Reducing congestion with integrated network management (INM)
Authors

This report was compiled by CEDR task group N6 (Congestion). Task group leader and main author: Christian Ebner (Austria)

Group members:

<table>
<thead>
<tr>
<th>Country</th>
<th>Contributor</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Michael Schneider</td>
<td>ASFINAG</td>
</tr>
<tr>
<td></td>
<td>Khaled El-Araby</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>Claus Lund Andersen</td>
<td>Vejdirektoratet Trafiktårnet</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>Ronald Adams</td>
<td>Rijkswaterstaat</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Ulrich Zorin</td>
<td>DARS</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Roger Siegrist</td>
<td>ASTRA</td>
</tr>
</tbody>
</table>

Approved by the Governing Board of CEDR: April 2017
Edited and published by: CEDR's Secretariat General
Ref.: CEDR report 2017/01 Reducing congestion with integrated network management (INM)

Disclaimer:

This document expresses the current position of CEDR. It does not necessarily represent the views of individual member countries and should not be considered the official position of member countries.
Executive summary

There is a clear link between growing mobility problems such as congestion and the widely acknowledged potential of smart mobility solutions. Smart mobility solutions such as integrated network management (INM) can help reduce congestion, ensure more efficient, safer, and cleaner transportation, and improve services for road users. When viewed from this perspective, integrated network management is defined as ‘an approach that includes both traffic management and traffic information measures integrated and managed within a transport network’ and is seen both as essential for the effective reduction of congestion and a no-regrets development.

Many NRAs are in the process of moving from single road management towards integrated network management that covers different modes, regions, borders, and/or networks. While the promises and potential of smart mobility solutions such as integrated network management are considerable and politically very popular, the implementation of these solutions is complex and has many operational, tactical, and strategic consequences that can be characterised at the very least as being challenging for the different stakeholders involved.

NRAs, road operators, and public transport operators must continue to work closely with one another to cope with the growing mobility of a changing society and increased congestion on roads. Existing and new ITS tools as well as data management and exchange will play a role by enabling active, integrated traffic management on the overall road and transport network (relation to TEN-T and to European corridors). In general, other players on the market will play a greater role with effects on traffic management and congestion.

The results of the work of task group N6 (Congestion, TG N6) during CEDR’s Strategic Plan 2013–2017 are presented in this report.

The amount of available data for traffic management is increasing rapidly, as is the number of different operating systems. Consequently, the analysis and exchange of data, strategies, and measures between different systems are important factors for a comprehensive, co-operational network-wide management.

In order to support and promote integrated network management (INM) with a view to ensuring optimum handling of traffic problems in the future, TG N6 makes the following recommendations:

- **Close cooperation is a key necessity**
  Smart mobility requires connected networks. When considered from this perspective, integrated network management can be seen as key to making our roads less congested and transport more efficient, safer, and cleaner. Positive basic conditions and frameworks need to be created to ensure that all partners with different responsibilities are willing to cooperate. It is therefore important that ALL CEDR members keep working on integrated network management and cooperate closely with each other so that they can deal with any impacts that may arise and in order to ensure that they are adequately prepared for new scenarios (e.g. cooperative systems and automated driving). This N6 report is meant to support CEDR members who are and/or who want to become active in INM.

- **A clear definition and consistent framework and a roadmap for INM are helpful**
  Integrated network management is a new and broad term. Using one definition of INM (‘a traffic management approach that includes both traffic management and traffic information measures integrated and managed within a transport network’) and a framework for deployment can help NRAs deploy and operate INM successfully. It is important to communicate the definition and framework within CEDR and start working with them actively. In addition, for those countries that are willing to adopt integrated network management, a
step-by-step approach, including early testing phases, is useful for the smart deployment of INM with reasonable cost-benefit effects.

- **A platform for knowledge exchange based on case studies is highly beneficial**
  A full-scale integrated network management approach is a relatively new part of most national traffic and transport policies. It can, therefore, be very helpful and cost-effective to provide a platform for knowledge exchange based on a rich knowledge base of traffic management case studies across CEDR members. Countries with little experience of INM can benefit hugely from a knowledge transfer based on best practice and relevant case studies. Consistent assessment results across case studies is quite helpful for knowledge transfer and needs to be enhanced in future phases.

- **Strengthening public-private cooperation for INM**
  In most cases, integrated network management requires cooperation between public and private partners. Different road authorities and stakeholders can have different—and sometimes conflicting—traffic policy goals, which can complicate efforts to find the optimum solution. Furthermore, private partners and service providers may play a bigger role and influence traffic management in a direct or indirect way. If NRAs/operators want to keep playing a strong, active role in the future, they need to be flexible to handle interaction with other key stakeholders such as suppliers, service providers, and the automotive industry and also to handle innovative measures such as cooperative systems and automated driving. A clear understanding of the proper mix and deployment time scales between conventional and innovative measures needs to be outlined, together with identification of relevant case studies, to enable a smooth transition. This calls for further strengthening of public-private cooperation, not only at strategic but also at tactical and operational levels. Public-private cooperation requires sound business cases. INM can be seen as a tool for the better utilisation of funds.

- **INM requires complete, high-quality data**
  Data completeness and quality are key aspects of the successful deployment and operation of INM schemes. Supplementary data sources such as crowd sourcing and floating car data (FCD) together with traditional data sources coupled with data quality schemes are necessary to ensure adequate quality of information. Use of supplementary data requires the opening up of cooperation with what are mostly private service providers. As a follow-up, a national database and consistent standards need to be set-up in each member country to allow for data integration and consistent exchange of data between national access points at cross-border levels.

- **Consistent delivery of services needs to be ensured**
  With more traffic information measures taken up by private players, service level agreements (SLAs) need to be integrated at operational level to ensure consistent delivery of services within agreements between NRAs and service providers. Case studies incorporating such SLAs should be investigated in order to come up with the right mix of traffic service quality related to level and scope of utilisation with the reduction of conflicting priorities among public and private players.

Regarding all developments on information and automation level, traffic management will continue to be the tool for handling traffic in the future and maintaining an active role for NRAs. A specific task group for traffic management can capitalise on the CEDR structure for bringing about different projects and programmes across European countries and across public and private partners in the right way and according to sound business models. Within AP2017–2019, such a framework can serve as a cooperation and knowledge exchange platform for the collection and dissemination of best-practice case studies through participation of more European countries in the working group.
# Table of contents

List of abbreviations and symbols........................................................................................................................................ 6

1 Introduction........................................................................................................................................................................... 7
   1.1 Traffic problems ............................................................................................................................................................. 7
   1.2 Current state of traffic management and INM in European countries ................................................................. 8
   1.3 Goals and strategy for reaching TG N6’s goals ........................................................................................................... 9

2 Scope of the report............................................................................................................................................................ 11

3 Approach ........................................................................................................................................................................... 12

4 Definition of and framework for INM.............................................................................................................................. 14
   4.1 Definition of INM.......................................................................................................................................................... 14
   4.2 Framework for INM .................................................................................................................................................... 15

5 N6 Activities..................................................................................................................................................................... 17

6 CEDR’s INM survey .......................................................................................................................................................... 18
   6.1 Overall survey results................................................................................................................................................... 20
       6.1.2 Definition of INM .................................................................................................................................................. 20
       6.1.2 Scope of INM ....................................................................................................................................................... 21
       6.1.3 Level of INM deployment .................................................................................................................................. 22
       6.1.4 Partners for the successful delivery of INM ........................................................................................................... 23
       6.1.5 Key objectives behind INM deployment .............................................................................................................. 24
       6.1.6 Tools used to deploy traffic management ........................................................................................................... 25
       6.1.7 INM case studies provided ................................................................................................................................ 26
       6.1.8 INM case studies: problems tackled ..................................................................................................................... 26
       6.1.9 Features of the INM case studies provided .......................................................................................................... 27
       6.1.10 INM case studies: success factors for INM deployment and operation ................................................................. 27
       6.1.11 Availability of assessment results for case studies ............................................................................................. 28

7 ITS interface to traffic management and INM .................................................................................................................... 29

8 Conclusions and recommendations .................................................................................................................................. 33

9 Proposed follow-up for the working group traffic and network management in AP2017–2019 ................................................. 35

