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ImPRoving thE uSe Of third-paRTy data by NRAs (PRESORT)

Report on Gap Analysis

Deliverable D3.3 Version 1.1

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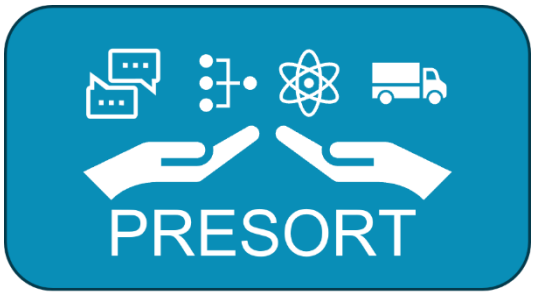

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D3.3 Report on Gap Analysis

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Executive summary

PRESORT is a CEDR Transnational Road Research Programme Call 2022 project aiming to empower National Road Authorities (NRAs) to maximize the potential of third-party data for improved road management. NRAs are increasingly reliant on data to optimize traffic, enhance safety, and minimize environmental impact. While NRAs collect much data themselves, a wealth of complementary data resides in third-party sources. PRESORT aims to address challenges hindering NRAs from fully utilizing this data. The primary objective of PRESORT is to deliver an evidence-based decision support guide to enable NRAs to make better decisions regarding HOW? and WHEN? to acquire and USE third-party transport data.

This deliverable aims to analyze data needs of NRAs and identify gaps between their current data resources and what is optimally required. It also explores challenges faced by NRAs and third-party data providers in acquiring, using, and maintaining data. We focused on three key ecosystems namely: Cooperative Intelligent Transport Systems (C-ITS), road safety and road user charging and tolls.

Methodology

Work Package 3 analyzed the needs and requirements of NRAs regarding third-party data. This builds on information collected during WP2: Capture. Additional information was collected via questionnaires, workshops, and interviews with NRAs and data providers. 29 participants from 10 countries attended the workshop, with 8 interviews with third-party data providers. In addition, 3 NRAs and 1 third-party data provider completed questionnaires. This information was compiled into a Data Catalogue of third-party datasets used by NRAs. This was used to perform a gap analysis, comparing the current state and use of data and processes with the NRA's desired state. This was done by considering desirability, technical fit, and business viability from both the NRA and third-party data provider perspectives. Based on the gaps, so identified, specific use cases were selected for further investigation in Work Package 4 (WP4).

Current state of third-party data use

The increasing use of third-party data by NRAs presents both opportunities and challenges. While this data offers high relevance and timeliness, concerns remain regarding accuracy, reliability, and privacy. NRAs are actively addressing these through collaborative efforts, technological advancements, and clearer regulatory frameworks. The development of standardized data formats and improved data-sharing mechanisms should further facilitate the wider adoption and effective utilization of third-party data.

Desired state of third-party data use

The workshop also revealed a strong desire among NRAs to use third-party data for enhancing C-ITS, road safety, and road user charging and tolls. NRAs see the potential of detailed, real-time data to improve traffic management and incident response. However, several challenges need to be addressed – as ensuring data quality, privacy compliance (especially GDPR), and compatibility with existing systems are key concerns. There is also a need for standardized terminology and clear data definitions to ensure smooth data exchange and integration.

Third-party data providers are eager to foster a more collaborative relationship with NRAs. They suggest NRAs embrace data sharing, prioritize data literacy, focus on desired outcomes, promote inter-NRA collaboration, streamline data access, and consider alternative infrastructure models. They also encourage participation in reciprocal data sharing, emphasizing quality over quantity, and also call for clear communication channels with NRAs. Lastly, they envisage a collaborative approach to data quality control, building trust and avoiding redundancy, and advocate a fair and transparent data marketplace that caters to diverse NRA needs.

Identified gaps

There are several gaps between the needs of NRAs and the services of third-party data providers, and we have considered these in terms of desirability, technical fit and business viability.

Desirability: NRAs want to collect large volumes of data but don't always use it effectively, while third-party providers focus on extracting actionable insights from the data not the volume per se. NRAs often want to access the individual vehicle data (alongside insights from data) but are limited by GDPR, while third-party providers need quick access to data but face bureaucratic hurdles. There is a tension between NRAs' desire for open data and providers' commercial interests, and a gap between local NRA restrictions and providers' need for cross-border data. Finally, NRAs and providers have different expectations around availability and coverage. Addressing these gaps requires collaboration, standardized practices, and technological advancements.

Technical fit: Several gaps hinder collaboration between NRAs and third-party data providers. NRAs lack data integration expertise and can struggle to understand vehicle-based data concepts in the same way as providers can lack understanding of the roads. There is a need for increased data literacy among NRAs and better coordination in data collection efforts. Additionally, data cohesiveness and standardization are lacking, with NRAs hesitant to adopt new technologies fearing additional costs and disruptions. Concerns about data privacy and security, especially with cloud-based sharing, further complicate the issue. In terms of quality, third-party data providers express confidence in their ability to deliver high-quality data, while NRAs remain uncertain and see room for improvement.

Business viability: Gaps include uncertainties in business models and agreements, complex stakeholder dependencies, unclear data ownership and rights, mismatched cost expectations, and distrust and competition. These issues stem from concerns about long-term stability of suppliers, involvement of multiple stakeholders, ambiguity in data usage, differing views on cost and value, and fears of losing control or competitive advantage. Addressing these gaps requires clear communication, collaborative learning, and well-defined agreements that consider the interests and concerns of both parties.

Despite the above gaps, there are still clear benefits from better use of the data already being delivered – filling them would maximise the value.

Selected use cases for deep dive in WP4

Four use cases have been identified for detailed investigation:

- *Traffic Management using Floating Car/Vehicle Data (C-ITS):* This explores the further potential of real-time vehicle data to improve traffic management, incident response, and asset management.
- *Using in-vehicle data:* How data from vehicles can enhance various aspects of road management beyond C-ITS, including asset management and safety.
- *eCall data use for Road safety improvement:* This focuses on leveraging eCall data to enhance road safety measures.
- *Leveraging new technologies for road user charging and Tolls:* This explores the potential of new technologies like AI and machine learning allied to data to improve road user charging and tolling operations.

PRESORT project description

PRESORT is a CEDR Transnational Road Research Programme Call 2022 project aiming to empower National Road Authorities (NRAs) to leverage the potential of third-party data for improved road management. NRAs are increasingly reliant on data to optimize traffic flow, enhance safety, and minimize environmental impact. While NRAs collect some data themselves, a wealth of complementary information resides with data from third-party sources. This data, encompassing information from vehicle manufacturers, navigation companies, and fleet management providers, holds immense potential for improving road user safety, traffic throughput, and environmental impact. However, NRAs struggle with various challenges, such as data accessibility, quality, governance, and integration with existing systems. PRESORT project aims to address the challenges hindering NRAs from fully utilizing this valuable data.

The primary objective of PRESORT is to deliver an *evidence-based decision support guide* that can be used to enable NRAs to make better decisions regarding HOW? and WHEN? to acquire and USE third-party transport data.

To achieve this objective, the PRESORT project follows the following approach:

- Capture and understand the current state of third-party data usage by NRAs.
- Analyse the core business needs of NRAs and how third-party data can address them.
- Identify key challenges and best practices in acquiring, using, and maintaining third-party data.
- Deep dive into specific use cases with the highest potential benefit from third-party data.
- Develop an actionable guide for NRAs to effectively identify, acquire, verify, maintain, and utilize third-party data.
- Disseminate the guide to all CEDR NRA member states.

To achieve these objectives, PRESORT project utilises a collaborative approach with defined roles and responsibilities for each consortium partner. The project follows a sequential work plan with regular engagement with stakeholders, quality assurance reviews, and technical reviews.

The expected outcomes of PRESORT include:

- A comprehensive understanding of the challenges and opportunities related to third-party data usage in NRAs.
- Identification of specific use cases where third-party data can provide the most significant benefits.
- Development of an actionable guide and data catalogue to support informed decision-making in NRAs.
- Dissemination of knowledge and best practices related to third-party data utilization.

By addressing the barriers for accessing and using third-party data, PRESORT aims to empower NRAs to leverage valuable data sources and ultimately enhance their services for the benefit of road users and the environment.

Glossary

AI	Artificial Intelligence
AV	Automated Vehicle
CAM	Cooperative Awareness Messages
CEDR	Conference of European Directors of Roads
C-ITS	Cooperative Intelligent Transport Systems
DoRN	Description of Research Needs
DRIP	Dynamic Route Information Panel
DPA	Data Protection Authority
EETS	European Electronic Toll Service
EV	Electric Vehicle
FCD/FVD	Floating Car data (also referred as Floating Vehicle data)
GDPR	General Data Protection Regulation
ITS	Intelligent Transport Systems
LiDAR	Light Detection And Ranging
ML	Machine learning
NAP	National access point
NRA	National Road Authority
OEM	Original Equipment Manufacturer
RTTI	Real-Time Traffic Information
SRTI	Safety-Related Traffic Information
TLC	Traffic light controller
VMS	Variable message sign (also known as DRIP)

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1 Introduction

National Road Authorities (NRAs) are increasingly reliant on data to achieve their goals in road safety, traffic flow, and environmental impact. While NRAs collect some data from their sources (sensors, cameras, etc.), today's connected vehicles offer a wealth of additional information. These vehicles can detect and share data on road conditions, traffic conflict situations, traffic patterns, and the environment, creating a new opportunity for NRAs.

Third-party data providers like vehicle manufacturers, navigation companies, and smartphone app developers collect vast amounts of transportation data. This data holds immense potential to complement and enrich NRAs' existing data sets, leading to improved road safety, traffic & asset management, construction activities, and, ultimately, customer satisfaction.

However, NRAs face challenges in utilising third-party data at scale despite the potential benefits. These challenges include:

- Data Access: Much third-party data is closed and not readily available to NRAs.
- Data Quality: NRA’s concerns exist regarding the quality and reliability of third-party data.
- Data Sharing: Technical, commercial, and legal barriers hinder data accessibility.
- Data Integration: Integrating third-party data with existing NRA data can be complex.
- Data Expertise: NRAs may lack the internal expertise to manage and utilize third-party data effectively.
- Data Governance: Establishing proper governance frameworks for sharing, security, privacy, and trust is crucial.
- Procurement: NRAs may lack established processes for acquiring third-party data.
- Cost-Benefit Analysis: Quantifying the cost-effectiveness of utilizing third-party data can be challenging.
- Business Models: Identifying appropriate business models and service level agreements for data acquisition is necessary.
- Legal Considerations: Regulations like GDPR can create additional hurdles.

The PRESORT project aims to bridge this gap by providing NRAs with the tools and knowledge to make informed decisions about acquiring and using third-party data. The project will deliver an evidence-based decision support guide that will assist NRAs in determining the "how" and "when" of incorporating third-party data into their core operations.

This deliverable *D3.3: "Report on Gap analysis*” presents the outcome of Work Package 3: "Analyse", which is intended to identify the needs of NRAs related to third-party data, capture the *current state of data use* within NRAs, identify the *desired state of data*, and analyse the *gap between current and desired state*. Furthermore, this Work Plan aims to identify few use cases for a deep dive in the next Work Plan WP4.

