-ITS services in Europe. The recommendations are pursued on a dual channel basis: the one preparing for legal certainty of the implementation framework (C-ITS Delegated Act), the other stimulating a powerful implementation layer (C-Roads as flagship of MS driven C-ITS pilots and deployment initiatives).

7.3.3. LOOKING AHEAD

The end goal is optimal performance and seamless operation with European added value of the networks, both cross borders and cross transport modes. Notably from the perspective of the user, whether freight, passenger or private. For this, continuity of services will be required with adequate quality levels and harmonization of information and the services built on that information.

International transporters and travellers will require continuous information, which accounts also for vehicle systems at different levels of automation. Information, including data, should be understandable and quality levels in different countries and circumstances should be adequate for the situation and known. Both road operators and service providers have roles to play, some are obvious, some can be mixed. Following the development in automation we can expect OEM´s to grow in importance also in the roles of data and service providers. One of the roles for service providers seems obvious: combining different data sources into end-user services. Hence data sources from operators should be available in standardised formats with known quality.

It is expected that roles will shift towards the future. Data sources from service providers may become useful for traffic management and could be used by road operators either as a more cost-effective solution or for enhancing coverage or service level. This can be for free or at commercial prices, depending on circumstances, arrangements or regulation.

For inter-modality, information from different sources should be available and easily accessible in standardised formats and at known quality levels. It is expected that inter-modal services can be based on those information sources by the market and service providers, as is happening already to a certain extent, e.g. the European multi-modal route planner for freight containers and its targeted version for the East-West Corridor.

Apart from user services, also cost savings for the construction, maintenance and operation of intelligent infrastructures may be achieved, because of harmonised

approaches and economies of scale. And in the intermodal field direct cooperation with modal partners may deliver integral and more effective and cost-effective solutions for transport, e.g. the cooperation between port, city and road operator in the Tallinn area.

7.3.4. ACTION NEEDED

As cooperation bring benefits in many areas and the transport system is getting more complex, we shall expect that the need for bodies bringing various stakeholders together, whether formal or informal, will grow. We can not expect that bilateral relations will be enough to cope with the growing needs, rather the opposite.

A dedicated platform (or -s) committed to improve CNC performance through use of ITS applications shall be in place, and individual champions, usually twins (formal/political and informal/technical) shall have leading positions in the work within specific areas.

When looking at European road transport, and accounting for inter-modality, we can also see that there will be a need for several bodies, and the number is growing. Experience show that bodies with well defined tasks work faster and achieve the goals set quicker than bodies with a wider scope.

Usually there is one organisation, person, or association who takes the initiative and provides initial guidance to get a cooperation going. Currently, the use of formal champions is very limited, whereas many initiatives is dependent on the leadership and work of specific individuals – informal champions. There are advantages with this that could be exploited further in European ITS as experience shows that where clear champions have been present, more progress have been made.

7.4. The Road Corridor Information Document (RCID)

7.4.1. BACKGROUND TO ROAD CID

ITS projects on corridors are often deployed in a similar manner but they are managed on a local, regional or national level and they are not connected to each other. Every separate organisation and traffic centre care mostly for their own region or metropolitan area. But Corridors represent the perspective you get when you look on traffic from satellite; you see flows that form trans-European movements, mainly consisting of freight vehicles. From a corridor perspective, there is a need for a descriptive umbrella, and this could be provided through the Corridor Information Document, CID. CID is a type of document that is already used by the CEF Rail Freight Corridors (Rail CID). For CEF road corridors we will call it Road CID to avoid confusion.

The idea with Road CID is to have one structured way of describing corridors. The Road-CID will contain descriptions of the general structure of the corridor, including network overview (important hubs, terminals and bottlenecks) and organisations concerned. It describes how the traffic management centres are structured as a series of interconnected traffic management areas along the corridor.

It also describes which ITS services (with focus on services relevant for corridor operation like HGV parking) that are available and where and especially which TMP´s that are in operation and how they connect. Hence the Road CID will provide the reader/user with an understanding of the general structure of traffic management on the corridor level.

7.4.2. CURRENT STATUS

A template Road CID is currently developed as a subtask to the Traffic Management & TMP working group in the EU EIP Cross Corridor Cooperation, CCC.

Suggestion from CID Rail is that the first versions of the CID will include basic information, while later versions will gradually become more detailed. A future Road CID will also contain information about for example geo-fencing, platooning and digital traffic rules. At the end of this document there is also one chapter with ideas for future Road CIDs.

A tentative content description of an early version of the Road CID is:

1. Corridor overview

The corridor presented as a map with major links and nodes indicated with their geographical names. This includes cities, border crossings, ferry lines, important intermodal connection points and connections with other CEF CNC´s.

2. Detailed network description

The Road Corridor expressed as a set of interconnected nodes and links. Tentatively this description should be made on the basis of the INSPIRE Directive[38].

3. Traffic Management Centres (TMC´s)

Typical information about a TMC are where it is located, which area it is covering, and which services that they are offering, operation hours and responsible organisations including contact information.

4. Traffic Management Plans

[38] More precise on the D2.8.I.7 Data Specification on Transport Networks – Technical Guidelines, April 2014

Traffic Management Plans, TMPs, are pre-defined plans for management of (more or less) temporarily reduced capacity for a specific part of a network (e.g. in association with a temporary tunnel closure or a major construction work). In the Road CID, all operational TMPs for the included corridor network should be listed.

7.4.2.1. FUTURE DEVELOPMENT

In later development phases, the Road CID shall be extended to include information that describe and support further digitalization. First examples of such information are:

5. Digital Traffic Regulations

The Road CID shall contain (meta-) information on where access to prevailing traffic regulations in digital format can be obtained, how these are formatted and which links and nodes they concern. This includes information on restrictions (height, width, weight) on carriages etc.

6. Areas for Geo-localization

A “digital” vehicle travelling along a corridor will need to continuously download information on prevailing rules and regulations, the conditions ahead and e.g. real time traffic information. Vehicles using automatic driving features (e.g. platooning) will need to know which conditions that are applicable and where.

The Road CID shall contain information on the presence of digitally defined geographical areas where special conditions may apply.

7.4.3. ACTION NEEDED

The current action carried out within the Cross Corridor Cooperation initiative hosted by the CEF ITS Corridor and EU EIP projects is a pilot study on the possible content of a Road CID with the aim of demonstrating future possibilities.

Hence there is a need for a firm EC action to further this work into real development of Road CID´s for the CNCs, or for a sub-set of CNC´s, close to the formal structure of the CNC organization.

7.5. Technical development

7.5.1. BACKGROUND

Availability of new and emerging technology is a strong driver for development. The current development within C-ITS is strongly connected to the principle of

connected vehicles, which in turn follows from and is dependent on data traffic through mobile communication networks together with e.g. development of sensor and video technology.