10 Annexes ............................................................................................................................................................................ 38
# List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASFINAG</td>
<td>state-owned company that plans, finances, builds, maintains, and operates Austria's entire primary road network and collect tolls on these roads</td>
</tr>
<tr>
<td>Astra</td>
<td>Swiss Federal Roads Office</td>
</tr>
<tr>
<td>CEDR</td>
<td>Conference of European Directors of Roads</td>
</tr>
<tr>
<td>DARS</td>
<td>Slovenia motorway company</td>
</tr>
<tr>
<td>EB</td>
<td>CEDR's Executive Board</td>
</tr>
<tr>
<td>FCD</td>
<td>floating car data</td>
</tr>
<tr>
<td>GB</td>
<td>CEDR's Governing Board</td>
</tr>
<tr>
<td>INM</td>
<td>integrated network management</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organisation for Standardization</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicators</td>
</tr>
<tr>
<td>NRA</td>
<td>national road authority</td>
</tr>
<tr>
<td>PPP</td>
<td>public-private partnership</td>
</tr>
<tr>
<td>QoS</td>
<td>Quality of Service</td>
</tr>
<tr>
<td>Rijkwaterstaat</td>
<td>Part of the Dutch Ministry of Infrastructure and the Environment and is responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands (main road and waterway networks and the main water systems).</td>
</tr>
<tr>
<td>SLA</td>
<td>service level agreements</td>
</tr>
<tr>
<td>SP</td>
<td>CEDR Strategic Plan</td>
</tr>
<tr>
<td>SP3</td>
<td>3rd CEDR Strategic Plan (2014–2017)</td>
</tr>
<tr>
<td>TCC</td>
<td>Traffic Control Centre</td>
</tr>
<tr>
<td>TEN-T</td>
<td>Trans-European Network for Transport</td>
</tr>
<tr>
<td>TG</td>
<td>task group</td>
</tr>
<tr>
<td>TG N6</td>
<td>CEDR ask group N6 (Congestion)</td>
</tr>
<tr>
<td>TG N7</td>
<td>CEDR ask group N6 (ITS for NRAs)</td>
</tr>
<tr>
<td>TM</td>
<td>traffic management</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic Management Centre</td>
</tr>
<tr>
<td>TMPs</td>
<td>Traffic Management Plans</td>
</tr>
<tr>
<td>VMS</td>
<td>variable message sign</td>
</tr>
<tr>
<td>WG</td>
<td>working group</td>
</tr>
</tbody>
</table>
1 Introduction

1.1 Traffic problems

Road users on European road networks face three traffic problems: delays, safety, and pollution. The economic impact of these problems is significant. For example, traffic problems are hampering accessibility for just-in-time deliveries in commercial and industrial areas and reducing the value of residential areas. The cost to society of traffic delays on Europe’s main roads is estimated at €15–20 billion per annum. Although no accurate estimates exist for Europe (only Dutch figures extrapolated to Europe), it is estimated that traffic delays on urban and rural roads also cost approx. €15–20 billion p.a.\(^1\)

In recent years, CEDR member countries have experienced increasing traffic volumes and more traffic problems in the form of increasing congestion and a higher impact of incidents on traffic flow. This trend is very clear, especially on motorways, and there is no immediate prospect of any major change in this development. Most delays and pollution in Europe occur in and around major conurbations. As cities grow, so too do their traffic problems. In and around major conurbations, there are often several (or many) road operators and public transport operators, each responsible for its specific part of the transport system. Traffic policy goals can vary from one road authority to another at urban and national levels and across Europe. Cities in particular can have very different traffic policy goals to NRAs.

![Figure 1: Congestion during peak hour in Vienna](image)

Safety problems and measures to reduce them are generally local in orientation. Although delays, pollution, and economic problems are often caused locally, they can be reduced both locally and at network level (e.g. by improving the distribution of traffic flows across the network or over different time periods or modes).

\(^1\) Dutch figures extrapolated to Europe.
However, most current measures to reduce congestion are local, while relatively few exist at network level. Although local measures can always be improved, improvement is difficult and costly due to the relatively dense deployment of local traffic management measures. There is much more room for improvement at network level. On average (over time, space, and modes), the capacity of the European transport system is certainly more than sufficient. It is the concentration of traffic on roads around conurbations in specific peak periods that is causing the greatest problems.

Traffic management and information measures at network level, including smart mobility measures in the form of cooperative systems and automated driving, are generally economically viable and can deal effectively with such problems. In general, existing innovative local measures are coordinated and optimised for use over the network. The costs relate mostly to coordination and centralised software and less to local deployment. The main difficulty in network-wide management (integrated network management, INM) is that organisations may need to cooperate to ensure a harmonised level of service to the user across modes, regions, and borders. This means first and foremost sharing some of the responsibilities and infrastructure. Secondly, it might mean an increase in traffic problems and costs for some of the cooperating organisations, while others experience the (greater) benefits.

The aim of this document is to help decision-makers introduce harmonised INM conditions, to demonstrate the potential of innovative smart mobility solutions and INM and the benefits that have already been achieved because of them, and to stimulate and support further adoption and effective deployment of INM measures.

Case studies highlighting specific integrated network management deployment, requirements, and key challenges encountered, were collected from across Europe to provide the platform for knowledge exchange between European partners to ensure effective planning and deployment.

1.2 Current state of traffic management and INM in European countries

National road authorities (NRAs) and road operators are increasingly working with all kinds of traffic management measures. Because of tighter budgets, a scarcity of space, and new policies, the role of Intelligent Transport Systems (ITS) and traffic management is increasing.

During its second Strategic Plan (2009–2013), CEDR set up a task group (T12) to gather and condense knowledge and experience on traffic management so that a common understanding could be reached by CEDR members. In the group’s final report, a traffic management strategy was proposed. Based on a problem-oriented approach, the T12 report suggested eight steps for moving from high-level goals to the implementation of measures and control scenarios (Traffic Management to reduce congestion, CEDR Final report Task group 12). The eight-step process described in the T12 Final Report can help traffic engineers find and establish the right measures and implement the most effective control scenarios.

However, these measures and control scenarios focused mainly on motorways and on single points and sections. To gain further positive effects and benefits in terms of traffic flow, travel times, and environmental aspects, it is necessary to link single measures and consider the transport network as a whole, covering various modes, networks, and stakeholders. A lot of work has already been done on traffic management and traveller information services. However, the integration of such
measures on a wide-scale across regions, borders, networks, and modes is not widespread in Europe.

Further work is needed to assess the broader picture of traffic management across borders, modes, measures, and networks. Case studies and best-practice examples of integrated network management are not uniformly reported, and there is a need for a knowledge base of European best practice in order to gain knowledge on how to effectively plan and deploy integrated network management across a variety of operating contexts.

In order to get a better overview of the current situation in different member countries, a survey was conducted between June and November 2015. For this survey, CEDR members were sent a questionnaire and asked to provide information about their views on and experience of current traffic management and integrated measures.

The final version of the questionnaire can be found in Annex A.

A notable element of this questionnaire is the need for and understanding of effective integrated network management. Some countries have specific needs regarding integrated network management across regions and borders; others have more complex needs involving urban and rural networks and covering road and non-road modes. Some have a national traffic management strategy and highlight the potential of integrated/coordinated traffic management strategies and measures to make the transport system more efficient.

During CEDR's third Strategic Plan (2013–2017), CEDR's task group N6 (Congestion, TG N6) worked on a general theoretical basis to develop the definition and framework conditions for INM to reduce congestion and tried to validate this framework through concrete case studies and survey results to make INM as clear as possible. TG N6 developed a framework for defining the basic conditions for effective integrated network management. Using this framework, a knowledge base of network management practices used to reduce congestion in various European countries coupled with the developed knowledge base of concrete case studies reported by the participating NRAs was established in the survey.

The results, as outlined in this report, provide a good overview of current practice in integrated network management and serve as a good starting point in the search for greater knowledge of effective network management measures. It is therefore necessary to broaden cooperation on future activities. The main points in continuing the work, within Action Plan 2017–2019 (AP2017–2019), is to help other countries understand and introduce INM in a more consistent manner and, even more importantly, to help each other move in the right direction together. Within the coming Action Plan, more case studies involving more European countries and stakeholders, coupled with a more thorough assessment of results and best practice, would promote INM even further and ensure coordinated deployment. There needs to be a greater concerted effort to disseminate and share knowledge of such case studies across Europe.

1.3 Goals and strategy for reaching TG N6’s goals

Within CEDR's third Strategic Plan (2013–2017), the Thematic Domain Network Management focused on the role of NRAs in safely reducing congestion, efficiently managing and operating the road network, and developing and providing a service to road users and others who may be
affected by the operation of road networks. To achieve this goal, seven task groups were set up within this thematic domain. These groups focused on performance, asset management, winter operations, heavy vehicles, road safety, congestion, and ITS. TG N6 dealt with congestion and integrated network management on a more tactical and operational level, while CEDR's TG N7 (ITS for NRAs) sought to identify NRAs' concerns and requirements regarding ITS measures on a more strategic level in line with key European actions and policies relevant to NRAs.

Right from the word go, close cooperation between task groups N6 and N7 was necessary for two reasons. Firstly, because most integrated network management strategies and measures are heavily influenced by ITS deployment on the road networks and secondly, because ITS deployment needs to be integrated across a number of dimensions in order to achieve maximum effectiveness on road networks.

In this respect, TGs N6 and N7 coordinated their activities and reporting (one NRA was represented in both groups) and held joint meetings to exchange knowledge and output. The first joint N6/N7 meeting took place in Copenhagen on 16 September 2015; the second in Vienna on 24 February 2016. The two groups worked together to identify case studies that relate traffic management measures to European ITS Actions as reflected in the European ITS Action Plan Directive. In this respect, TG N6's main focus was on operations and the deployment of concrete traffic management measures from the perspective of NRAs, while TG N7's focus was on ITS policy and strategy, taking into account innovative ITS measures as cooperative systems, automated driving, and widely deployed ITS measures. This distinction between operation and strategy needs to be maintained in AP2017–2019 in order to give both aspects the attention they need and deserve. At the same time, however, close cooperation should be maintained in order to achieve complementarity at strategic, technological, and operational levels.