Section 2 highlights the purpose and scope of this research. Section 3 discusses the methodology used in various steps. Section 4 provides current state of third-party data usage within NRAs and from third-party data providers’ perspective. Section 5 in contrast discusses the desired state of third-party data use by NRAs and third-party data providers. Section 6 shows the results of gap analysis from desirability, technical fit and business viability perspective. Section 7 aims to discuss various selected use cases for deep dive in WP4. Section 8 aims to provide conclusions and recommendations.

2 Purpose and scope

PRESORT aims to deliver an evidence-based decision support guide that can enable NRAs to make better decisions regarding how and when to acquire and use third-party transport data. This deliverable presents the findings of *Work Plan 3: "Analyse",* which is intended to meet the following objectives:

- Analyse the needs of NRAs in terms of data and processes based on their objectives.
- Identify which data and processes are optimally needed to meet the objectives of the NRAs. In context of third-party data.
- Explore the gap between the currently available, owned and used data and the optimally needed data.
- Analysis of challenges/barriers of NRAs and 3rd party data providers regarding data acquisition, use and maintenance.

Focal ecosystems

As the needs of NRAs arise from their core business, such as road safety, traffic management, asset management, construction, etc., the research was conducted with a focus on three main data ecosystems (as mentioned in DoRN), namely:

- **Road Safety**
  Road safety is a critical concern, and various efforts are being made to ensure that road use is as safe as possible. In the context of the EU, “Vision Zero” establishes a long-term goal to move towards zero fatalities in road transport by 2050 (EU Road Safety: Towards Vision Zero, 2022). Various data-related initiatives such as Data for Road Safety (DfRS)[1] bring together multiple stakeholders such as vehicle manufacturers, traffic information service providers, automotive suppliers and public authorities to ensure the availability of safety data required for comprehensive safety-related traffic information services.
- **Cooperative Intelligent Transport Systems (C-ITS)**
  Cooperative Intelligent Transport Systems (C-ITS) are advanced applications that aim to provide innovative services relating to different modes of transport and traffic management, thereby enabling various users to be better informed and make safer, more coordinated, and smarter use of transport networks. The CAR 2 CAR Communication Consortium defines C-ITS as transport systems where the cooperation between two or more ITS sub-systems (personal, vehicle, roadside and central) enables and provides an ITS service that offers better quality and an enhanced service level, compared to the same ITS service provided by only one of the ITS sub-systems. C-ITS allow effective data exchange through wireless technologies so that vehicles can connect with each other, with the road infrastructure and with other road users.
- **Road user charging and tolls**

  Road user charging, also known as road pricing or congestion charging, aims to make the costs that motorists pay more closely reflect the costs to others from externalities, such as air pollution or congestion (Laverty, A. 2021). These charges can take various forms, including:

[1] https://www.dataforroadsafety.eu/

- Toll Points: Charges are levied upon entering a specified area at toll points (such as motorway tolls).
- Congestion Charging: Charges apply when crossing into a specific area.
- Emission charging: Charging based on emission of the vehicle or based on emission zones.
- Area Charging: Charges, such as low-emission zones, cover any use within a designated area.

The implementation of road user charges varies by factors such as time of day, vehicle class, and emission standards. Notably, revenue generated from these charges is often earmarked for improving infrastructure or alternative transport options. Although these charges may not be directly set or collected by NRAs, data about their collection (eg toll road volumes and vehicle class) can still be of great value to NRAs.

Definition of third-party data

Although there are various definitions of third-party data depending on the domain, for the purpose of the PRESORT project, the following definition applies as mentioned in the WP2 Baseline report.

Third-party data is aggregated or collated by a provider not involved in the original collection of the data. The data is then provided to an NRA. It includes data from sources such as:

- Vehicle manufacturers (can also be third party data provider e.g., Michelin)
- Suppliers of in-vehicle technology (for example, Bosch, AISIN)
- Navigation and fleet management systems (for example, HERE, TomTom, INRIX, Be-mobile)
- Private mobility providers (for example, Uber)
- Specialist road condition data, including weather (for example, NIRA Dynamics, Vaisala, Meteorological office, Bridgestone (tyres))
- Other environmental monitoring services (for example, for air quality and noise)

3 Methodology

WP3 builds upon the information collected during WP2 and focuses on analyzing the needs and requirements of the NRAs in the context of third-party data use. In order to achieve the objectives in Section 2, a three-step process was followed in WP3:

1. **Analysis of NRA's data-related needs:**
   In addition to the information collected via a questionnaire during WP2 regarding the current state of third-party data use, additional information was collected to identify the objectives and needs of the NRAs. A workshop with various NRAs was organized to collect additional information, and several interviews with third-party data providers and NRAs were conducted.

   The information collected was compiled into a *"Data Catalogue"* (Deliverable D3.2), which is a comprehensive list of third-party datasets employed and utilized by NRAs across various use cases. This serves as a valuable resource for other tasks within the project. This step provides a foundation for the gap analysis.

2. **Gap analysis:**
   The information collected during the previous steps: questionnaire, data catalogue, interviews with third-party data providers and the outcomes of the workshops with NRAs were used to perform the gap analysis.

   For the gap analysis, the current state and use of the data and processes as described by the NRAs and the third-party data providers were compared with the desired state and use described by them. The gap analysis was performed by keeping the 3 aspects in mind, namely Desirability, Technical fit and Business viability, both from the 'NRA and the third-party data providers' perspectives.

   The various research questions within each aspect that were taken into account during the gap analysis are:

   Desirability

   - Is the desired data per ecosystem or use case available? How is the data made available in the more mature NRAs? What are the use cases that show best practise in the use of the data?
   - Which use cases show the most immediate need and are the low-hanging fruits to focus on or further investigate?

   Technical fit

   - Is the data available in the NRA or in combination with 3rd party data providers sufficient to fulfil their needs with regards to quality aspects based on the EU EIP Quality of RTTI Practical Guidelines, which define 5 major criteria, namely: Timeliness, Latency, Location accuracy, Classification correctness, and Event coverage?
   - Is the technical infrastructure on the asset and in-house data architecture available at NRAs to meet their needs from an NRA perspective?

- Is there a mismatch or is there a lack of data exchange protocols or standards needed for specific sharing and maintenance of data?

Business viability

- How was the procurement of the data justified for the specific use cases?
- Which features of the business case led to the decision to obtain data from 3rd parties? Which features were potential deal breakers at both sides of the table NRA and 3rd party data providers)
- Were there adjacent emerging use cases for the same data set considered?

3. Use cases for detailed investigation.

Based on the identified gaps within Gap Analysis, this step identifies four use cases for a deep dive in the following work plan, WP4.

3.1 Stakeholder engagement via questionnaires, interviews and workshops

To gather information about current practices, needs, and requirements of the NRAs regarding third-party data use, we engaged with stakeholders through workshops, interviews, and questionnaires.

Workshop methodology

On January 15, 2024, an online workshop was conducted in collaboration with the DROIDS project (Digital Road Operator Information and Data Strategy, funded by CEDR) to collect information on the current practices, needs, and requirements of NRAs. 36 participants (PRESORT + DROIDS) from 10 countries attended the workshop.

The workshop commenced with an introduction to the projects, followed by a clarification of key terms, including ‘third-party data.’

Throughout the workshop, participants engaged in four breakout room discussions. Three of these discussions were centred on the PRESORT project, while one focused on the DROIDS project. Each PRESORT discussion was dedicated to one of three primary ecosystems: Data for Road Safety, Data for Cooperative Intelligent Transport Systems (C-ITS), and Data for Road User Charging and Tolls. A total of 29 participants attended the breakout discussions for the PRESORT project. A list of various organizations that attended the workshop is given in Table 1.

Table 1: A list of various organizations that attended the PRESORT breakout discussions

Breakout room topic	Country	Organization	Number of participants
Data for Road Safety	Finland (FI)	Fintraffic	1
	Norway (NO)	IFE	1
	England (UK)	National Highways	1
	Finland	Traficon	2
	Ireland (IRL)	Transport Infrastructure Ireland (TII)	1
	Germany (DE)	VDI/VDE-IT	1
	Sweden (SE)	Trafikverket (Swedish transport administration)	1
	England	AECOM	1
	Netherlands (NL)	Royal HaskoningDHV	1
Data for C-ITS	Belgium (BE)	Transport & mobility Leuven	1
	Finland	Fintraffic	1
	Austria (AT)	ASFiNAG	1
	Norway	IFE	1
	Norway	SINTEF	1
	Netherlands	MAPtm	2
	Belgium	Mobiliteit en Openbare Werken, Vlaanderen	1
	England	National highways	1
	Belgium	F2S2	1
	England	University of Southampton	1
	Germany	DLR (National aeronautics and space research centre)	1
	Germany	Continental AG	1
	Netherlands	Rijkswaterstaat	1
Data for Road user charging and tolls	Norway	IFE	1
	Denmark (DK)	Vejdirektoratet	1
	Finland	Traficon	1
	England	AECOM	1
	England	White Willow	1
		Total	**29**

Discussions within each breakout room were conducted interactively, with participants collaborating on an online tool named “Concept Board” (Figure 1). This platform enabled participants to provide their input on various questions and facilitated seamless contributions, irrespective of group size.

The breakout discussions aimed to capture the current state of third-party data utilization by the NRAs. Topics included use cases associated with each ecosystem, third-party data linked to these use cases, opinions on third-party data quality (evaluated based on accuracy, reliability, consistency, relevance, and timeliness) and the challenges and barriers faced in using and maintaining third-party datasets.

The discussions also aimed to envision the optimal future utilization of third-party data. Participants engaged in identifying a range of use cases pertinent to the ecosystem and brainstormed on the necessary third-party data for these use cases alongside their primary objectives and requirements.

Discussion ended by capturing data required by NRAs to improve services in the future.