Similar dependencies can be seen in other areas of ITS: The development of LED technology has opened for use of solar powered road side panels without need for wired connection, vehicle detection can be made on long distances using radar technology etc. What we see is that technical development in all areas is beneficial to ITS development through better performance, lower cost and durable installations.

Hence technical development is in itself driving ITS deployment; new ITS are put in place simply because they have been made possible, without fulfilling transport system needs or driving policies. In this category, we address in-vehicle safety systems (ADAS), cooperative ITS (C-ITS), automation (e.g. automated driving), infotainment etc.

One can argue that in-vehicle safety systems (ADAS) are implemented in response to policies on safety, we will however select to include them among technology driven ITS as the implementation is market oriented rather than based on needs.

Beside the importance of technical development as such, much focus is also given to harmonization in terms of technical standards. It is proven that technical standards can drive competition and promote interoperability, hence lower the thresholds towards ITS deployment.

When considering the conclusions from the CNC Issues Paper, the need for technical development can be seen primarily in three areas:

- Enhancing multi-modality and freight logistics
- Effectively integrating urban nodes
- Extending cooperation with third countries

They all basically mean expanding the scope of ITS to include aspects that do not specifically relate to “traditional road transport”. What this mean in terms of “technical needs” is to a large extent unexplored.

7.5.2. CURRENT STATUS

Coordinated European ITS technology development has been carried out for more than 30 years and continue to take place. The importance of European development has been recognized as the European vehicle industry (for all transport modes) is part of the European industrial backbone. All development has been strongly related to technical standardization in the field of ITS, which has

been ongoing since the beginning of the 1990´s, notably with CEN TC 278 established in 1992.

When looking at activities during the last years and ongoing, very much focus is on development related to automated driving where the global competition is very strong.

A good insight in the width of past and ongoing development can be found in the Knowledge Base on Connected and Automated Driving[39] (CAD) providing a one-stop shop for data, knowledge and experiences on CAD in Europe and beyond.

In recent years much public attention has been given to development of common specifications following the establishment of the ITS Directive[40] and its delegated acts. Notably the C-Roads project where European road authorities, supported by the EC, develop C-ITS specifications in partnership with technical demonstration projects and sites. C-Roads, and similar projects, can be understood as authorities response to an industrial (market) driven technical development.

When looking at current technical development it is clearly driven by industrial ambitions (product development) together with policy needs mainly related to "local problems" as urban air quality, traffic safety, climate concerns, noise etc. Hence little technical development is made in response to needs related to cross-border and transport corridor related issues, in line with the problem areas defined by the CNC coordinators..

There are however a few technical projects with corridor focus, e.g. the East West Transport Corridor project[41] carried out within the EU EIP project in association with the ITS Corridor projects.

Result from EastWest[42] points at four groups of needs which can be associated to a corridor perspective:

- The need to accommodate truck parking at regular intervals along the corridor
- The need to secure that information is made available all along the corridor, including multiple transport modes

[39] https://knowledge-base.connectedautomateddriving.eu

[40] Directive 2010/40/EU

[41] https://www.its-platform.eu/activities/activity-3-%E2%80%93-feasibility-study-east-west-corridor-and-first-pilot-implementation

[42] Deliverable ITS Road Map for an Operational East – West Corridor across Northern Europe, July 2017

- The need of well working cross-border and international Traffic Management Plans (TMP´s)
- The need for harmonized user service interfaces (common look and feel) and access to best practise solutions

There are also very interesting projects where ITS successfully have been used to mitigate problems at transport mode interchanges and at border crossings, notably with third countries. Such examples include applications using the GoSwift queue management service[43], implemented at the Finnish – Russian border at Vaalimaa and also at the Estonian – Russian border. It finds also an application to manage HGV´s queueing for ferry transport from Tallinn, Estonia.

7.5.3. ACTION NEEDED

From the EastWest project one can conclude that the needs primarily are related to institutional issues and harmonization together with information management. These are issues dealt with in other action areas. Technical development here is highly relevant to safeguard CNC performance, but does not find its applications on the CNC level.

But there are also unexplored possibilities, as shown by the EastWest project and other examples (e.g. GoSwift), of new technical development that can support European cohesion and improve CNC performance.

7.6. Geofencing – Area definition

7.6.1. BACKGROUND

Geolocalization of an automated vehicle refers to its precise location at a given time. This location data is a key component for providing location-based services for ITS. Generally obtained by in-vehicle GNSS devices, geo-localization in ITS represents a promising approach to reach objectives such as an increased road safety, transport efficiency, or on-the-road services.

Geolocalization can enable various services which rely on precise geolocation data to define its parameters or limits. One of the widely tested services are currently around Geofencing, or zone management. These are services which utilizes geolocation data to provide a technology that applies a digital fence in the physical environment that prevents a vehicle or a person with certain characteristics from access to a particular location for a certain period of time or forces a vehicle to adapt to certain characteristics while operating in the defined zone.

[43] Created with support from the EU Central Baltic Programme, Interreg

It can be seen as a technical solution that can enable the possibility to affect behaviour and functions of vehicles within a geographical zone, for example, speed limitation and change of propulsion in hybrid vehicles from conventional to electric drive, limit vehicle access to particular zones and restricted areas or infrastructure.

Geofencing, i.e. defining the border of a zone to which certain conditions apply, is one element of ODD – Operational Design Domain, including also other parameters that may affect vehicles behaviour (e.g. time of day, type of vehicle, type of road within area, weather conditions etc.).

7.6.2. CURRENT STATUS

Geo-localization, identifying a precise position of an object (e.g. a vehicle), is primarily a capacity of the object itself (which it can solve by an integrated GNSS device). It is today very common in use and all OEM´s today offer this capacity with new vehicles (e.g. embedded in navigation systems etc.).

In order to enable the use of area based services, the road authorities need to describe zones (areas) in which certain conditions apply together with other elements of the ODD. Given that, the vehicle can position itself in relation to different zones representing e.g. the validity of specific regulations.

A lot of basic work has been done on how to define ODD´s in relation to transport (in particular related to Automatic Drive), notably the work done by SAE[44] through AVSC[45] and EU EIP[46], and through the INSPIRE directive specifications. But implementation project has shown that there is still no commonly agreed way to describe ODD´s in terms of geographical validity. In the METR[47] architecture this feature is offered by Digital Map Providers, and references to these are also given in the EU EIP work.