Integrated network management (INM) is a relatively new approach in most national traffic and transport policies. Some countries/regions with high congestion levels and dense road networks have gained initial experience with inter-network traffic management. Other European countries have either not yet encountered such problems or have not recognised the need to deploy and operate integrated traffic management measures and the opportunities presented by them. This means that there are significant differences in the amount and type of integrated measures or concepts in the field of traffic management and control, across modes, sectors, and stakeholders.

Based on the knowledge and expertise of the work undertaken at international and at member country levels, TG N6 provides a common CEDR understanding on the needs and requirements of NRAs regarding harmonised network operation services to prevent and reduce congestion.
2 Scope of the report

This final report provides an overview of the work done and the final output of TG N6 in SP3. It explains the approach used to develop a consistent definition for integrated network management and a framework for the effective deployment of INM measures to reduce congestion. The final report provides an outline of the scope, coverage, and best-practice case studies in the European countries represented by participating NRAs in the CEDR survey. The final report concludes with the results and conclusions of the extensive survey of 15 CEDR member countries and case studies supplied by 19 NRAs. It also contains a summary of the collaboration between TGs N6 and N7 on ITS for NRAs to survey the interaction between traffic management measures on the one hand and European ITS actions and innovative measures on the other across several CEDR members. The conclusions and recommendations in this final report do not, therefore, provide a pan-European view at this stage, but rather cover selected good examples of INM best practice from countries that participated in the survey. More countries and more case studies need to be involved in the follow-up phase of the work (in AP2017–2019), with more NRAs getting involved and more dissemination of new case studies and knowledge exchange.
3 Approach

According to CEDR’s SP 3, the goals for TG N6 were summed up in 5 action points, as illustrated in Figure 2.

| Best actions | • Get a better understanding of best actions to be taken to prevent and/or reduce congestion (reduce bottlenecks) and to deal with incidents and planning of maintenance more effectively. |
| Best practice | • Collect and share best practice / examples of cross-network management (cross border, cross regional, urban-interurban, multi-modal etc.) |
| New ideas | • Provide ideas how to link regional and national networks and their responsible authorities to operate more efficiently as a system |
| Requirements | • Provide a common understanding of requirements of NRA’s for integrated network operation services to avoid / reduce congestion in collaboration with new (private) providers / players and new systems |
| ITS support | • Identify how / where ITS and its players can support the targets, the potential and limitations of ITS, the basic conditions for implementation, and the most urgent needs for harmonisation |

Figure 2: Goals for TG N6 in SP3

First of all, it was necessary to have a common definition of integrated network management and to determine what kind of traffic management and information measures could be integrated within and across transport networks. Naturally, there is no clear point where single network management ends and integrated network management begins; the transition is more fluid, with complexity increasing with performance (see Figure 3).

Figure 3: Moving towards integrated network management
After finding a common definition of integrated network management (INM) and of harmonised network operation services, there was a need to establish a process that would allow the group to make recommendations on how NRAs could deploy INM.

TG N6 came to the conclusion that the best starting point was to use a pre-defined structure to analyse successful implemented examples of INM. On the basis of best practice, NRAs’ needs and requirements as well as the necessary frameworks and basic conditions for INM were defined. The final step was to make a recommendation to NRAs that would enable and promote the successful implementation of INM. Using this process and in accordance with the expected outcomes, four pillars or main tasks were identified for TG N6 (see Figure 4).

![Figure 4: The main tasks for TG N6 in SP3](image)

The first step was to send a questionnaire to the five countries represented in TG N6 in order to identify a common definition and framework for INM. In addition, case studies from the members of TG N6 were collected and analysed in order to find a clear structure for describing examples and making it possible to identify needs, requirements, and INM framework conditions. This was followed up by an extensive survey where 15 out of 26 CEDR countries provided a total of 25 case studies reflecting a variety of operating conditions.

The questionnaire and the template used to collect INM case studies can be found in Annex A.
4 Definition of and framework for INM

Based on initial discussions within N6 and a set of case studies, which was then followed up and validated by the INM experience and case studies provided in the survey, a common definition of INM and an INM framework were developed.

4.1 Definition of INM

INM can be defined as

'a traffic management approach that includes both traffic management and traffic information measures integrated and managed within a transport network.'

TG N6 thinks that this common definition will help NRAs that are interested in taking first or next steps in this area.

This definition covers the following parameters:

- a network managed as a system with compatible objectives among partners;
- integrated management across motorways, arterial roads, urban roads, public transport modes, and/or parking systems;
- cooperation between multiple actors, including public-private partnerships;
- the integration of traffic management and information measures and applications within a unified network strategy;
- the integration of roadside, pre-trip (home/offices/mobile), and mobile (in car/public transport) measures;
- pro-active and harmonised operations.

As seen in Figure 5, INM can be considered the link between transport flows and networks across one or several 'blocks' that include:

- transport mode: auto vehicle/public transit/regional train
- urban: motorway/urban network interface
- region: across various neighbouring regions
- national: across all sectors and regions at country level
• cross-border: international coordination between countries
• stakeholders: across various stakeholders including motorway operators, service providers, enforcement agencies, public transport operators, urban authorities, national organisations, etc.

INM means coordinating and linking traffic management and information measures across modes, networks, regions, borders, and/or authorities.

Figure 5: Various dimensions of integrated traffic management

4.2 Framework for INM

TG N6 proposed the following elements to set up the proposed INM framework used in the questionnaire to allow stakeholder needs to be assessed and case studies to be reported:
• problems tackled and/or objectives to be reached
• network deployment scale (urban, motorway, multi-modal)
• scope and level of integration
• scope of deployment (national, motorway, transport mode, region, urban, cross-border)
• level (single network, communication/information exchange, integrated network management)
• strategies: traffic information, traffic management or combined
• measures: traveller Information, traffic control, road-side/centre
• stakeholders involved and regulatory/cooperation frameworks, if any
• current level of deployment: study, under development, initial testing and deployment, full deployment and operation
• description of service(s): coverage, date of implementation, technical equipment packages
• impacts/assessment: experiences, benefits and benchmarking of outputs and outcomes, when available
• future expansions and developments
• recommendations for transferability

In terms of INM measures, three levels were identified for deployment:
1) institutional integration: coordination and collaboration across agencies and transport modes;
2) operational integration: joint operational strategies to manage and balance total capacity and
demand across a whole network;
3) technical integration: sharing and distributing information and system operations to support analysis and immediate response.

These points provided the framework for TG N6’s European survey on INM and its collection of case studies describing the successful use/implementation of INM. All NRAs that responded to the survey accepted the above definition and framework for INM. Most INM case studies reported having several dimensions of the framework but not all dimensions were reported in a single INM deployment.
5 N6 Activities

TG N6 started its work with a kick-off meeting in Vienna in September 2013. Since September 2013, several steps were taken towards arriving at a Europe-wide view on INM. Based on first case studies provided by each member of TG N6, an initial definition of INM and a framework structure for further analysis were elaborated. A first draft questionnaire was developed and tested using case studies provided by TG N6 members. Based on the outcome of this work, the questionnaire was improved. The questionnaire was finalised and was distributed to CEDR members between June and November 2015. A first analysis of the survey results was discussed at the last TG N6 meeting in Ljubljana in June 2016. A detailed, finalised analysis of survey results is included in this report.

In addition, TGs N6 and N7 (ITS for NRAs) coordinated their activities and reporting. One NRA was represented in both groups. They also held joint meetings to exchange knowledge and output. The first joint N6/N7 meeting was held in Copenhagen on 16 September 2015; the second in Vienna on 24 February 2016. The joint meetings were organised as workshops to discuss how traffic management will evolve in the next 5–10 years and to identify case studies in various CEDR countries that relate various traffic management measures to European ITS Actions and innovative measures.

![Figure 6: TG N6's working schedule and activities until the end of 2016](image)
6 CEDR's INM survey

In accordance with the framework developed for INM, a questionnaire was developed to get an overview of the objectives, needs, and requirements of European NRAs regarding INM and to provide guidance for effective INM on the basis of the best-practice case studies provided.

As a first step, an internal survey of TG N6 member NRAs was conducted to test the questionnaire and to gather initial views on INM and best-practice case studies from each of the five NRAs represented in the task group.

Following testing and validation of the initial questionnaire and an assessment of results, the questionnaire was distributed to a larger group of CEDR NRAs in order to get a more complete overview of needs, requirements, and best practice for INM at European level. The questionnaire used can be found in Annex A.

The Europe-wide survey of CEDR members started on 10 June 2015 and ended in November of the same year.

The main objectives of the survey were:
- to get a CEDR-wide overview of the current thinking on integrated network management and best practice in this area;
- to collect enough concrete material to contribute to TG N6's recommendations to CEDR;
- to create a basis for possible next steps.

In accordance with the design of the questionnaire, results of the survey were divided into two areas:
- general survey results detailing common definitions of INM and the requirements and needs of each NRA in this area;
- specific case studies detailing best practice in INM deployment (planned or in place) in each road authority that responded to the survey. In order to ensure consistent assessment across the survey, case studies were reported in accordance with the framework developed by TG N6.
Of the 26 road authorities that were contacted, 19 responses were received from 15 countries. Major countries such as France, Germany, Spain, and Italy, and many central and eastern European countries did not respond.