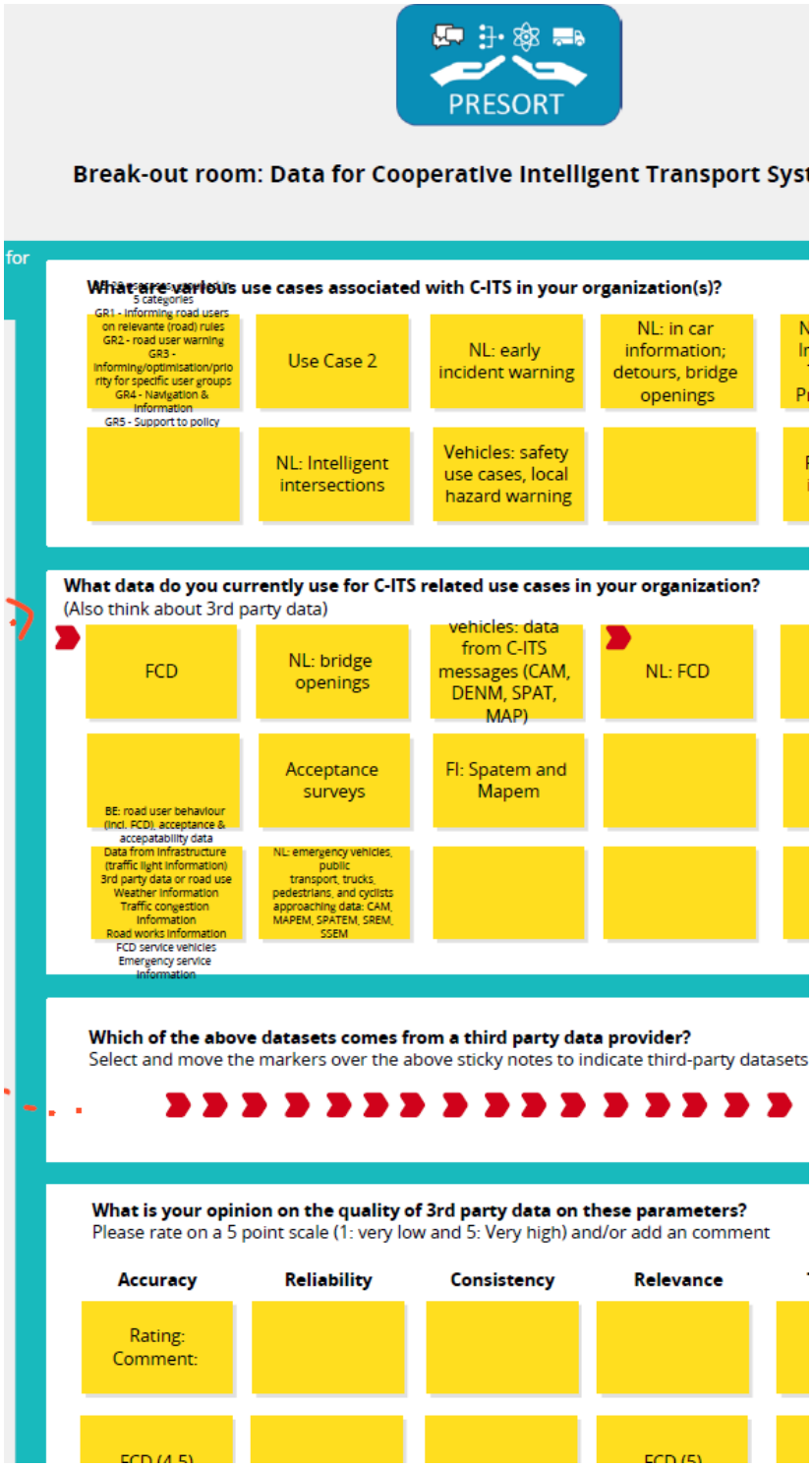

Figure 1: Example of inputs received via Concept board during the C-ITS breakout discussion

Interview methodology

To gain deeper insights from the perspective of third-party data providers, one-to-one (1:1) interviews were conducted with 8 third-party data organisations. A list of organisations that participated in an interview is provided in Table 2.

Table 2: A list of third-party data providers who participated in 1:1 interview

Organisation	Country	Type
Valerann	UK, Israel, Spain and US	Data insights, Platform, service provider
GEWI	DE	Data insights, Platform, service provider
AISIN mobility	BE	Data insights, Platform, service provider
HAAS Alert	UK/US	Alerts to connected vehicles, insights
Bridgestone mobility solutions	NL	Vehicle data, platform, service provider
INRIX	UK/US/DE	Data and service provider
Michelin	France (FR)	Data and service provider
Compass IOT	Australia (AUS)	Data and service provider

The interviews with third-party data providers focused mainly on understanding what datasets or services they offer and what challenges and barriers (technical or organisational) they face in producing, maintaining or sharing data with NRAs.

A set of general questions that were used for conducting interviews with third-party data providers is given in Appendix B.

Questionnaire methodology

A questionnaire was circulated after the workshop to capture more detailed and technical information from specialists within the organisation. Additionally, it was also intended for stakeholders who could not participate in the workshop or an interview. The questionnaire structure was similar to the content of workshops and interviews.

The questionnaire for NRAs received 3 responses from organisations, as mentioned in Table 3.

Table 3: A list of various organisations that responded to the questionnaire for NRAs

Topic	Country	Organization	Number of participants
Data for Road Safety	Sweden	Trafikverket	1
	Belgium Flanders	MOW Vlaanderen	1
Data for C-ITS	Belgium	F2S2, Consultant to AWV	1

On the other hand, the questionnaire for third-party data providers received 1 response from TomTom (Netherlands).

3.2 Data Catalogue

The findings from Work Package 2 (WP2) and a culmination of information gathered through questionnaires, interviews, and workshops were compiled to create a data catalogue (Deliverable D3.2). This data catalogue contains a comprehensive list of third-party datasets employed and utilized by NRAs across various use cases. The data catalogue also contains a data utilization dashboard, which provides an overview of a number of unique use cases and a number of unique third-party datasets used by various organizations across 3 ecosystems: C-ITS, Road Safety and Road user charging & Tolls within the data catalogue database.

The data catalogue is intended to remain dynamic throughout the project, continuously updated as new information becomes available. It serves as a valuable resource for various work packages.

4 The current state of third-party data usage

This section aims to illustrate the current state of third-party data usage, both from the perspective of NRAs and third-party data providers.

4.1 Within NRAs

The scale of third-party data usage by NRAs is slowly growing (as mentioned within the workshop), driven by the increasing digitization of road infrastructure and services. NRAs are already utilising third-party data to enhance various aspects of their operations, from road safety and traffic management to asset management and customer experience.

The use of third-party data is evident in several national strategies and action plans, as reported in the deliverable WP2 ”Baseline report” within section “Scale of NRA third-party data usage”. For instance, the EU's Intelligent Transport Systems (ITS) framework[2] aims to create a common European mobility data space, facilitating the pooling and sharing of data from various sources, including third-party providers, through various National Access Points (NAPs). Similarly, England’s Digital Roads strategy[3] emphasizes the use of third-party data to improve traffic management and customer experience.

The scale of third-party data usage is also reflected in the emergence of initiatives like Data For Road Safety (DFRS)[4], which relies on the dissemination of live information from various sources, including third-party providers, to enhance road safety across the EU and UK. Moreover, the development of urban mobility dashboards[5] and other applications by local authorities often involves the integration of third-party data to provide comprehensive insights into traffic patterns, congestion, and other relevant metrics.

Overall, the scale of third-party data usage by NRAs is significant and multifaceted. While the specific extent of this usage varies across countries and regions, the general trend indicates a growing reliance on third-party data to enhance various aspects of road infrastructure and services. This trend is likely to continue as NRAs increasingly embrace digital technologies and data-driven approaches to improve efficiency, safety, and sustainability in the transportation sector.

4.1.1 Cooperative Intelligent Transport Systems (C-ITS)

C-ITS promises to improve road safety, efficiency, and sustainability. NRAs are exploring C-ITS and often use third-party data to improve their services. The Talking Traffic initiative[6] in the Netherlands is a good example of how public-private partnerships can use third-party data to achieve goals like improved traffic flow, reduced emissions, and enhanced safety.

There are various use cases related to C-ITS within NRAs. Some of the use cases mentioned by NRAs during the workshop where third-party data is used are provided in Table 4.

[2] https://www.connectedautomateddriving.eu/roadmaps/list-strategies/
[3] https://nationalhighways.co.uk/our-work/digital-data-and-technology/digital-roads/
[4] https://www.dataforroadsafety.eu/
[5] https://www.eib.org/attachments/publications/technical_note_on_data_sharing_in_transport_en.pdf
[6] https://www.talking-traffic.com/

Table 4: Various existing use cases associated with C-ITS within NRAs

Country	Use cases
NL	• **Early Incident Warning:** Rapid dissemination of information regarding accidents or unexpected events on the road. • **In-vehicle Information:** Providing drivers with real-time updates on detours, bridge openings, and other relevant traffic information. • **Traffic Light Priority (SI-TLP):** Prioritizing certain vehicles at signalized intersections to improve traffic flow. • **Virtual message signs (VMS or DRIP):** Displaying route information and updates directly in vehicles, reducing the need for physical panels. • **Road Inspector Warnings:** Alerting drivers about the presence of road inspectors to ensure safety. This is based on two use cases: Emergency or Rescue/Recovery Vehicle in Intervention (ERVI) and Emergency or Prioritized Vehicle Approaching (EPVA). • **Intelligent Intersections:** Enhancing intersection management through advanced sensor and communication technologies.
BE	• **Informing Road Users:** Informing drivers on local traffic regulations and updates. • **Road User Warning:** Issuing alerts about potential hazards or changes in road conditions. • **Optimization/Priority for Specific Groups:** Tailoring traffic management to benefit certain user groups, such as emergency vehicles. • **Navigation & Information:** Assisting drivers with route planning and providing essential travel information. • **Support to Policy:** Aiding in the enforcement and promotion of traffic policies. • **Road User Behavior:** Monitoring and influencing driver behaviour to improve road safety.
FI	• **Signalized Intersections:** Implementing intelligent traffic signals to optimize traffic flow and reduce congestion.
DE	• **Local Hazard Warning:** Alerting drivers to immediate risks in their vicinity, such as roadworks or broken-down vehicles.

These use cases demonstrate the diverse applications of C-ITS across different countries, reflecting the unique needs and priorities of NRAs.

Various third-party datasets used by NRAs

For the above-mentioned use cases, a variety of datasets are required to achieve the desired objectives. However, NRAs often mention using the following data from third-party sources:

- **Floating car/vehicle data (FCD/FVD) –** Floating car data (also known as Floating Vehicle data (FVD)) is data from vehicles or mobile systems such as navigation and tracking systems, travel apps on smartphones, fleet management systems and other data from cars with an internet connection. The equipment continuously transmits signals with the vehicle's GPS position, ID and time (Fact Sheet Floating Car Data and Speed – Kennisnetwerk SPV (2021), Floating car data – NDW (2024)).
  NRAs in *Belgium, Germany and the Netherlands* mention using FCD within their C-ITS use cases related to traffic management. They obtain this data from third-party data providers. National Highways also uses third party FVD.

- **Road use data** – Road use data refers to information related road user behaviour as well as their acceptance based on surveys. Belgium obtains the data on road use from third-party data providers.
- **Weather information** – To manage the traffic effectively, weather data obtained from the third-party data provider is used in Belgium and Finland.
- **Traffic flow and congestion** - Belgium also reported on obtaining traffic flow and congestion data from a third-party.
- **Data from C-ITS messages** – Germany reported obtaining the data from C-ITS messages such as CAM, DENM, SPAT, MAP, etc., from third-party data providers.

Quality of third-party datasets perceived by NRAs

Data quality plays an important role in its adoption and effective use to improve the C-ITS services. Perceived quality of data sets by NRA's was assessed using several criteria. The NRAs were asked to rate the quality of third-party datasets based on 5 criteria: Accuracy, Reliability, Consistency, Relevance, and Timeliness of information.

For each criteria and third-party dataset, the quality was assessed on a Likert scale from 1 to 5, where 1 = Shallow quality and 5 = Very high quality.

The quality was assessed based on Table 5 provides an overview of the reported quality of C-ITS-related third-party datasets.

Table 5: Reported quality of C-ITS-related datasets

	Parameters				
Country: Type of data ↓	**Accuracy**	**Reliability**	**Consistency**	**Relevance**	**Timeliness**
NL: FCD	4.5	-	-	5	-
DE: Vehicle: direct C-ITS	5	-	5	5	5
NL: SI-TLP	4.5	4.5	4.5	-	-
DE: Vehicle: cloud-based	2	2	-	4	2
FI: Mapem	5	5	5	5	5
FI: SPATem	2	2	3	3	5
BE: General	4	3	2	3	3
Average	**3.8**	**3.3**	**3.9**	**4.1**	**4**

It can be seen from Table 5 that third-party datasets related to C-ITS have high relevance, timeliness, accuracy and consistency. However, reliability is average.