There are several examples of important ITS projects that uses this feature in 2020:

The most noticeable ones being in the NordicWay[48] projects. Being an EU supported consortium, the project is currently testing some geolocalized services

[44] SAE International

[45] AVSC Best Practice for Describing an Operational Design Domain: Conceptual Framework and Lexicon

[46] EU EIP A4.2 EU-EIP Activity 4.2 Facilitating automated driving Task 1: Identification of requirements towards network operators, v1.2, June 2020

[47] CEN TC 278 WG 17 Urban ITS

[48] CEF Projects ….

in the Nordic regions through two major pilots: Dynamically Controlled Zones and Dynamic Access control. These services offer to enable road authorities to adjust geo- and policy data in real-time and distribute data to service-subscribing vehicles which can adjust characteristics according to current zones and policy. Automatic access control, where certain parts of the infrastructure, at certain times, only give access to one or more different types of transport (i.e., It can be public transport, utility traffic, freight traffic or specific drivelines or fuels).

Other projects include;

- PPA, Amsterdam Practical Trials, project. For many years now local and national traffic management, together with industry apply several concepts to improve traffic flow. Some of the pilots included big events, e.g. Sail Amsterdam, where participants (~~10.000) got information via apps about routes to follow or available parking spaces, selectively depending on their own location.
- Smart Urban Traffic Zones is a project led by CLOSER at Lindholmen in Gothenburg. Aims to use geofencing to create smart urban traffic zones that can be self-regulated based on prevailing traffic and environmental situations.
- In Gothenburg where two fully electric buses and seven electric hybrid buses equipped with the technology have been rolling since 2015. Scania hybrid-trucks in Stockholm are geofenced to switch to electric drive in central areas to enable night-time deliveries.

Currently there are unclear intentions from road authorities to promote harmonization in geolocalization services, however they do recognize the need for it and the benefits it can bring. Ideally OEMs, for example would prefer having precis geolocalization data in the road infrastructure data as standard. This will push OEMs other than the market leader to integrate such technology in their vehicles which can take benefit of the geolocalized data.

7.6.3. ACTION NEEDED

At first hand is a we need a harmonized way for road authorities and other stakeholders to express the borders (or the extent) of geographical area on which certain conditions apply. Such areas can exist in an overlapping nature as different applications will have their own geographical zone in which a certain application (e.g. environmental conditions – electro drive only, a speed limit, permit to platoon for HGV´s etc.) is operational. The key is to make sure that the vehicle / driver is continuously informed by the conditions that apply in such areas.

As it stands at the moment, there isn't a commonly agreed method for authorities and other stakeholders to express such areas which can avail geolocalized services and what kind of ODDs the services shall be bounding. The role of road

authority here can be to provide such precise geolocalization data along with high quality road infrastructure data but the distribution of responsibilities still remains unclear.

Hence there is a certain need of laying down a commonly agreed method for authorities and other stakeholders to express geographical areas in a way that allows for a vehicle (through the OEM and/or driver and/or system and/or fleet manager etc.) to know what conditions apply.

7.7. Digital Traffic Regulations

7.7.1. BACKGROUND

The traffic situation, particularly in urban areas, is gradually becoming more difficult as new requirements and needs are introduced parallel to a growing transport demand. This is normally solved by the introduction of new regulations that may be as well temporary as subject to validity restriction in time. One immediate effect of this is the growing complexity of the information given to the road users, in general through roadside signs.

Traffic regulations are usually geographically limited with a very high resolution (loading bay, parking area, one-way street, …) which makes the information difficult to apprehend while driving in a busy environment.

This applies not only to urban areas but also to motorways where highly occupied sections in combination with adverse weather and road works generates a very complicated driving situation. This complexity puts also a hinder to the possibility to issue regulations; is it possible to add an additional dimension to regulations covering a specific road section? In a cross- or near border network also language problems must be considered: How much information in a foreign language can be taken in while driving?

The importance of this issue becomes obvious when it is put in relation to different levels of automation. Currently the first level of automation is based on video based recognition of roadside signs. But there are indeed limits to this technology.

7.7.2. CURRENT SITUATION

The need for Digital Traffic Regulations have been recognized in several environments. The Swedish roadmap for Connected and Automated Goods

Transport[49] and Automated Transport Systems – a Strategic Research and Innovation Agenda[50] pointed early at this need, and the EU EIP project, through the CCC[51] activity, initiated work on Digital Traffic Regulations in 2017[52]. Very important is an initiative taken by UrsaMajor Neo[53] which ended up in a proposal towards the CEF call in 2018; "DTR – Digital Traffic Regulation" involving ministries and public organisations from Austria, Germany, Netherlands and Portugal. This initiative pointed at three important dimensions of the issue:

Digitalisation of traffic regulations has multiple aspects:

- Digitalisation of the process to manage the regulation
- Digitalisation of collecting basic input data for regulation
- Providing digital traffic regulation data to relevant stakeholders

The application was not accepted for funding.

Very prominent is also the initiative taken by CEN TC278[54] in 2018; METR-Management of Electronic Traffic Regulations. Although the action focus on urban needs, they point at the relevance also for "non-urban context".

[49] SE Forum for Transport Innovation, Vinnova 2014

[50] SE Vinnova 2014

[51] Cross Corridor Cooperation

[52] DTR, EU EIP 2017

[53] CEF ITS Corridor project

[54] WG 17, Urban ITS

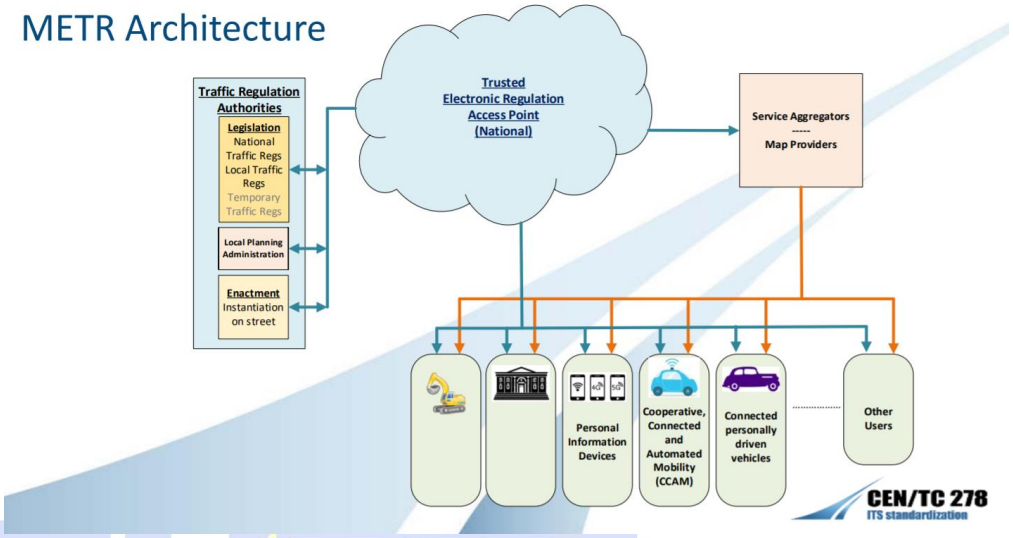

Figure: METR Architecture, CEN TC278 WG17, Knut Evensen

In a tentative architecture description WG17 indicate the need for a “Trusted Electronic Regulation Access Point (National)” a solution very close to the NAP´s related to the Delegated Acts (see section 7.8).