Since TG N6 thinks it is important to involve more countries in this important area of work, the group recommends inviting the major countries mentioned above to join the working group Traffic and Network Management and/or provide the group with relevant case studies during AP2017–2019.
Figure 8: The role and scope of road authorities that responded to the survey

Road authorities, with direct responsibility for planning and direct operation of road infrastructure, provided the majority of responses.

6.1 Overall survey results

This section outlines the key issues addressed in the survey and the overall results and conclusions of the survey.

6.1.2 Definition of INM

Figure 9: Opinions on the definition of integrated network management (INM)

Most road authorities that responded to the survey were of the opinion that the most important features of INM were the integration of traffic management and traffic information measures within a unified network strategy followed closely by the management of the network as a system with common objectives among partners. The second most popular feature of INM was cooperation of multiple actors and stakeholders. There was slightly less consensus among respondents that proactive and harmonised operations are a definitive characteristic of INM.

Based on these responses, INM can be defined as ‘a traffic management approach that includes both traffic management and traffic information measures integrated and managed within a common transport network’.

TG N6 is confident that this common definition will help road authorities that are interested in taking initial or next steps in this area.
6.1.2 Scope of INM

Figure 10: The scope of INM deployment in the road authorities that responded to the survey

Most road authorities that responded to the survey were of the opinion that the scope of INM covered integration across urban networks, regions, motorways, and/or modes. Surprisingly, there was relatively little consensus about cross-border integration (around 60% of road authorities that responded to the survey considered cross-border integration to be a vital feature). This might be due to the scope of NRAs that deal mainly with a national road network and that have no significant coordinated network management across borders (e.g. Iceland, Cyprus, UK, Finland, and Norway).

Based on these responses, it can be concluded that an integrated network management approach encompassing measures across modes/networks is a MUST focus for most road authorities.

All NRAs are of the opinion that urban networks are part of the scope of INM. However, the case studies received reflect the implementation of few integrated urban/interurban measures. There is a need to work more on this and on a compatible level of TM measures (consistent TM framework). The same conclusion can be derived for integration across modes, with few case studies demonstrating full integration of measures across modes.

TG N6 considers this an interesting conclusion that needs further and specific attention in the next phase to derive measures and case studies that illustrate high integration across networks and/or modes. In addition, there is a need in AP2017–2019 to include more case studies with cross-border elements to depict ways of integrating measures across borders in terms of TM strategies, data exchange, and the coordinated deployment of travel information/traffic control measures. For example, one or more cross-border corridor projects could be analysed in AP 2017–2019.
### 6.1.3 Level of INM deployment

![Level of INM deployment on your network](image)

Figure 11: Level of INM deployment in road authorities that responded to the survey

Around nine of the road authorities that responded to the survey reported the single deployment of INM. Only seven of the road authorities that responded to the survey reported multiple deployments of INM, with the rest reporting no current deployment. This shows that the level of INM deployment is not as widespread across CEDR as conventional network management measures.

One problem was that major European countries such as Germany, Italy, Spain, and France, which all have considerable experience of INM, did not respond to the survey. Consequently, the result for 'level of deployment' may not provide an accurate overview/mean value for all of CEDR, instead providing a good insight into the situation in smaller countries.

Because of the importance of INM for other developments such as automated driving, TG N6 feels that it is important that CEDR continues to focus on INM implementation and gets not only the bigger countries like Germany, England, France, and Italy involved but also more eastern and southern European countries.

On that basis, there is a need to expand into more compilation of best-practice INM deployments through wider participation and account for smart mobility measures as part of integrated measures with the need to continue and expand into more INM case studies in AP2017–2019.
6.1.4 Partners for the successful delivery of INM

The key partners in INM were identified on the basis of priorities. As expected, the road authorities that responded to the survey considered motorway operators, service providers, and national/regional authorities the most important partners for the successful delivery of INM measures. These were followed by regional authorities. Surprisingly, only 14 of the road authorities that responded to the survey considered urban authorities and public transport operators important, despite the emphasis on the urban/motorway interface and public transport in several European countries. Thirteen of the road authorities that responded to the survey saw the traffic police as enforcement actors with no involvement in the deployment and operation of INM measures, except where the traffic police is part of the traffic management team at regional and national level.

TG N6 also considers this to be an interesting response that requires further attention since the involvement of all public and private partners is crucial if INM is to be taken forward.

INM requires a number of partners. The role of NRAs is to take the initiative and bring more partners to the table. Some case studies show ways of involving more partners as service providers and public transport (PT) operators. Failure to do so will have negative impacts on effective TM. Aspects of the organisational challenges and different political goals within INM deployment are barriers to ensuring successful INM.
6.1.5 Key objectives behind INM deployment

![Figure 13: Key objectives behind INM deployment](image)

Most NRAs considered improving accessibility, decreasing traffic congestion, and enhancing safety and improving efficiency as the top objectives for deploying INM measures. More than 60 per cent of road authorities that responded to the survey considered easing local environment issues to be a major objective. Promoting inter-/multi-modality was seen as a major objective behind INM deployment by only slightly more than 40 per cent of road authorities that responded to the survey, indicating that multi-modal measures are largely being deployed at a more local level. More than 80 per cent of road authorities that responded to the survey saw enhancing traffic enforcement and enhancing security as minor and/or not important objectives when deploying INM measures.

In the view of TG N6, this underlines the potential of INM to contribute to the most important policy goals that have been set in the area of transportation and mobility. Growing congestion in the coming years requires a global network approach rather than single elements and more deployment in INM due to its positive impacts. More focus on the network approach will probably also support and facilitate better and more transparent tests and deployment of C-ITS and automation in the coming years.
6.1.6 Tools used to deploy traffic management

Figure 14: Tools used by road authorities that responded to the survey for traffic management

Traveller information services, followed closely by variable message signs, were the most frequently used tools in integrated network management (they are used by approximately 80 per cent of road authorities that responded to the survey). Slightly more than 50 per cent of road authorities that responded to the survey reported that they use incident/emergency management and speed management frequently. More than 50% of road authorities that responded to the survey said that they sometimes use line control systems, with hard shoulder running and ramp metering not being used by more than 60 per cent of road authorities that responded to the survey. Only 40 per cent of road authorities that responded to the survey use ramp metering and access control as traffic management measures in their networks.

In the medium to long-terms, new smart mobility measures can be seen as ways of complementing or even replacing traditional ITS measures in providing INM.

This survey covers a limited number of countries. There is a need to expand the survey to include more and bigger countries and more case studies to get a wider scope of measures.

Traveller information services (public and private) are necessary for INM, but there is a need to ensure consistent content and dissemination platforms. Data completeness and information quality is a key element for the successful deployment and operation of INM schemes. Service level agreements (SLAs) on operational level could be a solution for consistent delivery of services and information.

TG N6 is convinced that concrete INM examples that have proven to be effective are the best way to share knowledge with other CEDR members and help them move forward. Especially countries with little experience with INM and either none or only a few INM deployments could benefit from that and take a big leap forward, while more experienced countries could get new inspiration and maybe, where relevant, take the initiative to start cross-border projects.
6.1.7 INM case studies provided

In total, 25 case studies were provided, with several road authorities providing multiple case studies.

![INM case studies reported](image)

Figure 15: INM case studies reported in the CEDR survey

6.1.8 INM case studies: problems tackled

In the case studies provided, the following problems were the reason for/motivation behind the implementation and operation of INM (with ranking of the reported reasons):

1. Capacity and congestion problems
2. Environmental problems
3. Lack of information and common data
4. Incidents
5. Non-integrated traffic management/information solutions
6. Limited possibility for infrastructure expansion
7. High costs

This is very much in line with the key objectives of INM deployment reported in the general part of the survey, where road authorities said they considered capacity and congestion problems to be a high priority for INM (see Figure 13).
6.1.9 Features of the INM case studies provided

Most case studies provided by road authorities featured deployment covering both regional and motorway networks, with the majority either having traveller information services on their own or combined with traffic management services. The majority of case studies featured the exchange of information across entities as a minimum level of integration, although five case studies were reported as being totally integrated. Most INM deployments reported (14 case studies) were reported as being in full deployment and operation. Seven INM case studies were reported as being under initial testing.

6.1.10 INM case studies: success factors for INM deployment and operation

Based on the case studies provided, the following factors can be considered key to the success of the implementation and operation of INM:

- NRAs' coordination/leadership role: NRAs must bring stakeholders together and enable close cooperation, which is very important
- Focus on common goals and targets (including shared benefits): the network as a whole and not the scope of a single infrastructure should be considered
- Flexibility of NRAs and operators
- The communication of benefits: measured/proven improvements should be promoted and communicated. To this end, assessment is important
- Willingness to cooperate, between bodies with different responsibilities and across borders (regional, national and international cooperation between stakeholders, providers, NRAs, operators)
- Common service level agreements and quality criteria
- A step-by-step approach, early testing phases
- User orientation (user-oriented solutions): user satisfaction, benefits for the user
- Shared benefits and shared, minimised costs
6.1.11 Availability of assessment results for case studies

![Assessment Results of Case Studies](image)

Figure 17: Availability of assessment results for the case studies provided

No assessment results were available for the majority of the 11 case studies. Full assessment results were available for only six case studies.

In order to deduce the benefits/impacts of INM, many more case studies with concrete examples are needed. Assessment (i.e. identifying the impacts of particular measures or packages of measures) is a difficult exercise. All stakeholders agree that more work is needed to identify impacts and report them in a consistent manner.