In the context of C-ITS, the integrity of third-party datasets is crucial. However, some datasets are advertised as real-time, but in reality, they are only near-realtime. Also, the accuracy of false positive and false negative ratios in some datasets is questionable. Specifically, removing notifications (such as when a stationary vehicle is considered 'removed') poses challenges.

Challenges and barriers in utilizing third-party data for C-ITS

NRAs shared various challenges and barriers that can impede the effectiveness of third-party data-driven initiatives from their perspective.

One of the primary challenges is the *definition of roles and responsibilities* (FI), especially in the context of third-party data, where the delineation of road authority roles is often unclear. This ambiguity can lead to confusion over who is accountable for data-related issues and hinder C-ITS services' implementation.

Agreements and Data Quality: Another significant barrier is the *need for strong agreements between parties* that clearly outline data requirements, sustainable business models, and costs (BE, NL). These agreements are crucial for ensuring good C-ITS services but can be difficult to negotiate due to competition in data quality and the differing interests of public and private parties. In Belgium and the Netherlands, for instance, there is a noted challenge in motivating third parties to improve their data quality, which is often based upon successful negotiation and long-term cooperation based on clear business plans or mutually beneficial interactions.

Costs related to third-party data: Lack of willingness to pay by public authorities is a challenge (DE). NRAs believe that third-party datasets have long-term costs involved (including creating a sustainable business model) in comparison to road-side infrastructure.

Commercial and Privacy Issues: Commercial concerns are a major hurdle, with manufacturers often *reluctant to share information*, leading to issues with data availability (NL, UK). The General Data Protection Regulation (GDPR) adds another layer of complexity, imposing restrictions that can affect the timeliness and accuracy of data, particularly vehicle data shared in the cloud (DE). Privacy concerns also necessitate careful handling of sensitive data retrieval and the maintenance of anonymity, which can complicate long-term agreements and the development of sustainable business cases, as noted by stakeholders in the Netherlands and the UK.

Public-Private Partnerships and Data Ownership: Finding a win-win situation through public-private partnerships that focus on program continuity rather than project-based work is essential yet challenging (BE, NL). Data ownership becomes a contentious issue when new products or services are created from third-party datasets, raising questions about who holds the rights to the newly created value (NL, BE, UK). Trust, liability, and ensuring value for money are additional factors that must be navigated to foster successful collaborations between third-party data providers and NRAs (UK).

In conclusion, the challenges and barriers in using and maintaining third-party datasets are diverse and multifaceted. They require efforts to establish clear roles, negotiate strong agreements, address commercial and privacy issues, and create sustainable public-private partnerships. Overcoming these obstacles is crucial for leveraging the full potential of third-party datasets in C-ITS.

4.1.2 Road Safety

Road safety is a critical concern, and various efforts are being made to ensure that driving is as safe as possible. In the context of the EU, “Vision Zero” establishes a long-term goal to move towards zero fatalities in road transport by 2050 (EU Road Safety: Towards Vision Zero, 2022). Various data-related initiatives such as Data for Road Safety (DfRS)[7], bring together multiple stakeholders such as vehicle manufacturers, traffic information service providers, automotive suppliers and public authorities to ensure the availability of safety data required for comprehensive safety-related traffic information services. In addition, specifications for EU wide safety related traffic information (SRTI) and real-time traffic information (RTTI)[8] services are being adopted by member countries via their national access points (NAP) to ensure compatibility, interoperability, and continuity of ITS services.

NRAs play a critical role in ensuring the safety and efficiency of road networks. As traffic volumes increase and transportation systems become more complex, NRAs can leverage innovative technologies and data-driven approaches to address road safety challenges.

[7] https://www.dataforroadsafety.eu/
[8] https://transport.ec.europa.eu/transport-themes/intelligent-transport-systems/road/action-plan-and-directive/safety-related-traffic-information-srti-real-time-traffic-information-rtti_en

There are various use cases related to Road Safety within NRAs. Some of the use cases mentioned by NRAs during the workshop where third-party data is used are provided in Table 6.

Table 6: Various existing use cases associated with Road Safety within NRAs

Country	Use cases
NL	• **Speed Management:** Implementing strategies to regulate vehicle speed for safer and more efficient travel. • **Winter Management:** Addressing the challenges of winter weather through proactive measures
SE	• **Traffic Flow Optimization:** Utilizing data to enhance the efficiency of traffic movement. • **Incident Management:** Swiftly responding to accidents and disruptions to minimize impact. • **Severe Weather Handling:** Preparing for and managing extreme weather conditions. • **Winter Maintenance:** Ensuring road safety and accessibility during winter months.
IRL	• **Tunnel Queue Management:** Reducing congestion and improving safety in tunnel environments. • **Winter Gritting Program:** Maintaining road traction and safety during icy conditions. • **Speed Management:** Enforcing speed limits and encouraging safe driving behaviours.
UK	• **Road User Behaviour Monitoring:** Observing and correcting behaviours like phone usage and speeding. • **Lane Closures and Road Works Management:** Coordinating construction activities to minimize traffic disruption. • **Signs, Signals, and Diversions:** Guiding drivers effectively through altered traffic patterns.
FI	• **Traffic Fluency Estimations:** Predicting and improving the smoothness of traffic flow. • **Speed Management:** Controlling vehicle speeds to enhance road safety. • **Road Weather Information Services:** Providing timely data on road conditions during winter.

Across various countries, a diverse array of use cases related to road safety using third-party data showcases the potential of a data-driven approach to ensure safety.

Various third-party datasets used by NRAs

For the above-mentioned use cases, various datasets are required to achieve the desired objectives. However, NRAs often mention using the following data from third-party sources:

- **Travel time and speed data** – In Sweden, data related to speed and travel time is derived from FCD from a third-party data provider (INRIX). In addition, Waze also provides good and real-time estimates on travel time, which provides a first indication if there is an incident on the road (SE, UK, NL, BE, IRL, FI). Travel time data is also derived from mobile operator's data in the Netherlands.

- **Traffic event data** – Waze offers alerts related to events on a road which are crowdsourced. Many NRAs use Waze alerts in combination with travel time information to get a first indication of traffic events and prepare for event response. The NRAs often validate the data from Waze with additional sources of information such as roadside sensors (SE, UK, FI, BE, IRL).
- **Incident data** – NRAs use the data related to incidents from Data for Road Safety (DfRS) collaboration and in the future, eCall (SOS) alarms (SE, UK). Many NRAs also rely on data from Waze in combination with other sources of data (SE, UK, FI, IRL, BE).
- **Road friction** – In Sweden, road friction data is obtained via third-party data providers from a fleet of Volvo vehicles and NIRA Dynamics for Winter road management.
- **Data from OEMs** – In the Netherlands, the data from a fleet of Mercedes vehicles are used to identify various road safety hotspots, events, and hazards.
- **Data from cellphone operators** – In Finland, the data from cellphone operators is obtained for many traffic planning purposes. However, the coverage is around 30% of all mobile devices since only a few operators are part of the collaboration but data can be extrapolated mathematically, if required as this is a significant sample.
- **Weather data** – Since weather greatly influences road safety, data related to exceptional weather conditions is obtained from a third-party provider in Sweden and Finland.

These third-party data sets are often used in conjunction with other datasets such as road works, traffic counts, road cameras, roadside sensors, incident response data, etc., which are first- or second-party datasets for NRAs.

Quality of third-party dataset

Data quality plays an important role in road safety applications. NRAs indicated that data liability and consistency depend on the contract with the data provider. For example, Rijkswaterstaat in the Netherlands incentivises third-party data providers to ensure reliable, consistent, and accurate data. Additionally, rules and legislation can help improve data quality (BE). The data quality also depends on the maturity of the data. For example, data related to travel time and speed is mature and thus higher quality dataset is possible in comparison to event detection data, which is based on roadside sensors e.g., loop detectors (SE).

The NRAs were asked to rate the third-party datasets they encountered on a Likert scale for 5 data quality metrics: Accuracy, Reliability, Consistency, Relevance and Timeliness. Table 7 showcases the reported quality of road safety-related third-party data based on data quality metrics.

Table 7: Reported quality of Road Safety-related third-party datasets

	Data quality metrics				
Country ↓	**Accuracy**	**Reliability**	**Consistency**	**Relevance**	**Timeliness**
SE	3	3	3	5	4
UK	3	3	4	4	3
SE	3	4	4	5	4
BE	3	3	3	3	5
Average	**3**	**3.2**	**3.5**	**4.2**	**4**

It can be seen in Table 7 that the accuracy, reliability and consistency of third-party datasets are average, with high relevance and timeliness.

Challenges and barriers for NRAs in utilising third-party data for road safety

NRAs are increasingly looking to utilise third-party datasets to improve road safety. However, NRAs reported several barriers and challenges that hinder this process.

One major hurdle is **ensuring third-party data quality, accuracy, and relevance** (SE, DE, UK). The accuracy of these datasets can be questionable, with variations in how terms like "accident" are defined (BE, DE, IRL). For instance, data collected by one provider might define an "accident" differently than another, making it difficult to compare and analyze data sets. Sometimes certainty of an event is also not known (BE). Thus, data collection methods might not align with the NRAs' specific needs. Furthermore, restrictions on reusing data for purposes beyond its original collection can further limit its usefulness for NRAs. This is a concern for all NRAs considering third-party data sources.

Technical challenges also come into play. NRA's In-house legacy systems may not be designed to effectively use third-party data (SE). Integrating third-party datasets can be challenging due to differences in formats, protocols, and data structures (SE, BE). Organizations need to raise their focus on information management to ensure seamless integration and utilization of external data sources (SE). Inconsistent data formats and lack of standardisation across providers create additional challenges in data processing and analysis, a problem faced by many NRAs. For example, Sweden's technical/data architecture is incompatible with third-party data providers. Standardization efforts can improve interoperability across different data sources. On the other hand, the original purpose for collecting third-party data may not align with the specific needs of road safety applications. For example, using Anti-lock braking system (ABS) sensors as a proxy for road friction may not fully meet safety requirements (SE).

Another challenge mentioned by NRAs is **long-term continuity** with third-party data providers. Ensuring the continuity of data supply is a challenge. It's not known if third-party data providers will still exist in a few years.

Business considerations add another layer of complexity. The market for third-party data can be volatile, with unclear business models and costs making it difficult for NRAs to assess the long-term value and sustainability of data providers (SE). As highlighted by Ireland and the UK, EU and other procurement regulations and contractual limitations might further restrict NRAs' ability to access or use data. Additionally, NRAs may have limited control over how data is collected, hindering their ability to influence data collection methods specific to their needs. For example, third-party data providers often decide which data to collect and from which roads. Full coverage of the entire road network may not be achievable due to data availability limitations, and in most cases, the coverage of the dataset is not known (SE). As a result, NRAs have access to non-selective data (BE). Furthermore, third-party data providers might have little interest in developing location-specific solutions (IRL).

Finally, there are some **additional considerations**. NRAs are not aware of all available relevant datasets from third-party providers (BE). Establishing communication channels and identifying the right contacts within these organizations can be time-consuming (BE). However, the European Commission's Delegated Acts for SRTI- and RTTI data require that also private data owners present their available datasets in the national access points (NAPs), which is aimed to at least partly address this issue. Lastly, NRAs need to weigh the cost of acquiring and integrating third-party data against the potential benefits of road safety improvements. This cost-effectiveness analysis is crucial for NRAs (DE).