WG 17 consider the Access Point as a data base where a user can query combinations of regulations relevant for:

- a location (area or part of roadway)
- a specific period of time
- a specific purpose (Parking, speed limit, overtaking, intersection right of way,…)
- a specific vehicle class (Weight/height limit, goods delivery, emission zone, automated driving,…)

The architecture also points at the role (please observe one-way arrow in the figure above) of the Service Aggregators / Map Providers, and one can also consider the presence of an Interchange provider as discussed in section 7.8. It is also clear that the need for Digital Traffic Regulations shall be seen together with definition of geographical extensions (map issues), see previous section.

7.7.3. ACTION NEEDED

As TC278 WG 17 (METR) seems to prepare the establishment of a Project Team which will start the work on drafting standards, there is currently no clear organization of data providers / service providers / service users that will develop systems accordingly, feed it with data and make it available for users (of different kind). The need for such activity is obvious.

7.8. Integrated information management

7.8.1. BACKGROUND

Among the basic principles for future road CNC transport listed in section 5, the principles related to CNC Digital infrastructure (section 5.6) stand out in relation to information need and supply.

The starting point is that vehicles operate irrespective of borders etc. They are also basically under control of their own OEM´s, a situation that will be even stronger in the coming years: Automatic vehicles do not take all decisions on their own. The decision maker needs to be able to access information all along the route, from origin to destination, irrespective of borders of various kinds. The OEM must also know what conditions and situations concerning data access, quality etc, are applicable on different parts of the corridor.

Hence it is very clear that the vehicle / its controller requires information to be easily available.

Several Delegated Regulations adopted under the ITS Directive (2010/40/EU, notably Provision of EU-wide real-time traffic information services (2015/962)) aim at improving the accessibility of ITS travel and traffic data through the creation of National Access Points (NAPs). It is also compulsory for the EU Member States to designate a responsible competent authority (National Body, NB) for establishing NAPs.

Typically, a NAP can be reached through the website of the national competent authority (or directly through a web interface) where it will provide you with catalogues of available information sources / data bases and their content. Hence the NAP in itself mainly contain meta data.

7.8.2. CURRENT STATUS

7.8.2.1. EC INTIATIVES

In preparation for a revision of 2015/962, the EC have conducted a supporting study[55] which identifies NAPs as the backbone for ITS digital infrastructure, to

[55] Launched January 2020

which all current and future activities should be linked, also in view of the new working programme of the ITS Directive. The target scenario is that all NAPs are federated, thus facilitating access, pooling and sharing of data from existing and future transport and mobility databases in line with the European Strategy for data. This provides for the establishment of EU-wide common, interoperable data spaces in strategic sectors, including a Common European mobility data space.

The current intention by the EC is to establish a Programme Support Action (PSA) within the CEF Programme to support this federation[56] which in the period 2021-2023 will develop a basis for future federation of NAP´s.

7.8.2.2. MARKET DEVELOPMENT

As stated above, a key requirement on a fully functional transport corridor is that systems and services function and are provided regardless of borders and jurisdictions of any kind. It has also been shown that the introduction of C-ITS services will bring a tremendous growth in data needs and in the need for high quality data.

It is expected[57] that OEM´s and fleet managers will be in control of the data exchange with vehicles which in turn will be the most important sensor carriers, and thus data generators, in the road transport system. Considering this, can we then expect that national road operators and authorities through the NAP´s will be the natural manager of this data? That they will be in control of the data and/or host data exchange between actors in the road transport system?

In future road transport we can expect that communication providers and providers of energy will play to some extent equally important roles in relation to data. The hard infrastructure under the full control of road operators is only one infrastructure among several needed for road transport in a multi-modal and automated context.

A more likely development will be that a multitude of actors will participate in a wide network of data suppliers and consumers (users) and that a variety of bi- and multilateral relations for data exchange will emerge, each relation subject to a specific agreement on the conditions for data exchange[58]. The situation will be similar as the one for cellular communication.

The figure (from NordicWay and C-Roads) below describes a typical possible situation where Region/country 1 has a commercial Interchange supporting among others the data exchange for the Road Transport Authority, while in

[56] As presented in *Coordination mechanism to federate the National Access Points established under the ITS Directive, 200420*

[57] Section 5.6

[58] As defined in the CONVERGE project and implemented in e.g. the NordicWay projects.

Region/country 2 the Road Transport Authority operate an interchange. These two Interchanges are federated. In this case a Service Provider in Country/Region 1 has a direct connection also to the interchange in Region/Country 2, possibly to shorten communication time.

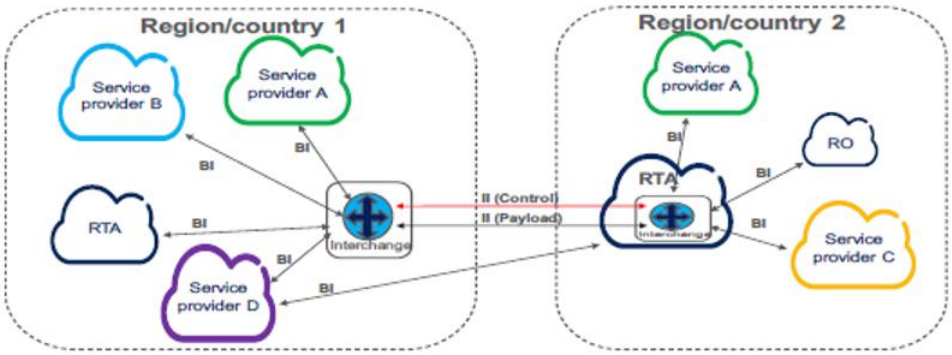

Figure: Federated Information Exchanges, NordicWay/C-Roads

7.8.3. ACTION NEEDED

The most important actions needed right now are made in support of facilitating the establishment, federation and exchange of data between any data holder, not only NAP´s. This can be done through the establishment of a network of professional data exchanges and through establishment of enough precise data standards to ensure that data is correctly interpreted, that the quality is certified and that information on which data is available where and on which conditions is available. Such interchange could technically be a NAP, but it could also be commercial data exchange operator linking various NAP´s and any other data supplier and consumer.

The EC and road operator initiatives have a primary focus on establishing a regulatory and technical (through standardization) framework allowing for federation of public data sources (explicitly NAP´s). In parallel there is a need to establish fully operational systems comprising interconnection of data interchanges which will provide insight in the design of working business models for operational data exchange between any combination of data suppliers and consumers, and also try out in real life application limits in terms of response and data delivery times etc.