The conclusions based on the survey responses show that no one yet knows exactly where NRAs in general are going with INM. However, instead of being a disadvantage, this is actually an advantage since it gives every CEDR member the chance to join the Traffic Management Group in AP2017–2019. This would enable participating CEDR members to assess and search for the best ways to implement INM so that it contributes the most to the goals set and to the other developments that NRAs are dealing with in the mobility arena. The proposed CEDR working group on Performance Indicators in AP2017–2019 can provide the framework for consistent reporting of impacts.

For information on the INM case studies received, see Annex C.

For further details on key case studies, please contact TG N6 or visit the CEDR website, where some key outlines of some case studies will be published.
7 ITS interface to traffic management and INM

Most integrated network management strategies and measures are highly influenced by ITS deployment on the road networks. Both traditional and new ITS deployment needs to be integrated across various dimensions in order to achieve maximum effectiveness on road networks. CEDR's TG N7 adopted a more strategic approach, focusing on the field of ITS, while TG N6 focused on operational and tactical traffic management measures. ITS topics and issues are highly relevant to the work of TG N6. This is why the two groups agreed to cooperate on several issues in order to share information and enhance the results of the work being carried out.

TGs N6 and N7 coordinated their activities and reporting (one NRA was represented in both groups) and held joint meetings to exchange knowledge and output. The first joint N6/N7 meeting took place in Copenhagen on 16 September 2015; the second in Vienna on 24 February 2016. Some of the main topics and activities are mentioned below.

7.1 Workshop about new directions for traffic management

The purpose of the workshop was to discuss how traffic management (TM) will evolve in the next 5-10 year horizon. Participants were divided into three transversal groups. Some of the overall findings and conclusions are given below.

- Challenges relating to increased congestion will continue and the focus will remain on improving traffic flow and traffic safety. This calls, among other things, for a continuing network approach from NRAs and also places high demands on the direction of new developments in automation and C-ITS.
- More stakeholders are getting involved in traffic management. These stakeholders have different objectives, needs, and priorities. Stakeholders should aim to work together and have a common strategy.
- NRAs and traffic management centres are expected to face many challenges in the transition phase from a low to a high degree of automation. Different penetration rates can be expected from country to country.
- Who does traffic management and who is responsible for it? NRAs will continue to operate roadside traffic management deployment but the role of the private sector and cooperation with the private sector in data generation and traveller information will increase. Harmonisation is required for route guidance and navigation services between both road-side and in-car services.
- The trend is towards more—and increasingly more advanced—equipment in vehicles and at the same time less traditional ITS roadside equipment.
- Everything is becoming more data oriented and connected, which emphasises the need for systematic data collection and exchange, data cleaning, and effective big data analysis.
- There is a need to look into the legal framework and possible harmonisation of national regulations.

Several discussions took place on how to continue work on traffic management at CEDR level. It was proposed that TG N6, as CEDR's operational traffic management-oriented group, would continue working on a more practical operational level of traffic management measures deployment with a network approach. It was also proposed that TG N7, which focuses more on the future, would continue working at the strategic level with focus on C-ITS and
One of the conclusions was that many NRAs are in the process of moving from single road management towards integrated network management and cooperation with other networks and stakeholders. That will, on the one hand, enhance overall performance. On the other, it will also add complexity. That complexity will increase even more in the coming years, when congestion is expected to get worse and new developments in areas such as C-ITS and automation will be introduced and will exist alongside more traditional traffic management measures and ITS.

### 7.2 Matrix with traffic management measures and ITS

The two groups worked together to develop a matrix that linked 10 selected classic types of traffic management measures on one side to European ITS Actions as reflected in the European ITS Action Plan Directive and to other innovative measures as C-ITS and automated driving on the other. Answers from Austria (AT), Switzerland (CH), Denmark (DK), Finland (FI), Greece (GR), the Netherlands (NL), Sweden (SWE), and the United Kingdom (UK) were collected and used to populate the matrix below.

![Figure 18: Matrix of traffic management measures relating to European ITS Actions](image-url)
The purpose of this exercise was twofold: firstly, to identify the areas where ITS can support traditional TM measures through reporting case studies that accommodated both. To this end, members of TGs N6 and N7 identified relevant case studies. Secondly, to provide overviews and highlight the areas where countries are active in various ITS and traffic management areas and where it could be relevant to exchange knowledge and coordinate activities.

Most of the countries presented their individual matrices containing case studies incorporating both ITS and traffic management measures. The resulting matrix summarising the results was developed. Some of the overall findings and conclusions were:

- N7 has a more strategic approach with a special focus on the ITS area, while N6 focuses on traditional traffic management measures. The matrix shows that there is a need for more cooperation and coordination between these groups and disciplines, especially regarding roadworks management, incident management, lane control, variable speed limits, alternative route management, roadside information, and winter maintenance supporting systems in relation to the ITS Directives Priority actions (b) and (c), C-ITS, and automation.
- It is very important to provide road users with good-quality services. ITS priority actions should help NRAs improve in this area. However, there are still differences in national policies in NRAs delivering key traffic management and traffic information services.
- The goal is to have pan-European interoperable traffic management services. Therefore, standardisation issues are relevant. Some examples are:
  - Road data warehouse is using TISA recommendations as guidance, e.g. the standard is there but not obligatory.
  - Safety messages are standardised to the access point. However, how the automotive industry should standardise messages to users has not been defined.
  - OEMs indicate that everything in the future will be processed and stored in the cloud.
- The quality of data is an issue (the quality needs to be agreed at a high-decision making level in the organisation). Data quality was the most difficult aspect in ITS priority action (c).
- Automation is going to influence all traffic management topics in the future. It will probably be a big challenge—also an economic challenge—for all NRAs to handle this well. Road users and political stakeholders will expect NRAs to continuously provide or ensure consistent traffic information and guidance in the transition period towards a higher level of automation, while NRAs will, at the same time, have to downgrade/adjust and in time phase out more traditional traffic management measures.
- It is important that CEDR task groups and working groups provide recommendations and guidance to NRAs in these areas through the Governing Board to help them solve challenges with mobility, congestion, and safety.

### 7.3 Recommendations regarding future work in AP2017–2019

In the course of joint discussions about future work on traffic management, ITS, automation and C-ITS in AP2017–2019, it became evident that it would be difficult to merge the two task groups without downgrading important areas. The suggestion is, therefore, to maintain a distinction between operation and strategy in the coming CEDR Action Plan 2017–2019, while also maintaining close cooperation between the two groups. This will ensure complementarity at strategic, technological, and operational levels. This could be a starting point for the identification of...
further case studies and more concrete projects and a basis for future workshops dealing with special traffic management measures.
8 Conclusions and recommendations

The following conclusions and recommendations are based on the objectives and findings of TG N6 and the knowledge acquired from the CEDR INM survey. Key conclusions and recommendations can be taken up and expanded upon in AP2017–2019.

The amount of available data for traffic management is increasing rapidly, as is the number of different operating systems. As a consequence, the analysis and exchange of data, strategies, and measures between different systems are important factors for comprehensive, co-operational network-wide management.

In order to support and promote integrated network management (INM) with a view to ensuring optimum handling of traffic problems in the future, TG N6 makes the following recommendations:

- **Close cooperation is a key necessity**
  Smart mobility requires connected networks. When considered from this perspective, integrated network management can be seen as key to making our roads more efficient, transport safer and cleaner, and to provide road users with a better level of service. Positive basic conditions and frameworks need to be created to ensure that all partners with different responsibilities are willing to cooperate. It is therefore important that ALL CEDR members keep working on integrated network management and cooperate closely with each other so that they can deal with any impacts that may arise and in order to ensure that they are adequately prepared for new scenarios (e.g. cooperative systems and automated driving). This N6 report is meant to support CEDR members who are and/or who want to become active in INM.

- **A clear definition and consistent framework and a roadmap for INM are helpful**
  Integrated network management is a new and broad term. Using one definition of INM (‘a traffic management approach that includes both traffic management and traffic information measures integrated and managed within a transport network’) and a framework for deployment can help NRAs deploy and operate INM successfully. It is important to communicate the definition and framework within CEDR and start working with them actively. In addition, for those countries that are willing to adopt integrated network management, a step-by-step approach, including early testing phases, is useful for the smart deployment of INM with reasonable cost-benefit effects. Each participating CEDR member should outline a road map for planning and deploying integrated traffic management measures in line with overall transportation/traffic management strategies at national and urban levels.

- **A platform for knowledge exchange based on case studies is highly beneficial**
  A full-scale integrated network management approach is a relatively new part of most national traffic and transport policies. It can, therefore, be very helpful and cost-effective to provide a platform for knowledge exchange based on a rich knowledge base of traffic management case studies across CEDR members. In some cases, INM sounds difficult. However, at an operational level, it can meet requirements and solve critical problems at network level. Countries with little experience of INM can benefit hugely from a knowledge transfer based on best practice and relevant case studies. Consistent assessment results across case studies is quite helpful for knowledge transfer and needs to be enhanced in future phases.
• **Strengthening public-private cooperation for INM**
  In most cases, integrated network management requires cooperation between public and private partners. Different road authorities and stakeholders can have different—and sometimes conflicting—traffic policy goals, which can complicate efforts to find the optimum solution. Furthermore, private partners and service providers may play a bigger role and influence traffic management in a direct or indirect way. If NRAs/operators want to keep playing a strong, active role in the future, they need to be flexible to handle interaction with other key stakeholders such as suppliers, service providers, and the automotive industry and also to handle innovative measures such as cooperative systems and automated driving. A clear understanding of the proper mix and deployment time scales between conventional and innovative measures needs to be outlined, together with identification of relevant case studies, to enable a smooth transition. This calls for further strengthening of public-private cooperation, not only at strategic but also at tactical and operational levels. Public-private cooperation requires sound business cases. INM can be seen as a tool for the better utilisation of funds.