By understanding these challenges and barriers, NRAs can develop strategies to mitigate them. Addressing these challenges requires a strategic approach, collaboration with data providers, and a thorough understanding of legal, technical, and operational aspects.

4.1.3 Road user charging and tolls

There are several policies in place regarding road user charging and tolls. Taxation systems for vehicles in each country depend on their policies. For example, in Norway, electric vehicles (EVs) are exempt from tolls and road tax as they use their own lanes or public transport lanes (e.g., bus lanes).

There are various use cases related to road user charging and tolls within NRAs. But it is also worth noting that the *toll operators are also third-party data providers* since they collect data for their purposes even if the NRA does not collect or set tolls. Several use cases, like determining the appropriate toll fees and monitoring traffic flow and congestion at toll points, are common and seen within many NRAs. Some of the specific use cases mentioned by NRAs during the workshop are provided in Table 8.

Table 8: Various use cases associated with road user charging and tolls within NRAs

Country	Use cases
Bulgaria (BG)	• **HGV Charges:** Providing truck origin-destination matrices. • **Research Data**: Collecting data for research purposes.
UK	• **Ultra Low Emissions and Clear Air Zones:** Implementing charges based on emissions standards
NO	• **Energy Price Prediction:** Using third-party data to predict energy prices for electric vehicle charging (encouraging charging during low-price periods). • **Charging Stations Usage:** Monitoring usage of charging stations.
DK	• **Incident and Weather Information:** Providing incident and weather updates. • **Special Events:** Handling tolls during special events (e.g., Coronation).
FI	• **Congested Hours:** Adjusting toll charges during peak hours (morning and afternoon). • **Public Transport Influence:** Leveraging public transport availability when setting up toll charges.
Other	• **Speed/Regulation Enforcement**: Integrating the data from tolls for speed or regulation enforcement. • **Road Space Booking**: Managing road space allocation. • **Dynamic Charges**: Adapting charges based on real-time conditions.

Various third-party datasets used by NRAs

For the above-mentioned use cases, a variety of datasets are required to achieve the desired objectives. One of the key sources of data related to road user charging and tolls is obtained from toll operators who in this case is a third-party data provider.

From the workshop discussion, the following data from third-party sources was reported to be used by the NRAs:

- **Onboard unit (OBU) data** – In Bulgaria, data from onboard units (OBUs) installed in trucks is collected from a third-party data provider.
- **Foreign Visitors**: In Denmark and UK, data related to toll usage by foreign visitors is used.

- **Fee Payment Service Provider's data**: In the UK, the data from retail payment service providers (e.g., PayPoint) in shops is used to monitor toll payments.
- **Travel time**: In Germany, data related to travel time is obtained from toll operators.
- **Third-Party Toll Operator's data**: In Denmark, data from a toll operator is obtained (e.g., bridge operator between Sweden and Denmark).
- **Stay Time of HGV Foreign Visitors**: In Denmark, data related to the stay duration of heavy goods vehicles (HGV) is obtained for policy purposes.
- **HGV characteristics**: In Germany, data related to vehicle characteristics (Weight Class / Axles / Euro Emission Class) is obtained to tailor charges.
- **Vehicle Monitoring and Classification with LIDAR**: LIDAR technology along with loop detectors are used to classify vehicles in the UK.
- **Traffic flow data**: In Norway, Denmark, and Finland, traffic data is obtained using Internet of Things (IoT) devices or from toll operator's registers to analyze traffic patterns.
- **Vehicle registration data**: In the UK, vehicle registration data is obtained from vehicle licensing authority (e.g., DVLA)
- **HGV Data for Parking**: In Germany, HGV data from toll operators is used to optimize parking facilities and fees.
- **Public transport data**: In Finland, data related to the availability of public transport is obtained.
- **Tachograph violations**: In Germany, data related to tachograph rule violations is obtained.
- **EV association data**: In Norway, EV-related data are obtained from a third-party EV association.
- **Weather data:** In Denmark, the toll operator of the bridge between Denmark and Sweden also provides data related to weather.
- **GPS data**: HGV charging is supported by GPS data from an OBU rather than just roadside technology in many countries, including Bulgaria, Slovakia and Slovenia.

Quality of third-party dataset

The quality of third-party data plays a critical role in road user charging and toll systems. Reliable data ensures accurate billing, efficient operations, and fair treatment of users.

The method of data collection has an impact on its accuracy. In the UK, automatic number plate recognition (ANPR) is used mostly for toll collection.

Furthermore, the geographical coverage of third-party data can be a significant limitation, as highlighted by Denmark. Their experience suggests that third-party data often focuses on major roads and highways, leaving a significant portion of the smaller road network uncovered. This limited coverage can hinder the effectiveness of road user charging systems, particularly in regions with extensive rural areas where smaller roads play a crucial role in transportation.

Another key issue identified was the inconsistency of data provided by third-party providers. Since toll operators handle a small part of the road network, they might not have sufficient resources or competences for data collection although the toll business is highly data driven on revenue from vehicles. Thus, it sometimes leads to insufficient data, depending upon the use case, as pointed out by Norway. Also, the data collected by different third parties are different in terms of geographical coverage, type details and precision, which often differs from the priorities and requirements of NRAs, as pointed out by Denmark.

Challenges and barriers for NRAs in utilising third-party data for road user charging and tolls

NRAs face challenges and barriers when it comes to utilize third-party data from road user charging and tolling systems. These challenges can be broadly categorized into technical, legal, political, and commercial aspects.

One of the major hurdles is the **inconsistency of data definitions and standards**. Different third-party vendors may have varying interpretations of key data points, such as vehicle classification (e.g., what constitutes a "heavy goods vehicle"). This lack of standardization makes it difficult for NRAs to integrate data from multiple sources and ensure their accuracy for billing purposes. The issue is further compounded by different countries' policies and cost structures, leading to inconsistencies across borders.

Data privacy and security concerns like GDPR pose another significant challenge. NRAs must ensure compliance with these regulations while also collecting the necessary data for effective road user charging. This can be a complex balancing act, as highlighted by Denmark. There are concerns about collecting first and last mile data and also in the specific case of military and defence vehicles.

Several **political and commercial factors** also hinder the utilization of third-party data. In the UK, for instance, the concern lies with the fact that tolling revenue is not always collected by the NRA, creating a potential misalignment of interests. Additionally, competition among road operators can disincentivize data sharing, as they may be reluctant to give away valuable information to competitors. This is particularly relevant in Denmark, where municipalities and NRAs have different administrative levels for managing data.

Technical challenges further impede the efficient use of third-party data. The lack of standardized data formats across different providers makes integrating and utilising the data effectively difficult. Additionally, security concerns surrounding cross-border data exchange can create additional hurdles. Denmark specifically highlighted the growing volume of data as a challenge, requiring NRAs to invest in robust data handling capabilities.

The large volume and complexity of data generated by modern On-Board Units (OBUs) can overwhelm NRAs. Extracting meaningful insights from this raw data requires significant expertise and resources. Furthermore, the rise of electric vehicles (EVs) disrupts traditional fuel tax-based systems, necessitating alternative data sources to ensure fair charging for all users.

In conclusion, NRAs face significant challenges in utilising third-party data from road user charging and tolling systems. Addressing these technical, legal, political, and commercial challenges is crucial for establishing a fair, efficient, and future-proof system for road user charging.

4.2 From a third-party data provider's perspective

Various third-party data providers were interviewed (or sent out a questionnaire) to gain an understanding of their perspective regarding the use of third-party data by the NRAs. This section provides an overview of the current state of data, services, and collaboration by the third-party data providers. Research on currently provided data and the future plan for providing data.

Valerann (UK, Israel, Spain and US)

Valerann, headquartered in Israel, whose platform *Lanternn*[9] combines cutting-edge data fusion, AI, and machine learning to enhance road safety, optimize traffic management, and improve overall road network efficiency.

Their platform leverages data from multiple sources and refines it into insights for the specific use cases of the NRAs. They offer solutions for NRAs with different maturity levels, ranging from integration into the traffic management system of NRAs to provide insights via their platform for road operators with limited IT capabilities. Their solution is cloud-based and capable of providing real-time data.

Lanternn claims to offer a real-time view of road networks for safety management during roadworks and on roads, assessment and prevention of risks and dangerous behaviour, traffic control at large-scale events, operations KPI monitoring and traffic management, road operations resource planning, and reduction of congestion and CO_2 emissions.

Key features include event and incident alerts, traffic flow monitoring (speed, count, density), real-time weather updates, road context insights (topology, infrastructure), live CCTV feed integration, resource tracking (e.g., patrol locations via GPS), and accident risk profiling and prediction.

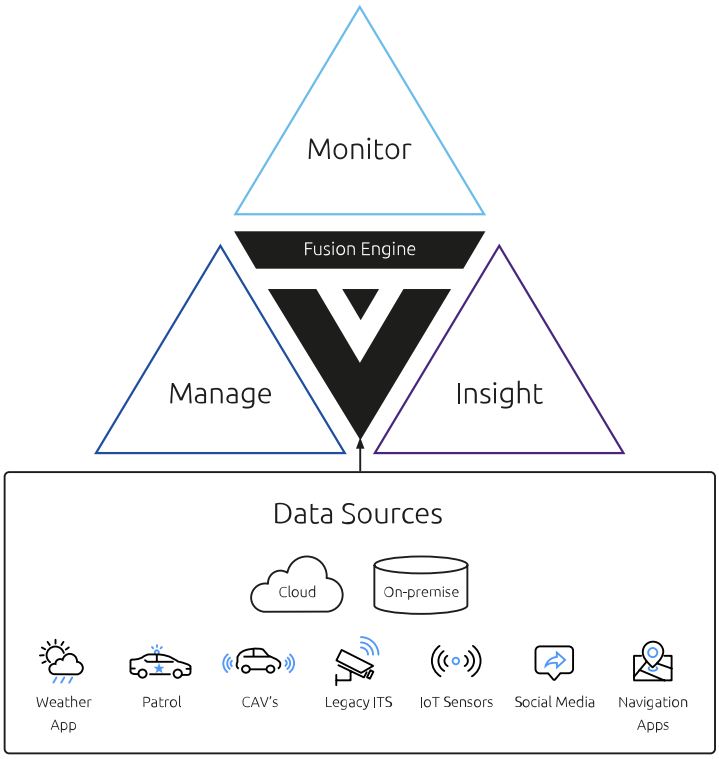

Figure 2: Valerann's fusion engine

Insights generated by the Fusion Engine (Figure 2) include road/network status and condition, journey times and route closures, infrastructure health and active work zones, accident hazards detection (e.g., stopped vehicles, wrong-way driving), traffic anomalies and adverse weather forecasts, risk profiling, and historical accident modelling, enabling traffic management actions with automatic incident response workflows.

[9] https://www.valerann.com/

GEWI (DE)

GEWI provide a solution called the GEWI platform[10] which is a comprehensive solution designed to meet the needs of public authorities, particularly those involved in managing transportation and traffic-related services. The GEWI platform serves as a tool for public authorities such as road operators, police etc., allowing them to access integrated data, collaborate effectively, and manage traffic-related services efficiently.