E.g. through the NordicWay initiative[59] a working federation between national and multi-national data interchanges, each serving several data suppliers and users, have been established, but there is a need to extend the scope and geographical extension of the federation.

7.9. Performance measurement and assessment of effects.

7.9.1. BACKGROUND

ITS investments will always compete with other investments on availability to resources, particularly with physical infrastructure. The methodology to calculate costs and benefits related to investments in physical infrastructure have a very long tradition and have been subject to considerable research and development. It is now built into the investment decision process. But good estimates on effects from ITS investments are difficult to make, in particular on aggregated level.

Still the possibility to calculate effects from ITS is essential in order to drive continued digitalization and achieve the effects that are known, yet without figures.

The starting point is the establishment of agreed performance criteria, i.e. the effects that are considered to contribute to the goals set with the investments. These can be improved safety (reduced number of accident), lower emissions of climate gases, lower traffic noise levels etc. which are valid to assess effects from local investments, e.g. to solve a bottleneck. Such effects from local investments, e.g. improvement of a controlled intersection, can fairly easily be estimated, e.g. in accordance with the EU EIP Handbook[60], but how do you estimate effects from e.g. “improved lane control” or improved traffic flow monitoring on a corridor level?

7.9.2. CURRENT SITUATION

The ITS Corridor projects have been actively cooperating on developing methods for assessment of ITS costs and benefits and have published handbooks as well as results summaries through the EU EIP project website[61]. Each of the ITS Corridor project contribute with benefit assessment of their activities in accordance with the handbook and the results are compiled in recurring summary reports.

[59] CEF projects NordicWay 1, 2 & 3

[60] https://eip.its-platform.eu/EvalLib

[61] https://eip.its-platform.eu/EvalLib

The content of the EU EIP evaluation work draws on various sources and work on the subject, in particular the ITS KPI definitions developed by DG MOVE[62] as well as the definitions contained in the body of work relating to the EasyWay and EIP+ studies. The report also provides a comparison of related, if not directly corresponding, EU/EIP and DG MOVE KPIs (deployment and benefit). It is important to note that while some differences have been acknowledged, these do not represent 'mistakes or omissions' but should be considered within the context of applicability of said KPIs; specifically:

- EU/EIP KPIs are in general more detailed and should be used primarily for evaluation purposes;
- DG MOVE KPIs are more 'generic' and should continue being employed by Member States as part their reporting duties to the Commission.

7.9.2.1. CASE STUDY NEXT ITS

A well known case study has been made by the NEXT-ITS 1 & 2 projects[63], with the objective to assess the effects from ITS deployment on the Northern sections of the Scandinavian-Mediterranean CNC by improving the efficiency, reliability and safety of the corridor as well as to reduce the environmental impacts of road transport.

The total length of the NEXT-ITS corridor sections are about 3 000 km, but the impacts of the NEXT-ITS 1&2 measures cover a much larger road network, about 25 000 km. This is due to that many measures focus on improving the effectiveness and quality of traffic management centre operations. In the participating countries, the traffic management centres of the road authorities provide their services on the whole comprehensive TEN-T network, and even wider, on the whole main road network including the arterials to the bigger cities connected by the main road networks. This had to be taken into account in cost-benefit calculations.

Therefore, in the benefit calculations, the whole impacted network has been included into the calculations. For example, in the Finnish case the improved weather service influences all main public roads, a network that is more than 13 000 kilometres, the traffic condition and travel time related benefits affect a network of 5 600 km whereas the safety related information services only benefit part of the NEXT-ITS corridor, less than 300 km. Furthermore, the most extensive services including e.g. lane management, only very minor parts of the network was covered including a few tunnels. These different networks influenced per service

[62] Key Performance Indicators for Intelligent Transport Systems, AECOM 2015

[63] CEF ITS Corridor projects

have been taken into account in the benefit calculations per each country, and the benefits have been estimated one network (with one bundle of services) at a time.

The total estimated effects of the services in NEXT-ITS were considerable, about 2.3 million vehicle hours driven less and circa 300 000 vehicle hours less spent in congestion annually.

The results of NEXT-ITS1&2 were indeed considered positive. However, the effect estimates were based on a desk-top analysis, and have to be compared to the actual statistics from the NEXT-ITS corridor and the national networks affected. It is clear that effects of the applied services are extremely difficult to measure and will have to be estimated partly as has been done in the ex-ante evaluation. In addition, the effects of the services are complicated to measure in this era of technology disruption due to connected and automated driving, the internet of things, digitalization, etc. In addition, one aspect fully excluded in the current analysis is the “value of being informed” - i.e. even if the individuals are not changing their behavior, which could be measured by “traditional benefits”, they may value being well informed.

An important conclusion from NEXT ITS is that while local actions have important effects on corridor sections, these effects are difficult to distinguish from the total effect which from the beginning is difficult to estimate and value. Suitable KPI´s for core network performance should be sought on a higher level.

7.9.3. ACTION NEEDED

The application of KPI´s and the possibility to understand and to translate impact from measures into costs and benefits in a monetary sense is essential. The effects from ITS investments need to be described and compared to other investments on a financial basis. What is needed is to define which indicators that are best suited to describe performance of a transport corridor and can be used to benchmark against other transport corridors. This would also require that the same monetary values are applied to the performance criteria used.

On Core Network Corridors, that include sections in several countries, we face currently a situation where the value of effects (fatalities, emissions, time lost in congestion, …) differ a lot between different sections of the corridor depending on country or region. This makes it truly difficult to assess costs and benefits from ITS measures on a corridor basis in a way that allow for benchmarking by using the same criteria as is used for local measures.

Instead work should be done in order to identify and agree upon performance assessment criteria that work specifically on a corridor level.

8. Drivers to make things happen

8.1. Drivers for CNC digitalization

As shown in the studies presented in our previous reports, road authorities / operators primarily deploy ITS with focus on solving local needs through local measures. To establish and operate ITS that optimize network/corridor performance, various drivers (including incentives) are needed to ensure that stakeholders also value and include the corridor perspective in their investment decisions.

Such drivers may include:

- Incentives like financial support to projects supporting the development of corridor strategies
- Legal measures that require, support and facilitate innovations in infrastructure investments, but which also may provide restrictions and limitations that prevent innovation.
- Knowledge on corridor performance and its impact on local traffic, with particular attention to the impact from freight transport
- New traffic management tools combining local and corridor perspectives
- Support in planning and design for transport system balancing local and corridor needs
- Stakeholder cooperation for identifying potential benefits from integration of systems and services

The importance (strength) of these drivers depends on the specific situation: Which condition is needed in order to drive development?