• **INM requires complete, high-quality data**
  Data completeness and quality are key aspects of the successful deployment and operation of INM schemes. Supplementary data sources such as crowd sourcing and floating car data (FCD) together with traditional data sources coupled with data quality schemes are necessary to ensure adequate quality of information. Use of supplementary data requires the opening up of cooperation with what are mostly private service providers. As a follow-up, a national database and consistent standards need to be set-up in each member country to allow for data integration and consistent exchange of data between national access points at cross-border levels.

• **Consistent delivery of services needs to be ensured**
  With more traffic information measures taken up by private players, service level agreements (SLAs) need to be integrated at operational level to ensure consistent delivery of services within agreements between NRAs and service providers. Case studies incorporating such SLAs should be investigated in order to come up with the right mix of traffic service quality related to level and scope of utilisation with the reduction of conflicting priorities among public and private players.

Regarding all developments on information and automation level, traffic management will continue to be the tool for handling traffic in the future and maintaining an active role for NRAs. A specific task group for traffic management can capitalise on the CEDR structure for bringing about different projects and programmes across European countries and across public and private partners in the right way and according to sound business models. Within AP2017–2019, such a framework can serve as a cooperation and knowledge exchange platform for the collection and dissemination of best-practice case studies through participation of more European countries in the working group beyond the six NRAs represented in the current task group N6.
9 Proposed follow-up for the working group traffic and network management in AP2017–2019

9.1 Outlook

In recent years, CEDR member countries have experienced increasing traffic volumes and more traffic problems in the form of increasing congestion and the higher impact of incidents on traffic flow.

The trend is very clear, especially on motorways, and there is no immediate prospect of any major changes in that development.

Figure 19: Development in traffic volumes on the road network in Denmark.

There are no indications that developments in the fields of C-ITS and automation in the coming five years will have a significant positive impact on the increasing traffic problems in CEDR countries. On the contrary, the early implementation of these new technologies may generate even more challenges for NRAs and others in their efforts to keep traffic flowing and road users happy using traditional traffic management measures.

There is, therefore, a need for NRAs to keep focused on three areas in the coming years:

- Continuation of traditional traffic management (e.g. traffic control, incident management, route monitoring, provision of (data for) pre-trip and on-road information) on motorways and other vital parts of the road network.
- Preparations for C-ITS and automation should feature close dialogue and cooperation with stakeholders in these areas. The focus should be on making the relevant adjustments to traditional traffic management in time and supporting developments in C-ITS and automation by providing input (for example, in connection with the evaluation of trials and the development of equipment and automated vehicles) and assessing the results and their consequences.
- Increasing cooperation with other stakeholders in traffic management partly to strengthen INM and partly to improve the relations with these stakeholders in the light of the coming challenges with C-ITS and automation.
In all three areas, it would be of value for NRAs/CEDR countries to exchange and discuss experiences, partly to learn from each other and partly to get closer to a more harmonised approach that will benefit all NRAs. This needs a continuation of the work on INM and a setup of transversal cooperation with stakeholders in C-ITS and automation through the workshops and continued cooperation with TG N7.

9.2 Proposed Traffic and Network Management working group in AP2017–2019

Sharing know-how and experience within CEDR is a main target of the proposed working group Traffic and Network Management in AP2017–2019. The Traffic and Network Management working group will act as a platform that condenses all the material to be used at the appropriate levels of CEDR and NRAs. The overall objective of the proposed working group Traffic and Network Management is to condense, structure, and transfer experience, knowledge, and useful information about traffic management measures on European road networks (regional, national, and cross-border) to CEDR EB/GB, but also among experts and people within CEDR countries dealing with traffic and transportation (NRAs, operators, municipalities, police, etc.).

The work will be done by a network of national and international experts from NRAs and road operators. Working group members will provide expertise in the field of traffic management in general and at national level. Based on the knowledge and expertise of the work undertaken at national level, the group will concentrate on a few selected, pre-defined measures/services and go into more detail.

On each of the selected topics, the proposed working group will collect best practice examples of deployment and operation and discuss and share existing knowledge/experience. Workshops will be held to promote this exchange.

Based on the examples already mentioned above, interesting/important pre-defined measures/services could among other things include:

- mobile traffic management systems and their integrated use,
- linking local measures as incident management to integrated Traffic Management & Information Services,
- intelligent construction site management,
- hard shoulder running,
- traffic management centres (operational aspects and supporting systems),
- organising (big) data, and
- initial experience of using C-ITS for information and, if available, traffic management.

Regarding C-ITS, the proposed Traffic and Network Management working group could, in cooperation with the working Group on Automated Driving, help build a bridge between national and local authorities.

The core of the WG's strategy in AP2017–2019 will be to organise workshops on specific topics and/or concrete case studies to discuss key factors and lessons learned. Sharing this knowledge can help countries that are already working with those traffic management measures to further improve their operations and can help those countries that also have ideas or are already willing to implement those measures. The results of these workshops will be summarised in fact sheets on specific topics. These fact sheets will highlight available knowledge/experience.
The topics will be defined each year, according to requirements. The working group will therefore investigate focus areas among the TG members and via CEDR EB. As an added value, in each workshop session of the Traffic and Network Management working group, there will be opportunities to exchange experience in all fields of traffic and integrated network management between different countries with different responsibilities of NRAs and other fields of TM and ITS.

The Traffic and Network Management working group will get in contact and interact with other CEDR activities, other organisations, institutions, and stakeholders (e.g. EasyWay continuation) to discuss their point of view and coordinate working content and targets in order to avoid redundancy and ensure progress.
10 Annexes

ANNEX A: Questionnaire

CEDR European NRA Questionnaire on Integrated Network Management (INM)

Introduction

Many NRAs are in the process of moving from single road management towards integrated network management covering different modes, regions, borders and networks. According to CEDR Strategic Plan 2013-2017, the objectives of the CEDR N6 Task Group on Harmonised Network Operation Services are to:

- Provide a common definition and understanding of integrated network management (INM) and the requirements of NRA's for integrated network operation services to avoid / reduce congestion in collaboration with new (private) partners / players and innovative systems
- Collect and share best practice / examples of cross-network management (cross border, cross regional, urban-interurban, multi-modal etc.)
- Provide ideas how to link regional and (inter)national networks and their responsible authorities to operate more efficiently as a system
- Provide concrete recommendations for NRA's for the further development of integrated network management services.

The survey will be used to get an overview of objectives, needs and requirements of NRAs in Europe regarding INM and provide guidance for effective INM on the basis of best-practice.

On that basis, we would like to ask your opinion on a range of issues.

The questionnaire is structured into 2 parts: first part on a general basis with the second part for specific case studies in your network. The average time for filling in the questionnaire will take less than 10 minutes.

For any questions, please contact the following CEDR N6 Task Group members:

- Christian Ebner, ASFINAG Service GmbH, Tel.: +43 50108 17610; Email: christian.ebner@asfinag.at
- Michael Schneider, ASFINAG Service GmbH, Tel.: +43 50108 17625; Email: michael.schneider@asfinag.at

Please fill in this questionnaire by the end of July 2015.
--- Part 1 ---

a) **Information about you and your organisation**

**Question 1:** How would you describe your organisation and the work scope of that organisation? *(Check any that apply).*

- Policy Making
- Planning, Strategy and Organisation
- Funding and Supervision of Operation
- Direct operation of infrastructure or services
- Control or enforcement
- Advice, research, consultancy
- Other user service provision (e.g. information or payment services)
- Other role (please specify)

If 'other' is ticked in the above table, please describe here: ……………………………

**Question 2:** What is your level of professional experience (in years) of dealing with:
- Transport in general (transport / infrastructure engineering, operations, economics, policy, etc.)?
  ………. years
- Road network traffic management?
  ………. years

**Question 3:** What is your position in your organisation? Please describe briefly your role
…………………………………………………………………………………………………………………………

b) **Definition and Scope of Integrated Network Management (INM)**

*Check any that apply*

**Question 4:** Do you agree with the definition for INM as
- Network managed as a system with common objectives among partners
- Cooperation of multiple actors (public and private stakeholders)
- Integration of traffic management and information measures and applications within a unified network strategy
- Pro-active and harmonized operations
If not, please provide your view regarding definition of INM
…………………………………………………………………………………………………………………………

**Question 5:** Scope of INM covers integration across
- Regions
- Borders
- Modes
- Motorways
- Urban network
Would you include other areas to be covered by INM?
…………………………………………………………………………………………………………………………

**Question 6:** What is the level of deployment of INM in your network?
- 0: No current deployments
- 1: Single deployment
- 2: Multiple deployments
**Question 7:** What important partners need to be involved for successful delivery of INM?