Some of the key aspects of this platform are:

1. Data Integration and Harmonization:
    - The GEWI platform acts as a central hub for collecting, harmonizing, and integrating data from various sources. It aggregates information from different organizations, ensuring seamless collaboration and efficient data sharing.
    - Specifically, the platform incorporates data from other organizations, such as traffic management centres, road agencies, and other relevant stakeholders.
2. Usage by Police and Other Authorities:
    - Public authorities, including law enforcement agencies like the police, rely on the GEWI platform for their day-to-day operations.
    - The platform provides tools and features that enable authorities to monitor traffic, manage incidents, and respond effectively to emergencies.
3. Real-Time Traffic Information:
    - One of the features of the GEWI platform is its integration with real-time traffic data sources.
    - For instance, it collaborates with TomTom, a leading provider of navigation and mapping services, to offer up-to-date traffic information. This includes details on congestion, accidents, road closures, and alternative routes.
    - By leveraging real-time data, public authorities can make informed decisions, optimize traffic flow, and enhance overall safety.

AISIN mobility (BE, UK, IRL, FR, & NL)

AISIN mobility, headquartered in Belgium, manufactures a range of in-vehicle safety technologies, including stability control, steering systems, and advanced driver assistance systems. AISIN mobility has a dedicated business for the road maintenance sector known as “RoadTrace”[11]. At Road Trace, they identify high-risk areas on roads before crashes occur, using advanced monitoring of harsh braking incidents and analyzing real-world driving behaviour data from connected vehicles.

Their services associated with RoadTrace are:

1. **Safety Insights:** Safety Insights automatically identifies high-risk areas on the road network where the probability of a KSI (killed or seriously injured) incident is highest. They provide connected vehicle and other contextual data to help clients better understand what is happening on roads, enabling them to make informed decisions.

[10] https://gewi.com/
[11] https://www.roadtrace.eu/

This service allows road operators to act proactively before collisions occur and to make better decisions using analysed data insights from vehicles driving on roads to identify the most effective investments.

2. **Mobility Analysis:** This service helps in understanding how all types of road users travel on the road network. By combining geolocated information from all types of road users, they deliver a measurement of relative traffic flow and speed profiles across the entire network, at any time, in all conditions, for each type of vehicle (HGV, LCV, cars).

It is to be noted that Road Trace do not provide or resell data, rather they focus on providing actionable insights from the data from connected vehicles for road operators. These insights can be used for prioritising road safety, asset management and maintenance schemes. They are collaborating with NRA's and governments to develop deeper insights and maximize outcomes from connected vehicle data.

HAAS Alert (UK/US) [12]

HAASAlert is an automotive technology company that provides a digital alerting system for connected vehicles on the roadway. Their goal is to improve road safety by giving drivers more time to react to potential dangers.

An overview of HAASAlert's key services and technologies:

1. **SafetyCloud®:** SafetyCloud is HAASAlert's connected vehicle platform. It plays a crucial role in making roads safer by sending real-time digital alerts to drivers via vehicle dashboards and infotainment systems, navigation applications, and smartphones to aid drivers earlier in making safer, smarter driving decisions. These alerts come from various sources, including emergency responders, work zones, school buses, roadway infrastructure, and other active hazards.

   These alerts inform drivers and roadway workers about nearby and upcoming hazards and incidents up to 30 seconds in advance. By providing real-time information, SafetyCloud digital alerts prevent collisions with approaching drivers by getting their attention earlier and more effectively.

2. **R2V® Service (Responder-to-Vehicle):** R2V is HAASAlert's SafetyCloud digital alerting solution designed for public safety agencies, roadway workers, and other fleets. It can be installed on any alerting vehicle, allowing it to deliver digital alerts to nearby drivers. This proactive approach enhances overall road safety.

3. **R2R® Service (Responder-to-Responder):** R2R is another SafetyCloud digital alerting solution. It enables public safety fleets to communicate with each other while actively responding on the road. By sharing critical information, responders can coordinate effectively and improve safety outcomes.

Some of the key points about HAAS Alert's services are:

- They use various data sources, including emergency vehicle location, wildlife migration patterns, and road closure schedules.
- They work with car manufacturers and road authorities to implement their system.
- Their service is free to use for NRAs and road users.
- They use existing data sources to generate alerts, rather than requiring new infrastructure.

[12] https://www.haasalert.com/gb

- Aims to create a comprehensive data network for road safety through partnerships.

Bridgestone mobility solutions (NL)[13]

Bridgestone Mobility Solutions is part of Bridgestone which is headquartered in Tokyo specializing in comprehensive solutions for urban development and transportation challenges. They specialises in obtaining actionable insights from vehicle performance, driving behaviour, traffic dynamics, road conditions, and weather data using machine learning and AI.

They collect data from sensors embedded in cars to understand driving behaviour and road conditions. This data can be used to improve road safety. For instance, they can identify harsh braking, cornering, or acceleration instances. They can also monitor weather conditions and road quality. On the other hand, Bridgestone can provide anonymized data on vehicle usage patterns, origin-destination information without revealing specific routes, and data from vehicle dashboards like temperature readings.

The company is specialized in vehicle GPS fleet tracking, safety camera solutions, driver safety, and vehicle diagnostics and empower fleet managers and drivers to make informed decisions on vehicle maintenance, cost-savings, and safety.

Leveraging real time data sources including Floating Car Data (FCD), Hazardous Driving Events, Extended Floating Car Data, Origin Destination Data, Standstill Data, ICE Vehicle Profiles, Electric Vehicle Profiles, and EV Charging Events, the company delivers comprehensive insights for data-driven decision-making.

Visualizations of use cases, such as 24-hour FCD trace coverage in cities like London and Berlin, and CO2 emissions mapping in Amsterdam, offer actionable intelligence for effective urban planning and transportation management.

INRIX (UK/US/DE)14

INRIX offers a suite of cloud-based applications tailored to enhance mobility management, successfully contributing to the management of traffic, parking, safety on the roads and a trip trends. INRIX provides both data as a service and software as a service solution and it provides into a number of different verticals, the automotive sector, the public sector and also enterprise, which is everything that isn't automotive and public sector. INRIX is a private sector business, it wants to help the public sector authorities deliver those outcomes in a way where they can leverage products and services.

INRIX offers a diverse range of products and services which includes Roadway analytics, traffic management, driving time, speed and volumes, signal analytics, location analytics, safety monitoring and safety alerts.

Michelin (FR)15

Michelin is a French company that focuses on analyzing and targeting key risky areas on roads. They help road authorities to understand the road user behaviour. By leveraging near-miss data, it identifies potential danger zones and allows to understand existing accident-prone

[13] https://www.bebridgestone.com/our-businesses/bridgestone-mobility-solutions/
[14] https://inrix.com/
[15] https://mobilityintelligence.michelin.com/en/

areas. Additionally, Michelin provides insights to assess impact through before-and-after analysis and enabling data-driven decision-making. For example, insights can show how drivers and vulnerable road users react to changes in road geometry, infrastructure, signage & weather, not just focussing on what changes can be made but also highlighting which measures are working.

Some of the services that Michelin provides are:

1. **Road Departure Analysis:** Michelin examines incidents related to vehicles leaving the roadway. This analysis helps identify areas where road design or conditions contribute to such occurrences.
2. **Driving Events Detection:** The company monitors driving events, such as sudden braking, acceleration, or swerving. Detecting these events can highlight risky driving behaviour and inform safety measures.
3. **Safety Diagnosis at Any Point of Interest (POI):** Michelin assesses safety conditions at specific locations, including intersections, pedestrian crossings, and other critical points. Understanding safety risks at POIs is crucial for effective road management.
4. **Wrong-Way Driving Detection:** Identifying instances of wrong-way driving is essential for preventing head-on collisions. Michelin's data helps identify zones where drivers are "confused" , identifying potential entry points from wrong-way driving, that can be addressed by road authorities. For example, how many drivers "almost" went the wrong way and made a corrective maneuver.
5. **Before/After Traffic Flows and Speed Analysis:** By comparing traffic flow and speed data before and after specific interventions (such as road improvements or signage changes), Michelin evaluates the effectiveness of safety measures.
6. **Vulnerable Road User (VRU) Safety Analysis:** Michelin considers the safety of pedestrians, cyclists, and other vulnerable road users. VRU safety analysis is a Machine learning model which leverages AI to understand the correlation between: historical crashes, road geometry, road infrastructure, points of interest, driving behaviors (speed + events), vehicle volumes, and VRU travel patterns. Such analysis based on various factors could provide a level of risk across a network for different classes of road-users.

Compass IOT (AUS)[16]

Compass IoT is an Australian company owning a data-driven platform used by transport authorities. It collects data from private vehicles (via SIM cards) and public data providers at a frequency rate of about 10 seconds. They are a re-seller of data solutions and also provides a self-service platform allowing end users to understand speeds, g-forces on roads in USA, Australia and the UK. Their platform employs advanced algorithms to predict near misses, origin-destination patterns, travel time, and road conditions. It has access to a large pool of anonymous data sources, providing a robust representation of road networks.

Compass IoT works on a variety of domains including driver behaviour, freight logistics, origin-destination for commercial trips, asset management, road safety, and EV charging. Their datasets help in improving road safety, transport and infrastructure.

[16] https://www.compassiot.com.au/

TomTom (NL)[17]

TomTom is a map and navigation service provider based in the Netherlands. They provide various data and services related to traffic management, asset management, and road safety. They offer comprehensive insights on traffic analysis, origin-destination, travel time, risk hotspots, incidents, etc. They also offer floating car data (FCD) from their systems installed in many vehicles on roads.

On the road safety side, TomTom provides safety-related traffic information (SRTI) data collected via their AmiGO application. This data is available for free.

On the other hand, TomTom provides following data related to CITS:

- Real-time traffic feed with information about Hazards, Roadworks, Road Closures, Jam Tail Warnings and other categories.
- Historical traffic information with speed information (average, median and percentiles).

Regarding the datasets requested by NRAs, TomTom mentioned that both real-time traffic data and historical data sets are often used by NRA's. For example, National data warehouse (NDW) in the Netherlands only uses historical datasets, while the German Autobahn GmbH uses both real-time and historical data.

Regarding data collection, TomTom collects GPS data from their own systems and software, but sources additional information (like contextual information around real-time data and sensor vehicle form vehicles) from other sensors. For example, in the Netherlands:

- They collect GPS probe data from their own software and systems
- They source contextual information from NDW, ANWB, Heijmans and Tripservice
- They source sensor data from OEM's

Their real-time data is updated every 30 seconds, whereas historical data is available after 48 hours.

[17] https://www.tomtom.com/

5 Desired state of third-party data usage

This section aims to shed light on the desired state of third-party data usage, both from the perspective of NRAs as well as third-party data providers.

5.1 From NRA's perspective

During the workshop, the NRAs discussed desired/future use cases to improve their services using third-party data within each ecosystem using the structure as in Appendix A. This provided an opportunity to understand which use cases are interesting to them and what data they need to accomplish their desired objectives.

5.1.1 Cooperative Intelligent Transport Systems (C-ITS)

Within the ecosystem of C-ITS, various desired use cases were identified and discussed with the NRAs. For each of the use case, emphasis was placed on what third-party data would be required to achieve the desired outcome. The key findings and insights gained from the discussion with NRAs for the selected use cases are presented in the tables below.