8.2. Conditions supporting ITS deployment

ITS deployment, including the actions proposed in this roadmap, can be facilitated through targeted means and measures. Following literature study, results of workshops etc (reported in D2[64]), the following conditions (state of play) are considered to support harmonized and synchronized ITS deployment on road transport corridors:

A. Availability of funds allocated for ITS investment;

[64] D2 ITS Deployment Drivers, Incentives and other mechanisms supporting ITS deployment on transport corridors, February 2019

B. Harmonized ITS systems and services; availability to standards etc facilitate procurement and deployment

C. Synchronized investment plans; simultaneous need from (e.g. neighbouring) several actors

D. Urgency; immediate needs speeds up investments

E. Predictability; knowledge of expected effects supports the use of ITS

F. Business interest; many potential suppliers and future profit expectations drives the deployment and use of ITS.

G. Policy interest; here we include (often public) stakeholder general interest of executing influence and avoiding the risk of being "outside" a process

H. Knowledge; access to knowledge and awareness of ITS options speed up and facilitate deployment

Of these, conditions A, C, D and F will directly call for investments in ITS while the other will facilitate ITS deployment.

8.3. ITS Deployment driver efficiency

The conditions listed above are created by the use of "drivers", i.e. measures that create these conditions. The potential impact of a specific measure will then be dependent on the importance of the condition in combination with how efficient the driver is to create this condition.

The investigation made (and reported in D2) showed that the most important drivers behind ITS deployment in general, when considering the importance of the various conditions above, were (in priority order):

- Availability of funds
- Urgency
- Harmonization, and
- Business interest including Policy interest

When looking at the specific needs related to CNC digitalization, we can assume a low level of urgency, thus the most efficient ways to generate development are to **make funds available, make standards available, engage public actors (create policy interest) and to some extent engage commercial actors in the development (create business opportunities)**.

This has been accounted for in the Actions definition provided in the following section.

9. Proposed actions

The concluding roadmap for CNC digitalization, as seen from the EU EIP perspective, ends up with 9 actions in three categories presented below

9.1. Actions to establish an organizational base

9.1.1. ACTION FOR CHAMPIONS AND PLATFORMS

9.1.1.1. TARGET

Dedicated platform (-s) committed to improve CNC performance through use of ITS applications shall be in place, and individual champions, formal and informal, shall have leading positions in the work within specific areas.

9.1.1.2. ACTION CONTENT

For stakeholders to merge into interest groups (as done in the European ITS Platform – EU EIP) and safeguard their position, for the EC to offer enough policy influence for platform member.

For CNC digitalization proposal is to combine efforts between CNC Coordinator offices and national road authorities / operators into a CNC Digitalization Platform. Participation of private stakeholders (business) should also be facilitated.

9.1.1.3. STAKEHOLDERS

Prominent stakeholders are as well European institutions (that benefit from the work done in platforms) as all kinds of stakeholder representatives that fear missing out on influencing the process. “Lobby organisations” like UITP, ASECAP, CEDR, ACEA, POLIS etc. are natural participants in ITS related platforms beside business and public partners. For the cause of CNC digitalization, key stakeholders are Road operators and authorities mainly on the national level, similar to what is seen in e.g. EU EIP together with relevant business stakeholders.

9.1.1.4. DRIVERS

Key drivers are Availability to funds, Policy interest and Business opportunities.

9.1.1.5. SUITABLE FORMAT

Two typical, albeit quite different, models are given by the CCAM Platform and the EU EIP project whereas the latter include considerable financial support (and co-funding by partners) in return for work done. Participation in the CCAM platform is driven mainly by Business and Policy interest.

An interesting format concerning Champions is the assignment of Corridor Coordinators for the CNC´s, with the role of pushing work forward.

9.1.1.6. PRIORITY

High priority. Platforms need to be operational in order to take on assignments. To start up platforms when they are needed take very long time.

9.1.2. ACTION TO ESTABLISH ROAD CID

9.1.2.1. TARGET

From their own interest, each CNC shall develop a Road Corridor Information Document and establish an organization / solution for the continued management of this document. “Document” shall be understood as a suitable form for management and distribution of the information contained, hence it may be a website etc.

9.1.2.2. ACTION CONTENT

The Road CID shall be designed to gradually extend to include more information when available and needed. The first steps of the action shall be to:

- Establish a Road CID template, first version
- Perform pilot developments with this template
- Develop an organization for the continued management
- Initiate wide data collection through the organization

9.1.2.3. STAKEHOLDERS

Public / National road authorities play a central role in the Road CID development. Particularly as they will have the full responsibility to ensure completeness and correctness of information supplied. Also, European institutions through the Corridor Coordinators offices, have a strong interest and should be engaged in the work.

Possible actors are CEDR, EC, ASECAP, CNC Coordinators, Road authorities

9.1.2.4. DRIVERS

The strongest driver behind Road CID is the **Perceived need**. CNC coordinators and road authorities will fail to develop “digital corridors” without full real time knowledge of “neighbouring” systems and services. Development and piloting of solutions will require European **financial support**, e.g. through the CEF programme (this is not a research activity).

9.1.2.5. SUITABLE FORMAT

The development will require pilot implementations. A suitable format is a collaborative European development project supported by European institutions and funding programmes (e.g. CEF).

A format for later continued operation needs to be developed as part of the pilot.

9.1.2.6. PRIORITY

The Road CID is very valuable, but the priority is considered to be **Medium**.

9.2. Actions to establish the needed technical preconditions

9.2.1. ACTION FOR CROSS BORDER ITS DEVELOPMENT

9.2.1.1. TARGET

Operators of CNC sections and services shall have the organization required to offer continuous cross-border and intermodal services.

9.2.1.2. ACTION CONTENT

The needs are primarily related to institutional issues and harmonization, together with information management. Technical development is highly relevant to safeguard CNC performance, and may find its applications on the CNC level to solve critical bottleneck situations at cross-border or cross-mode situations. A possible method would be to systematically study cross-border and cross-mode situations in order to identify possibilities for improved performance.

Possibly, the action content is provided by other actions here listed but with complementary participation of representatives from other (than road) transport modes.

9.2.1.3. STAKEHOLDERS

A wide range of stakeholders from several transport modes. This is probably the most challenging aspect of this action, which calls for an organization clearly associated with the **CNC coordinators offices**.

9.2.1.4. DRIVERS

Development and piloting of solutions will require European **financial support**, e.g. through the CEF programme (this is not a research activity).

9.2.1.5. SUITABLE FORMAT

Projects shall be executed as part of the CEF programme. Possibly as multi-stakeholder CEF projects or as PSA´s.

9.2.1.6. PRIORITY

Considering the policy aspects and the urgent call to include more ITS in the CNC, the priority is **High**.

9.2.2. ACTION FOR SERVICE HARMONIZATION

9.2.2.1. TARGET

Users of the CNC shall perceive services provided as seamless in terms of content and interface.