- Motorway operators
- Travel information service providers
- Traffic police
- National authorities
- Regional authorities
- Urban authorities
- Public transport operators
- Other e.g., research institutes, industry, etc., (please specify):

- ........................................................

**Question 8:** In your organisation, how important are the following objectives in implementing or planning to implement Integrated Traffic Management solutions in your network?

<table>
<thead>
<tr>
<th>Not Important</th>
<th>Minor</th>
<th>Major</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreasing traffic congestion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancing safety (prevention of accidents / effective emergency response)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancing security (prevention / detection of crime, vandalism, terrorism or planning for / mitigation of natural disasters)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easing local environmental issues (pollution, local air quality, noise, visual effects)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving user-friendliness, information or accessibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving efficiency to reduce costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promoting intermodality, multimodality or modal shift</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancing traffic enforcement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Are there other objectives, please specify: ........................................................

**Question 9:** What tools do you use to deploy traffic management measures in your network?

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes / Occasionally</th>
<th>Frequently / All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Variable Message Signs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Line (Lane) Control Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Speed Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard Shoulder Running</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ramp Metering/Access Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incident and Emergency Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traveller Information Services (web, radio, …)</td>
</tr>
</tbody>
</table>

Are there other tools, please specify: ........................................................................

Further remarks or suggestions: .................................................................................
--- Part 2 ---

Case Studies for Integrated Network Management (INM)

Please provide details on case studies that represent INM by your organisation and fill out the following questions for each case study. Please provide some additional material such as figures, maps, reports, presentations, etc. to illustrate your reported INM deployment (you have the possibility to upload files as a last step in the questionnaire for each case study). At the end of the first case study you will be asked to either finish the questionnaire or to start further case studies.

INM Case Studies Reporting Template

- Country/Region Implemented:
- Problems tackled
- Objectives to be reached
- Network deployment scale (urban, motorway, multi-modal)  
  Check any that apply
- Scope of deployment across:
  - cross-borders
  - national level
  - motorways
  - transport modes
  - regions
  - urban/interurban

- Level of integration
  - single network management
  - communication/information exchange between systems
  - totally integrated network management

- Strategies:
  - traffic information,
  - traffic management
  - combined traffic information and traffic management

- Measures:
  - Traveller Information,
  - Traffic control

- Stakeholders involved and regulatory/cooperation frameworks, if any

- Current Level of Deployment:
  - Study and concept
  - under development,
  - initial testing and deployment,
  - full deployment and operation

- Description of service(s):
  - Coverage: ……………
  - Date of implementation: …………..
  - Technical equipment packages: ……………
• Impacts/Assessment: Experiences, benefits and benchmarking of outputs and outcomes, when available ……………………………

• Key Factors and Lessons learned:
  o Problems encountered: ……………
  o Solutions made: …………………
  o Success factors: …………………

• Future expansions and developments

• Recommendations for transferability

• Further remarks or suggestions

• Please provide some additional material such as figures, maps, reports, presentations, etc. to illustrate your reported INM deployment:
  Please upload at most one file:

  Upload files

• Contact person (email, contact details)

| Your name: ______________________________ |
| Title: ______________________________    |
| Organisation: __________________________ |
| Address: ______________________________ |
| City + postcode: _______________________  Country: __________________ |
| E-mail: _______________________________  Telephone number: (+ ___) ____________ |

Many thanks for your help!
| Annex B: INM Deployment Survey Results by Country |

<table>
<thead>
<tr>
<th>INM Area</th>
<th>Surveyed</th>
<th>Deployed</th>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestion Reduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incident Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17/17 INM services in Table 12 are available for download here. Please select here.
ANNEX C: INM Case Studies Reported
C1: Case Studies: General