C-ITS: Use case 1	
Using in-vehicle information for Traffic, Incident, and Asset management	
Objective	Using the in-vehicle information to improve incident management (NL) Accurately advise end of traffic/incident queues to drivers (UK)
Desired outcome	Information on road conditions and possible incidents
Required third-party data	• High quality Floating car/vehicle data (FCD/FVD) (BE, NL) • In-vehicle data like hard braking, rain, etc. (NL, FI) • Road operator fleet data (DE) • Missing/incorrect traffic signs (DE) • Road operator fleet data (DE) • End of queue alerts and detection (UK) • Location, Direction, Speed, and Density of vehicles (UK)
Data requirements	• Accurate and precise data of single vehicles (not constrained by GDPR) (BE) • Full geographical coverage in high-use areas (BE) • Update frequency – Daily or real-time (depending on use case) (BE) • Based on the use case, detailed data might need to be aggregated (BE)
Challenges	The interpretation about what is personal information is not clear. This interpretation differs within different countries, even with EU laws. This leads to difficulty in GDPR compliance. (BE)

C-ITS: Use case 2	
Early detection of incidents	
Objective	Early detection of incidents by combining data from different sources like vehicle braking, FCD, apps like WAZE/Flitsmeister etc, tow trucks, ANWB
Desired outcome	Probability, start and end time, and location of an incident
Required third-party data	• Floating car/vehicle data (NL) • Broken vehicle information (NL) • Data from navigation apps like Waze, Flitsmeister, etc. • In-vehicle data (e.g., hard braking) • Stopped vehicle on emergency lane (NL)
Data requirements	• High accuracy of the location • Real-time and accurate notification at the start of an incident • Reliable prediction about end of disruption

C-ITS: Use case 3	
Traffic light priority in signalised intersections (SI-TLP)	
Objective	Providing priority to specific road users: emergency vehicles, public transport, vehicle fleet, and vulnerable road users
Desired outcome	Accurate and reliable vehicle data (especially from emergency vehicles) that improve this service on safety and efficiency
Required third-party data	• Vehicle data from OEMs • Navigation data • Fleet management data • Emergency vehicle data from emergency services: Ambulance, police, fire brigade
Data requirements	• Data privacy and anonymity (NL) • Accuracy, real-time, and low latency data (NL) • High level of data details (NL) • Timeliness of data, position accuracy, and reliability
How will the data be used?	Utilizing the locations, speeds, directions, and strategic route change information of vehicles to prepare Traffic Light Controller (TLC) to optimize traffic lights based on predictions, and to provide TLC priority services.

C-ITS: Use case 4	
Parking of Trucks	
Objective	Informing trucks where parking spots are available and let them reserve a spot
Desired outcome	Avoiding trucks parked on the emergency lanes
Required third-party data	Number of free parking spots and location (NL)

C-ITS: Use case 5	
Warning for slow-moving or stopped service vehicles (BE)	
Objective	To warn slow or stopped service vehicles performing dynamic road works, service inspection, snow removal etc. of upcoming
Desired outcome	Reduction in incidents or unsafe situations for service vehicles
Required third-party data	• Wrong way driver warnings data from Bosch • GPS location data from vehicles (from trackers or On-Board units)
Data requirements	• Penetration rate - 95%+ of vehicles • Geo coverage - 100% of high-speed roads (highways & secondary roads) • Uptime - 95%+ • Frequency - Dynamic and realtime • Level of detail - High

To further improve the C-ITS services, NRAs mentioned that dynamic environmental data which represents the real world would be beneficial. This includes data related to traffic flow, incidents ranging from minor to severe, vehicle occupancy data, vulnerable road user data, etc. In addition, data from other services such as public transport, electric vehicle, shared mobility, navigation data etc. would also be potentially useful to improve the C-ITS services.

From the mentioned use cases, it is evident that NRAs desire to leverage more detailed data from the vehicles such as Floating car/vehicle data or in-vehicle information to improve the incident, traffic and asset management. In addition, integration of data from various services like public transport, electric vehicles, shared mobility, and navigation data can further enhance the effectiveness of C-ITS services.

In terms of requirements, data from third-party providers needs to be accurate, precise, and often real-time to be useful. The data is further deemed useful when it has high geographical coverage with high level of detail and quality. However, issues such as data privacy and compliance with GDPR remain top priorities within the NRAs, which emphasize the need for clear regulations and robust data management strategies.

5.1.2 Road Safety

NRAs can harness the use of third-party data as a key strategy to improve the road safety. Several use cases which are desired to improve the road safety were shared by the NRAs. The detailed information related to the use cases are discussed in the tables below.

Road safety: Use case 1	
Winter management	
Objective	Improve driving safety due to adverse weather conditions
Desired outcome	• More targeted responses or preventative measures e.g. salting or lowering speeds (IRL) • Timely safety messages (road warnings, slipperiness, friction, traffic information) to road users (SE) • Improved winter maintenance planning • Low investment in roadside units
Required third-party data	• Friction of road surface (SE, FI, IRL) • Slipperiness warning from in-vehicle system (FI) • Visibility (SE, FI) • Weather forecasts (SE, FI, UK) • Local weather conditions (IRL) • Road user reports (e.g., Waze data) (UK) • Data for Road Safety (DfRS) datasets (SE, UK) • Camera information from vehicles (FI) • Freight On-Board units data (e.g., from Microlise) (UK) • Data from sensors places on roadside (e.g., Smart Studs) • Aggregated and quality assured data combined from many brands (SE)
How the data will be used?	• Traffic risk estimation (FI) • Improve STATS 19 data, reduce accidents and congestion (UK) • To agree on requirements, definitions and algorithms to use (SE)
Data requirements	• Depends on use case (SE) • Geographical coverage: all major roads, highways (where dynamic traffic signs are available) (SE, UK, IRL) • High accuracy and reliability (UK) • Should have a data quality indicator • Privacy: Should be GDPR compliance (no personal data) • Compatibility: Should be able to integrate with existing data management systems • Notification of data outages or no data outages • Identification of severity (to determine whether to provide advisory or warning) • Must have a validated demonstration

Road safety: Use case 2	
Improved Incident Management with decreased response-times (SE)	
Objective	Improve incident management, provide decision support and planning for improvements in the current infrastructure
Required third-party data	• Travel times/speed data • Origin-Destination data • Route choice • Tail of congestion (location) • Road conditions • Visibility on road • Road surface friction • Accidents • Wrong-way-driver • eCall data • Hazard lights status on vehicles • Large animals on road • Road works area
How the data will be used?	• Getting a real-time picture of the traffic situation • Planning for improvement of the road infrastructure
Data requirements	• Agreed terminology • Agreed coverage, penetration and quality for the purpose of usage • Update frequency: Dynamic/real-time • Level of detail: Aggregated from many vehicles/sources • Type: Analysed information (not raw data) • Data format: Agreed format with third-party data provider

Road safety: Use case 3	
Fast incident detection (BE)	
Objective	Faster incident detection through OEM/service provider data in order to protect and resolve the incident faster
Desired outcome	Faster incident management on highways
Required third-party data	Incident detection data from the sensors of vehicles (from OEMs or service providers) – including location and time
Data requirements	• Real time • Low False alarm rate • High geographical precision • Frequency: Dynamic / real-time • Level of detail – Detailed • Standard – DATEXII • Transfer method - API

Traffic safety is one of the key priorities within NRAs, and they strive to focus on using third-party data for preventative measures such as winter management and faster response times to incidents. The use cases discussed all highlight the importance of real-time traffic data for improving winter maintenance, incident management, and overall road safety. The NRAs desire to utilize in-vehicle data as it holds tremendous potential for more detailed real-time monitoring of traffic conditions. In addition, environmental data related to friction on the road, visibility, weather, road conditions etc. can help in taking precautionary measures to avoid any incidents on the road.

Data requirements for mentioned use cases are extensive and vary depending on the specific use case. However, some common themes emerge across the scenarios discussed.

Firstly, there is a strong emphasis on data quality. The data needs to be accurate, reliable, and have a high level of detail. This is especially crucial for safety-critical applications like winter management, where precise information on road conditions like friction and visibility is paramount. Data sources should also be GDPR compliant, meaning they cannot contain personally identifiable information.

Secondly, real-time or near real-time data is essential for most use cases. Traffic situations are constantly evolving, so traffic management systems need to be able to react quickly to changes. This necessitates data with high update frequency and low latency.

Finally, compatibility and interoperability are key. Traffic management systems often integrate data from various sources, so the data needs to be provided in a standardized format that can be easily integrated with existing systems. Additionally, clear agreements on terminology and data definitions are crucial to ensure everyone involved is on the same page.

5.1.3 Road user charging and tolls

The discussion explored the emerging landscape of road user charging and tolls, focusing on the transformative potential of artificial intelligence (AI) to revolutionize tolling operations while navigating the evolving challenges posed by the rise of electric vehicles (EVs) and data privacy concerns.

Road user charging and tolls: Use case 1	
AI based Tolling	
Objective	To improve the tolling operations and customer service by a fair, efficient, and future-proof system for road user charging.
Desired outcome	• Reduce costs of data collection in comparison to investment in roadside sensors • Increased uptime and improved performance • Improved safety • Encourage more electric vehicles • Improve customer satisfaction
Required third-party data	• On-Board unit's data • Information related to exemptions • Weather data • First and last mile data • Vehicle performance data to determine vehicle load, road wear, journey type, etc. • Public transport data

	• Images from CCTV in cars • Special events information
How the data will be used?	• Maximise intelligence about network and users • AI tools
Challenges	The privacy limitations due to GDPR and security limits by police and defence sectors, would be a problem for data access.

In addition to the above use case, several other challenges were mentioned that need to be addressed. The traditional fuel tax is much easier to collect by the NRAs, however, with the increasing numbers of EVs, the revenues are declining, and NRAs need to find a new solution for EVs.

The design of vehicle charging system for all vehicles (similar to a truck charging system) would enable road authorities to determine when and where a vehicle has driven. For example, if it drives on the most congested parts of the road network in certain periods of time, then it might receive a higher price in comparison to when it drive in the off peak hours. In this case, however, NRAs need a management based on dynamic status. The problem for NRAs would be to handle all the data and dynamic decisions regarding the different situations, while ensuring data privacy and an NRA might not be in charge of toll collection.

In future, road charging for all vehicles based on distance travelled (although it exists for trucks) is a possible solution, but it requires complex data management and raises privacy and acceptability concerns. As more quality data is collected on vehicles, authorities will have new opportunities to set fees and policies.

5.2 From a third-party data provider's perspective

Third-party data providers express a strong desire for a more collaborative and informed relationship with NRAs. Some of the key points for NRAs related to their desire mentioned by many third-party data providers are as follows:

- **Embrace a mindset change**: NRAs should move away from a perception of data ownership towards a model of data collaboration and sharing. This shift would encourage greater integration of third-party data into NRA operations.
- **Enhance data literacy**: Data providers urge NRAs to prioritize education and training on data utilization, ensuring a thorough understanding of data potential and analytical capabilities. This would enable them to make more informed decisions about data procurement and utilization.
- **Outcome-oriented approach**: NRAs should focus on achieving desired outcomes, such as improved safety and traffic management, rather than replicating existing processes with third-party data. This outcome-oriented approach would facilitate innovation and encourage the adoption of new technologies.
- **Promote inter-NRA collaboration**: NRAs should foster collaboration among themselves and with local authorities to ensure consistent data coverage across all roads, regardless of ownership. This would lead to a more seamless and comprehensive data landscape.
- **Streamline data access**: NRAs should facilitate faster and easier access to their data for third-party providers. This includes reducing bureaucratic hurdles and ensuring data is available in a timely manner.
- **Consider alternative infrastructure models**: NRAs should be open to exploring alternative infrastructure models, such as cloud-based platforms and Software-as-a-

Service (SaaS) solutions. This would allow them to leverage third-party expertise and technology without significant upfront investment.