9.2.2.2. ACTION CONTENT

The key element of the work will be to provide common (European) guidelines for service design regarding:

- Principles for user interfaces
- Principles for vehicle interfaces where relevant
- Principles for location (where) and provision (when) of services
- Quality definition and requirements

The availability of well documented Best Practises will be a cornerstone in the work. As local adaptations will always be made, these guidelines shall be made to function as voluntary harmonization tools. An important aspect to solve is the long term maintenance of reference material and the need for a sustainable management solution for Europe.

9.2.2.3. STAKEHOLDERS

Public / National road authorities need to play a central role in this development as they have the responsibility on their respective road sections. They are also the primary beneficiaries of Reference handbooks and guidelines.

9.2.2.4. DRIVERS

Development and piloting of solutions will require European **financial support**, e.g. through the CEF programme (this is not a research activity).

9.2.2.5. SUITABLE FORMAT

This is a good example of a platform driven development. The ITS Corridor projects and their cooperation through the EU EIP platform is a good example of a suitable organization.

9.2.2.6. PRIORITY

This is in practise an ongoing work that needs to be continue without interruption. Hence the priority is **High**.

9.2.3. ACTION FOR GEOLOCALIZATION

9.2.3.1. TARGET

European road operators / authorities shall have an agreed method to define geographical areas (road section, area, etc.) for the purpose of traffic regulation and operation.

9.2.3.2. ACTION CONTENT

Standards are needed as a base together with the INSPIRE directive specifications which can provide a regulatory / technical base. Much of this basis seems to be available, but development of specifications are essential in order to establish operational implementations (profiles) of the standards when available.

Following this, tests and pilot activities have to be carried out involving OEM´s, national authorities etc.

9.2.3.3. STAKEHOLDERS

Public / National Road Authorities have to play a central role in this development as they will have the full responsibility to ensure completeness and correctness of information supplied, and systems in support of this have to be established. However, as the need is European, European institutions must engage and take a strong position in the initial phase.

Possible complementary actors are CEN, CEDR, EC, ASECAP, ACEA (OEM´s)

9.2.3.4. DRIVERS

Technical standards need to be in place together with a suitable technical solution. **Regulation** seems to be in place, but tools will be needed to ensure that countries provide the information required in the agreed format through the agreed channels.

Development and piloting of solutions will require European **financial support**, e.g. through the CEF programme (this is not a research activity).

9.2.3.5. SUITABLE FORMAT

Standardization through CEN TC278 is initiated and will need continued participation and support.[65]

The development will require pilot implementations. A suitable format is a collaborative European development project supported by European institutions and funding programmes (e.g. CEF).

9.2.3.6. PRIORITY

The solution need to be fully in place to allow for automation at level 4 or higher which will be needed around 2030.

[65] May be concluded?

However, considering the amount of work needed and that this is a prerequisite for e.g. DTR´s, the priority is **Very High**.

9.2.4. ACTION TO MAKE DIGITAL TRAFFIC REGULATIONS AVAILABLE

9.2.4.1. TARGET

All traffic regulations, and other forms of guiding principles like traffic management plans etc., that are needed for a driver / vehicle to perform in accordance with rules set when driving on road sections of the CNC shall be available in real time in a known digital format through a known interface.

9.2.4.2. ACTION CONTENT

- Standards are needed as a base
- Development of specifications are essential in order to establish operational implementations (profiles) of the standards when available
- Tests and pilot activities have to be carried out involving OEM´s, national authorities etc.

9.2.4.3. STAKEHOLDERS

Public / National Authorities have to play a central role in this development. In particular as they will have the full responsibility to ensure completeness and correctness of information supplied. However, as the need is European, European institutions must engage and take a strong position in the initial phase.

Possible actors are CEDR, EC, ASECAP, ACEA, POLIS etc.

9.2.4.4. DRIVERS

Technical standards need to be in place together with a suitable technical solution. Following that, **regulation** will be needed to ensure that countries provide the information required in the agreed format through the agreed channels.

Development and piloting of solutions will require European **financial support**, e.g. through the CEF programme (this is not a research activity).

9.2.4.5. SUITABLE FORMAT

Standardization through CEN TC278 is initiated and will need continued participation and support.

The development will require pilot implementations. A suitable format is a collaborative European development project supported by European institutions and funding programmes (e.g. CEF).

9.2.4.6. PRIORITY

The solution needs to be fully in place to allow for automation at level 4 or higher which will be needed around 2030.

However, considering the amount of work needed, the priority is **Average** already at this stage.

9.2.5. ACTION FOR INTEGRATED INFORMATION MANAGEMENT

9.2.5.1. TARGET

Seen from a user or service provider perspective, road transport related information for all of Europe shall be accessible through an access point of free choice.

9.2.5.2. ACTION CONTENT

The action aims at establishing data standards (standard profiles) for this use, to ensure that data is correctly interpreted and that the quality level is known. The action will also cover business aspects including information on which data is available where and on which conditions, in support of integration. Building on the framework of current and future amended ITS legislation, the action can be seen to extend the proposed initiative for a project aiming at federation of NAP´s.

Piloting will be needed to assess time critical applications suitability for data exchange mechanisms (as an alternative to peer-to-peer communication).

9.2.5.3. STAKEHOLDERS

Stakeholders are primarily found among organizations with a strong business interest in data management and provision. Service providers like TomTom and Here, OEM´s and data warehouses are evident stakeholders. Also experts in high speed commercial data exchange like Ericsson and Vodafone are relevant. Data owners, providers, like national road authorities have an important role to play.

9.2.5.4. DRIVERS

Technical standards need to be in place together with a suitable technical solution. Development and piloting of solutions will require European **financial support**, e.g. through a Framework Programme projects.

9.2.5.5. SUITABLE FORMAT

Standardization through CEN TC278 is well advanced on most aspects. The development will require pilot implementations. A suitable format is a collaborative European research and innovation project supported by European institutions and funding programmes (e.g. FP).

9.2.5.6. PRIORITY

The initiative shall be seen in the light of the proposed PSA on Federation of NAP´s. Hence the action shall be initiated with **High** priority.

9.3. Actions for CNC performance assessment

9.3.1. ACTION FOR CNC KPI´S

9.3.1.1. TARGET

The goal is to establish KPI´s related to Core Network Corridor performance that enable benchmarking between corridors concerning information quality and continuity of services. The KPI´s can also be used to monitor improvements and as a basis for decisions on further actions.

There is a need to identify also non-digital KPI´s that are workable on the corridor level with focus on performance measurements like emissions, safety, productivity etc. Whether or not to combine these two needs into one action remains to be discussed.

9.3.1.2. ACTION CONTENT

The action should start with the definition of possible KPI´s, their advantages and disadvantages, and continue with trial implementations of these KPI´s on existing CEF corridors.

9.3.1.3. STAKEHOLDERS

The Action should be hosted by CEF Corridor Coordinators offices. It is important to engage also competent transport operators beside infrastructure holders in the work.