<table>
<thead>
<tr>
<th>Country</th>
<th>Country Region implemented</th>
<th>Problems tackled</th>
<th>Objectives to be reached</th>
<th>Network deployment scale (urban, motorway, multi-modal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Norway</td>
<td>Congestion, stress on roads and unavailability of travel options</td>
<td>Proactive traffic management to improve safety and efficiency, improved safety, efficiency and network operation via better coordination of stakeholder actions</td>
<td>Urban, multimodal</td>
</tr>
<tr>
<td>Poland</td>
<td>Poland</td>
<td>Incidents, congestions</td>
<td>Traffic safety, efficiency, quality</td>
<td>Urban, motorway</td>
</tr>
<tr>
<td>Iceland</td>
<td>Iceland</td>
<td>Incidents, congestions</td>
<td>Safety, efficiency, travel efficiency, quality</td>
<td>Urban, motorway</td>
</tr>
<tr>
<td>Austria</td>
<td>Project Carleti</td>
<td>Reducing traffic emissions by traveler routing information to select a low-emission route</td>
<td>Reductions of total traffic emissions, improvement of local urban air quality at 2 major urban/interurban routes</td>
<td>Urban, motorway</td>
</tr>
<tr>
<td>Estonia</td>
<td>Estonia</td>
<td>Planning of future design work</td>
<td>Cross-border benefits</td>
<td>Cross-regional</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Luxembourg</td>
<td></td>
<td></td>
<td>National roads, multi-modal</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Slovenia</td>
<td></td>
<td></td>
<td>Multi-modal (railway only for HGV)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Switzerland</td>
<td>&quot;Traffic in the City&quot;</td>
<td>Capacity restrictions for HGV</td>
<td>Multi-modal (railway only for HGV)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Switzerland</td>
<td>Dynamic Routing parking facilities</td>
<td>Best access for exhibitors and visitors</td>
<td>Urban, motorway, multi-modal, intermodal</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Switzerland</td>
<td>Dynamic Routing, parking facilities</td>
<td>Optimizing traffic control, guiding and routing</td>
<td>Urban, motorway, multi-modal</td>
</tr>
<tr>
<td>Austria</td>
<td>Austria</td>
<td>Variety of services (diversity, regional integration, coverage, various databases, multimodal, quality)</td>
<td>Harmonization of Traffic Information, Improved End User Services</td>
<td>Multi-modal</td>
</tr>
<tr>
<td>Sweden</td>
<td>Sweden</td>
<td>Congestion: stress on roads</td>
<td>Smoothness, travel time, better safety</td>
<td>Non-existent in metropolitan area</td>
</tr>
<tr>
<td>US</td>
<td>US</td>
<td>Congestion: stress on roads</td>
<td>Smoothness, travel time, better safety</td>
<td>Non-existent in metropolitan area</td>
</tr>
<tr>
<td>Austria</td>
<td>Austria</td>
<td>Traffic Control System Salzburg</td>
<td>Regulating the traffic in the city</td>
<td>Urban and motorway, Smart traffic and parking management based on information using road side information infrastructure</td>
</tr>
<tr>
<td>Denmark</td>
<td>Denmark</td>
<td>Strategic traffic management in East Jutland/Aarhus area</td>
<td>Reducing negative effects from congestion, ensuring better use of the infrastructure and the transport system, need for more coordination between road users, traffic information and incidents</td>
<td>Urban and motorway, Covering an area about 73 x 100 km with more than 1,000,000 inhabitants. The biggest and most complex (Amhøj 250,000 inhabitants), Randers (85,000) and Vejle (50,000), Odense (45,000) ACTA up to 72,000 vehicles</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Netherlands</td>
<td>Cooperation ITS Country</td>
<td>Main problems to be tackled are incidents associated with work zones and remaining probe vehicles from vehicles. The city is in the process of implementing the C-ITS services on an international scale to improve safety and efficiency by a minimal impact on the environment</td>
<td>Proportionally on motorways and concerning both heavy and light vehicles</td>
</tr>
<tr>
<td>Netherlands</td>
<td>The Netherlands</td>
<td>Incident Management in The Netherlands</td>
<td>Maintains the communication of all points and bodies involved in traffic flow in the principal road network to create support and agreement (voluntary) to accommodate the flow of the road following an accident or incident, ensuring that each party participates in the basis of its own risk and responsibility</td>
<td>Incident Management on the principal road network (mainly motorways)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>The Netherlands</td>
<td>Dutch Data Warehouse for Traffic Information</td>
<td>Providing traffic data as open data to be accessible and without conditions, contributing to innovation and governmental transparency and efficiency</td>
<td>NOVIA collects traffic data on all motorways, main road roads and main road roads in the Netherlands</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Amsterdam</td>
<td>Practical Trial Amsterdam</td>
<td>The main problems tackled are the traffic problems (delay) on the motorways around Amsterdam, on the main roads in the city and the main roads of the Province of North Holland. Furthermore, the purpose of the project is to gain insight and practical experience in the development and implementation of an integrated network management. This includes the cooperation of several road authorities as well as the cooperation with private industries and universities. The results are intended as basis for nationwide applications</td>
<td>Providing traffic data as &quot;open data&quot; to weather and emergency services and other non-commercial users. Providing such data to these users increases safety and efficiency, reduces costs and increases congestion and improves public opinion towards traffic management.</td>
</tr>
<tr>
<td>Country</td>
<td>C2: Case Studies</td>
<td>Scope of deployment across</td>
<td>Level of integration</td>
<td>Strategies</td>
</tr>
<tr>
<td>---------</td>
<td>------------------</td>
<td>----------------------------</td>
<td>---------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Norway</td>
<td>Norway</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Finland</td>
<td>Finland</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Iceland</td>
<td>Iceland</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Austria</td>
<td>Austria</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Sweden</td>
<td>Sweden</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>UK</td>
<td>UK</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Denmark</td>
<td>Denmark</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Netherlands</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Netherlands</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Netherlands</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Netherlands</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Country</td>
<td>Case Study</td>
<td>Service Description</td>
<td>Date of Implementation</td>
<td>Technical Equipment Packages</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>----------------------</td>
<td>------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Austria</td>
<td>Project Carinthia</td>
<td>Graz, Styria, Austria</td>
<td>November 2014 - February 2015</td>
<td>Traffic simulation, lane Control, VMS, travel time in rural areas, traffic information services, road services</td>
</tr>
<tr>
<td>Estonia</td>
<td>Estonian Link</td>
<td>Eliminating the infrastructure barriers on north-south development of border areas / reconstruction of Estonian road connections in the city of Tallinn</td>
<td>2013-04-08 01:20</td>
<td>EIEP E08-2710585.01 EUR, total budget: 2710585.01 EUR</td>
</tr>
<tr>
<td>Armenia</td>
<td>Armenia</td>
<td>North Armenia</td>
<td>2010-06-10 01:20</td>
<td>Import cooperation in traffic engineering, Operation cooperation in traffic management, Levels of quality of travel information services, Assessment and evaluation of results</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Switzerland</td>
<td>Switzerland</td>
<td>Dynamic network</td>
<td>2012-06-10 01:20</td>
</tr>
<tr>
<td>Austria</td>
<td>Traffic Information Austria</td>
<td>Austria</td>
<td>National, Multi-modal door to door routing and additional traffic information (parking and traffic penalties), short term parking areas, public transport information, (PDI...)</td>
<td>December 2010, since then a variety of on-site user services have started (public)</td>
</tr>
<tr>
<td>Denmark</td>
<td>Strategic Traffic Management in Central Jutland / Aarhus area</td>
<td>Denmark, East Jutland / Aarhus area</td>
<td>2010-06-10 01:20</td>
<td>Webpage and app</td>
</tr>
<tr>
<td>Country/Region Implemented</td>
<td>Problems Encountered</td>
<td>Key Factors and Lessons Learned</td>
<td>Success Factors</td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------</td>
<td>-------------------------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>Norway/Region implemented</td>
<td>High costs of maintaining and developing site systems and check box systems, low usability and availability of them</td>
<td>Full integration and agile approach on development</td>
<td>NSP’s strong insight and leadership, ability to make agile decisions</td>
<td></td>
</tr>
<tr>
<td>Finland/Region implemented</td>
<td>High institutional boundaries</td>
<td>National co-operation needs, instructions, common incident management tools, working at common premises with all major stakeholders</td>
<td>Awareness of considerable mutual benefits despite the normal costs</td>
<td></td>
</tr>
<tr>
<td>Austria/Region implemented</td>
<td>High traffic volume and high specific geographical location of Luggau need establishment of traffic flow in case of overloading or incidents (for primary distribution); tunneling and great events in downtown of Luggau</td>
<td>Cooperation, warning, dynamic route guidance with VMS on motorway and urban streets, program modification by traffic signals on urban streets, event information in combination with traffic information and routing proposals (e.g. park and ride)</td>
<td>Close cooperation and communication with all stakeholders, frequent meetings, workshops</td>
<td></td>
</tr>
<tr>
<td>Norway/Region implemented</td>
<td>Low particular issues</td>
<td>Joint cooperation planning phase has high importance for future implementations</td>
<td>Joint funding from EU funds</td>
<td></td>
</tr>
<tr>
<td>Switzerland/Region implemented</td>
<td>High traffic volume, high geographical location of Luggau</td>
<td>User-friendliness of system to reconnect to the observed travel compliance rules</td>
<td>Close cooperation and communication with all stakeholders, frequent meetings, workshops</td>
<td></td>
</tr>
<tr>
<td>Luxembourg/Region implemented</td>
<td>legislation problems, information exchange between institutions</td>
<td>Solutions for data exchange used (standard)</td>
<td>Adequate parking, facilities, information exchange</td>
<td></td>
</tr>
<tr>
<td>Slovenia/Region implemented</td>
<td>Joining the euro zone for the drivers who are driving between Ljubljana and Maribor</td>
<td>New traffic signaling</td>
<td>Adequate parking, facilities, information exchange</td>
<td></td>
</tr>
<tr>
<td>Switzerland/Region implemented</td>
<td>Traffic congestion due to high frequency in city for trade fair</td>
<td>Traffic volume increase important on road network, which has space limitations</td>
<td>Traffic congestion, warning, dynamic route guidance with VMS on motorway and urban streets, program modification by traffic signals on urban streets, event information in combination with traffic information and routing proposals (e.g. park and ride)</td>
<td></td>
</tr>
<tr>
<td>Austria/Region implemented</td>
<td>Lack of project, lots of stakeholders, varying interests</td>
<td>Open and frequent communication (frequent steering committees)</td>
<td>Bringing together all relevant infrastructure and traffic information providers</td>
<td></td>
</tr>
<tr>
<td>Netherlands/Region implemented</td>
<td>Different arrangements for incident management at different levels</td>
<td>Solutions made for 1</td>
<td>Solutions that are useful for road users, better coordination of activities among the partners and cost-effective common solutions</td>
<td></td>
</tr>
<tr>
<td>Austria/Region implemented</td>
<td>Lack of technical training and cooperation</td>
<td>Solutions made for 1</td>
<td>Solutions that are useful for road users, better coordination of activities among the partners and cost-effective common solutions</td>
<td></td>
</tr>
<tr>
<td>Denmark/Region implemented</td>
<td>Insufficient cooperation and communication between different road authorities</td>
<td>Solutions made for 1</td>
<td>Solutions that are useful for road users, better coordination of activities among the partners and cost-effective common solutions</td>
<td></td>
</tr>
<tr>
<td>Netherlands/Region implemented</td>
<td>Limited exchange of information</td>
<td>Solutions made for 1</td>
<td>Solutions that are useful for road users, better coordination of activities among the partners and cost-effective common solutions</td>
<td></td>
</tr>
<tr>
<td>Netherlands/Region implemented</td>
<td>Limited exchange of information</td>
<td>Solutions made for 1</td>
<td>Solutions that are useful for road users, better coordination of activities among the partners and cost-effective common solutions</td>
<td></td>
</tr>
<tr>
<td>Netherlands/Region implemented</td>
<td>Limited exchange of information</td>
<td>Solutions made for 1</td>
<td>Solutions that are useful for road users, better coordination of activities among the partners and cost-effective common solutions</td>
<td></td>
</tr>
</tbody>
</table>
### C5: Impacts and Key Assessments

<table>
<thead>
<tr>
<th>Country</th>
<th>Case Studies</th>
<th>Challenges and Impacts</th>
<th>Recommendations for Translatability</th>
<th>Future Research Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>High environmental and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>High economic and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>High environmental and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>High economic and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>High environmental and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>High economic and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>High environmental and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>High economic and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>High economic and social costs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Further Research Needs
- Development of additional case studies from across Europe, including Mediterranean and Eastern European countries.
- Expansion of ex-ante economic analysis to include all relevant economic and social impacts.
- Development of additional spatial impact assessments, including the impact of border crossing on local economies.
- Development of additional qualitative assessments, including the impact of cross-border infrastructure on local communities.
- Development of additional environmental impact assessments, including the impact of cross-border infrastructure on local ecosystems.
- Development of additional social impact assessments, including the impact of cross-border infrastructure on local societies.

### Recommendations for Translatability
- Development of additional case studies from across Europe, including Mediterranean and Eastern European countries.
- Expansion of ex-ante economic analysis to include all relevant economic and social impacts.
- Development of additional spatial impact assessments, including the impact of border crossing on local economies.
- Development of additional qualitative assessments, including the impact of cross-border infrastructure on local communities.
- Development of additional environmental impact assessments, including the impact of cross-border infrastructure on local ecosystems.
- Development of additional social impact assessments, including the impact of cross-border infrastructure on local societies.

### Future Research Needs
- Development of additional case studies from across Europe, including Mediterranean and Eastern European countries.
- Expansion of ex-ante economic analysis to include all relevant economic and social impacts.
- Development of additional spatial impact assessments, including the impact of border crossing on local economies.
- Development of additional qualitative assessments, including the impact of cross-border infrastructure on local communities.
- Development of additional environmental impact assessments, including the impact of cross-border infrastructure on local ecosystems.
- Development of additional social impact assessments, including the impact of cross-border infrastructure on local societies.

### Further Research Needs
- Development of additional case studies from across Europe, including Mediterranean and Eastern European countries.
- Expansion of ex-ante economic analysis to include all relevant economic and social impacts.
- Development of additional spatial impact assessments, including the impact of border crossing on local economies.
- Development of additional qualitative assessments, including the impact of cross-border infrastructure on local communities.
- Development of additional environmental impact assessments, including the impact of cross-border infrastructure on local ecosystems.
- Development of additional social impact assessments, including the impact of cross-border infrastructure on local societies.
Ref: CEDR report 2017/01 - Reducing congestion with integrated network management (INM)