9.3.1.4. DRIVERS

This action will be fully dependant on European financing.

9.3.1.5. SUITABLE FORMAT

A suitable format is a collaborative European development project, carried out within the CEF programme. Eventually as a PSA.

9.3.1.6. PRIORITY

There is no expressed need at the moment, but the slow progress in the area can partly be explained by the absence of suitable KPI´s for benchmarking corridors. Hence the priority should be considered as Average.

9.3.2. ACTION FOR COLLECTION AND COMPILATION OF ASSESSMENT DATA

9.3.2.1. TARGET

European road authorities / operators shall have continued access to data enabling adequate assessment of costs and benefits related to ITS deployment, in particular concerning cross-border investments.

9.3.2.2. ACTION CONTENT

The action is similar to what is currently carried out within EU EIP SA5, and previously in e.g. EasyWay, where member states through ITS Corridor projects, contribute with data from assessment of ITS deployment projects. This means that ITS Corridor deployment projects conduct assessment in accordance with common guidelines and that the results are compiled and published on a European level.

The work should also account for new KPI´s, e.g. related to a corridor perspective and effects on the digital performance.

9.3.2.3. STAKEHOLDERS

Road authorities and road operators have to contribute with assessment data, and need to cooperate also on the compiled assessment. Also organizations like CEDR and ASECAP are relevant as stakeholders.

9.3.2.4. DRIVERS

This action will clearly benefit from **European support**, but stakeholders own interest (policy interest) is an important driver.

9.3.2.5. SUITABLE FORMAT

This is typically a platform oriented European project, whereas the current model with a base in EU EIP, financed through the CEF programme, is relevant. As the work should be seen as a long term initiative, temporary financing models are not to be recommended.

9.3.2.6. PRIORITY

The more data, the better. Considering the need for continuous data collection, the current work should continue (one way or another). Hence the priority is **High**.

10. Conclusions

National road authorities and operators focus on national needs in their infrastructure planning, including ITS deployment. For establishing a network of digital Core Network Corridors the work in EU EIP SA 4.3 has shown that there is a need for European activities to reach the goals set.

With this document EU EIP proposes a set of European digitalization actions that should be carried out in cooperation between road operators and authorities, European agencies, business interests and other relevant stakeholders.

The basis for our selected actions is that a digital CNC is characterized by three characteristics:

The driver, cargo and the vehicle experience a seamless transport system

The driver, the cargo and the vehicle systems do not experience “borders” along the transport route. Neither between geographical areas nor between transport modes. Systems and services are provided in accordance with the user needs and preferences.

Relevant stakeholders and organizations cooperate

Organizations that contribute to the development, delivery and operation of a digital CNC work together through established fora and formats where responsibilities are clearly defined and evolution is supported. As digitalization contributes to a rapid growth in economy with new actors and new services, new business models and business relations will emerge based on common interests.

Data is always available

The key to a seamless transport system is accessibility to and availability of data. All relevant data must be available and accessible for all needs at any moment to any entity in the system, and business models for the supply and use of data shall be transparent and appropriate.

Some of these actions are already ongoing or in different state of preparation. Our recommendations do not exclude these actions as their listing is necessary in order to give a full picture. Our concluding proposed list of actions and their current status are presented in the table below:

Action	Current status
Actions to establish an organizational base	
Action for champions and platforms	Many platforms and initiatives ongoing. We see a need for an initiative towards CNC digitalization
Action to establish Road CID	First studies under way. A more solid structure needed.
Actions to establish the needed technical preconditions	
Actions for cross border ITS development	Little focus on cross-border (and other interfaces) situation in current work. Need for dedicated work on cross-border aspects.
Actions for service harmonization	Much work ongoing, e.g. through EU EIP. Important that work continues.
Action for geolocalization	Harmonization well underway, but a huge need for road operators and authorities to cooperate with implementation
Action to make Digital Traffic Regulations available	Related to above. Management standards underway, but a huge need for road operators and authorities to cooperate with implementation
Action for integrated information management	Related to the current NAP initiative. Important to include a wider range of stakeholders and new business models
Actions for CNC performance assessment	
Action for CNC KPI´s	Current KPI´s do not relate to the digital performance and the corridor qualities. Much work needed.
Action for collection and compilation of assessment data	Ongoing e.g. in EU EIP. Need to be further expanded and continued.

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- Proceedings from workshop: ITS for the CEF / CNC corridors, Rome 16 May 2019

12. Glossary and abbreviations

Abbreviation	Explanation
4G	Fourth generation mobile telecommunications technology
5G	Fifth generation mobile telecommunications technology
ACEA	European Automobile Manufacturers´ Association
ADAS	Advanced Driver Assistance Systems (in-vehicle safety)
ASECAP	European Association of Operators of Toll Road Infrastructures
CAD	Connected and Automated Driving
CAM	Cooperative Awareness Message
CCAM	Cooperative, Connected and Automated Mobility
CEDR	Conference of European Directors of Roads
CEF	Connecting Europe Facility
CEN	European Committee for Standardization
CID	Corridor Information Document
CNC	Core Network Corridor
C-ITS	Cooperative Intelligent Transport Systems
DAB	Digital Audio Broadcasting
DENM	Decentralized Environmental Notification Message
DG	Deployment Guideline / Directorate General
DG MOVE	EC Directorate General for Mobility and Transport
DSRC	Dedicated Short Range Communication (5.8 GHz)
EC	European Commission
EIP	European ITS Platform
EIP+	European ITS Platform+
ETA	Estimated Time of Arrival
ETSI	European Telecommunication Standards Institute
EU	European Union

Abbreviation	Explanation
FLS	Freight and Logistics Services
FM	Frequency Modulation
FOT	Field Operational Test
GPS	Global Positioning System
I2I	Infrastructure-to-Infrastructure Communication
I2V	Infrastructure-to-Vehicle Communication
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
ITS G5	European profile standard for communications in the 5 GHz band (based on IEEE standard 802.11/802.11p)
ITS-R	Intelligent Transport System Roadside Station
ITS-V	Intelligent Transport System Vehicle Station
IWW	Inland Water-ways
KPI	Key Performance Indicator
NAP	National Access Point
ODD	Operational Design Domain
OEM	Original Equipment Manufacturer (here meaning vehicle manufacturer)
POLIS	European Cities and Regions Networking for Innovative Transport Solutions
R&D	Research and Development
RDS-TMC	Radio Data System – Traffic Message Channel
RWW	Road Works Warning
TEN-T	Trans-European Network - Transport
TIS	Traveller Information Services
TMC	Traffic Management Centre
TMP	Traffic Management Plan

Abbreviation	Explanation
TMS	Traffic Management Services
UITP	The International Association of Public Transport
V2I	Vehicle-to-Infrastructure Communication
VMS	Variable Message Signs