- **Participate in reciprocal data sharing**: NRAs should actively participate in reciprocal data sharing with third-party providers and other NRAs. This would create a richer data ecosystem, benefiting all stakeholders.
- **Prioritize quality and relevance**: NRAs should focus on procuring high-quality data that is relevant to their specific use cases rather than simply accumulating large volumes of data. This would ensure that data is used effectively and efficiently.
- **Clear Communication and Collaboration:** Data providers call for enhanced communication channels with NRAs, allowing for a seamless exchange of feedback and requirements. This would facilitate the development of customized data solutions that precisely address NRA's needs.
- **Robust Data Quality Assurance:** Providers advocate for a collaborative approach to data quality control, with NRAs actively participating in validation processes. They emphasize the need for NRAs to trust the quality of third-party data, avoiding redundant efforts to recreate existing data sets.
- **Fair and Transparent Marketplace:** Data providers envision a data marketplace that caters to diverse NRA needs, offering a wide range of data products and services. They emphasize the importance of flexible licensing models that allow for data sharing and collaboration among public sector entities.

By addressing these desires, third-party data providers believe they can establish a more productive and mutually beneficial relationship with NRAs, ultimately leading to improved road safety, traffic management, and infrastructure development.

6 Gap analysis

NRAs have a strong interest in utilizing data from third-party providers. This interest stems from the potential cost savings, expanded data sources, and collaborative opportunities. However, to facilitate effective data exchange, it is essential to address existing gaps between NRA requirements and what third-party data providers can offer. In this section, we explore the current situation, highlight gaps identified during the analysis phase of PRESORT, and discuss ways to enhance the current state. The identified gaps are categorised based on three aspects: Desirability, Technical fit and business viability.

6.1 Desirability aspect

The desirability aspect delves into the core motivations and expectations driving NRAs and third-party data providers in their data interactions. It explores the alignment, or lack thereof, between their visions for data utilization, desired levels of detail, and the speed and ease of data access. The inputs from the workshop, interviews and questionnaires were analyzed to identify gaps in the desirability of NRAs and third-party data providers. The identified gaps are as follows:

1. **Data storage and utilisation**

   A significant mismatch exists between the data practices of NRAs and third-party data providers. This is because NRAs have traditionally accumulated large volumes of data eg from loops, perhaps without fully utilizing its potential due to a lack of understanding or resources. Meanwhile, third-party data providers, such as Valerann and HAAS Alert, are developing innovative solutions that may render some of this raw data collection unnecessary by going straight to the insights, the data reveals. This disconnect stems from differing data visions, values assigned to specific datasets, and varying expectations of data quality.

   Context: NRAs traditionally prioritize data ownership and control, viewing it as an asset to be amassed. However, this approach can lead to underutilization and missed opportunities. Third-party data providers, on the other hand, focus on extracting actionable insights from data, often through real-time analysis and tailored solutions. For example, an NRA might collect extensive traffic data but lack the expertise to analyse it for patterns that could inform infrastructure improvements. A third-party data provider, using advanced algorithms and machine learning, could quickly identify these patterns and provide recommendations to the NRA.

   NRAs and third-party data providers can try to develop better mutual understanding based on data vision, identifying the value of specific datasets, and how that is related to data quality levels.

2. **Desired Level of detail in data**

   A gap exists between the desire of NRAs for individual vehicle-level data and the privacy limitations imposed by the GDPR on third-party data providers. NRAs seek granular and real-time data to understand traffic patterns, optimize infrastructure, and enhance safety, while third-party data providers must adhere to strict regulations that protect individuals' privacy.

Context: NRAs often require (as they are used to it from traditional sensors like loops) detailed information about individual vehicles, such as speed, location, and travel patterns, to inform decision-making. However, GDPR prohibits third-party data providers from collecting or processing personal data without explicit consent, making it difficult to provide the level of detail that NRAs desire. For instance, an NRA might want to analyse the driving behaviour of specific vehicles to identify high-risk drivers or areas prone to accidents. However, a third-party data provider may only be able to provide aggregated, anonymized data that obscures individual identities, limiting the NRA's ability to take targeted action.

NRAs and third-party data providers could collaborate and invest in advanced data anonymisation techniques to enable granular data sharing while maintaining privacy.

3. **Quick access to data by third-party data providers**

A gap exists between the technical feasibility of rapid data access and the actual time it takes for third-party data providers to obtain data NRAs. This delay is primarily attributed to bureaucratic hurdles, including restrictive legal standards, multiple layers of stakeholders, and complex approval processes. While data sharing can be achieved within minutes technically, it often takes weeks in reality due to institutional inefficiencies.

Context and Example: many third-party data providers, such as HAAS Alert, Valerann, and Bridgestone mobility, require timely access to road-related data to develop and deliver innovative solutions for road safety, traffic management, and infrastructure optimization. However, they face significant obstacles in obtaining data due to the slow and cumbersome bureaucratic processes of NRAs.

Establishing a clear and efficient data governance framework along with standardised data-sharing agreements can minimise bureaucratic delays. Furthermore, third-party data providers can engage with NRAs in the early stages of the project to discuss data requirements and sharing.

4. **Data independence**

Third-party data providers desire to maintain data resilience, accuracy, and independence. While NRAs are a primary source of road-related data, third-party data providers like INRIX recognize the importance of diversifying their data sources to ensure reliability, comprehensiveness, and the ability to address gaps or inconsistencies in the data.

Context: Third-party data providers often utilize data from various sources, including NRAs, to develop innovative solutions for traffic management, navigation, and road safety. However, relying solely on NRA data can be limited due to potential inaccuracies, gaps in coverage, or delays in data availability.

Prioritisation of data quality, timeliness, and accuracy could ensure that third-party data providers can rely on the data provided. Furthermore, the need for good standards for data exchange becomes crucial in this context.

5. **Open data sharing and commercial interests**

A tension exists between the desire of NRAs to share purchased data as open data and the commercial interests of third-party data providers who rely on data licensing

for revenue generation. NRAs often seek to maximize the public benefit of data by making it freely available, while third-party data providers need to protect their investments in data collection and processing.

Context: Third-party data providers like TomTom invest significant resources in collecting, processing, and analysing road-related data, which they then license to various customers, including NRAs. However, when NRAs share this licensed data openly, it can undermine the third-party data provider's business models, as potential customers may access the data for free, reducing the demand for their services. For example, an NRA might purchase traffic data from a third-party data provider and then might want to make it available as open data for use by app developers, researchers, or other organizations. This open access could diminish the value of the data for the third-party data provider, who might have otherwise licensed it to these same entities.

It is possible to explore hybrid models that allow for both open data access and commercial use, potentially through tiered licensing structures or revenue-sharing agreements with third-party data providers.

6. Cross-border data

A significant gap exists between the local responsibilities and restrictions of NRAs and the need for third-party data providers to access cross-border data for certain use cases, such as FCD/FVD, trip tracking, toll registration, and origin-destination analysis. This disconnect hinders the development of seamless cross-border services and limits the potential for data-driven innovation in the road sector.

Context: NRAs operate within specific national borders and are bound by local regulations and policies. However, many road-related activities, such as freight transport and long-distance travel, inherently cross borders. Third-party data providers require access to cross-border data to provide accurate and comprehensive services, but this can be challenging due to varying regulations, restrictions by data protection authority (DPA), lack of standardisation, and privacy concerns across different countries. For instance, a third-party data provider developing a cross-border tolling system would need access to toll transaction data from multiple countries to accurately calculate tolls and ensure seamless payment processing as well as the vehicle as it travels. The European Electronic Toll Service (EETS) offers interoperability of toll systems in EU and standardised data. However, obtaining this data from non-EU countries (e.g., UK) can be complex due to differing privacy regulations, data collection methods, and technical infrastructure across borders.

Initiating collaborative efforts with neighbouring countries to establish cross-border data-sharing agreements and frameworks can help fill this gap.

7. Data availability to NRAs

A gap exists between the expectations of NRAs and third-party data providers regarding the speed and efficiency of data availability. While third-party data providers consider connectivity and data processing time as standard aspects of their core business, NRAs still perceive challenges in accessing data quickly and efficiently, impacting real-time decision-making and response capabilities.

Context: Third-party data providers, such as Valerann, specialize in collecting, processing, and delivering data in real-time. They have established robust

infrastructure and processes to ensure seamless data flow and quick response times. However, NRAs might not have the same level of technical infrastructure or expertise, leading to delays in accessing and utilizing data. For example, a third-party data provider might provide real-time traffic data to an NRA through an API. However, the NRA's systems might not be equipped to handle the data stream efficiently, leading to delays in displaying the information on traffic management dashboards or informing decision-making processes.

Investments in modernizing technical infrastructure to support real-time data processing and integration, as well as developing or acquiring technical expertise, could resolve this issue. There are great differences between mature and less mature NRAs in this respect.

8. **High coverage**

A gap exists in achieving complete data coverage and alignment between the data collected by third-party data providers and the specific needs of NRAs. While NRAs desire comprehensive coverage across their entire road network, third-party data providers often prioritize areas with higher population density or commercial value, leading to potential gaps in less developed regions. Additionally, the type, detail, and precision of data collected by third-party data providers may not always align with the priorities and limitations of NRAs.

Context: NRAs require data on all road assets within their jurisdiction, regardless of location or traffic volume. These data are essential for planning, maintenance, and safety initiatives. However, third-party data providers might focus their data collection efforts on areas with higher traffic density or commercial potential, as these areas offer greater opportunities for monetization through services like traffic information or navigation apps.

For example, a third-party data provider might collect detailed traffic data in major urban centres but have limited coverage in rural areas. This could leave NRAs in those rural areas with insufficient data to effectively manage their road networks, potentially leading to safety hazards or inefficient maintenance practices.

NRAs could consider collaborating with third-party data providers to expand data coverage in underserved areas, exploring potential incentives or partnerships to incentivize data collection in less populated regions.

In conclusion, the identified gaps between NRAs and third-party data providers underscore the need for collaborative approaches, standardized practices, and technological advancements to bridge these divides. Addressing these disparities is crucial to unlock the full potential of road-related data, fostering a data-driven ecosystem that benefits both public and private stakeholders while ensuring privacy, data resilience, and accessibility.

6.2 Technical fit aspect

In addition to desirability, technical fit plays a crucial role in ensuring successful collaborations between NRAs and 3rd party data providers. Technical fit focuses on the processes of data generation, storage, and transfer. In this section, we explored the gaps in the technical fit aspect based on the inputs from questionnaires, interviews and workshops. The identified gaps are as follows:

1. **Lack of Data Integration and Expertise**

   There is a significant gap between the data integration and utilization capabilities of NRAs and third-party data providers. While some third-party data providers excel at integrating data from various sources to provide valuable insights for use cases like road safety, many NRAs lack the resources, expertise, or infrastructure to effectively utilize and integrate such data. NRAs also recognize the need to focus on information management, as their in-house systems struggle with handling data formats provided by third Party Data Providers This creates a missed opportunity to maximize the potential of available data for improving road safety outcomes. To address the issues arising from incompatible data models, the European Commission has limited the allowed data models to e.g. DATEX II in the Delegated Regulations.

   Context: NRAs often collect valuable data related to road infrastructure, accidents, traffic patterns, and other relevant factors. However, these data may be incomplete or difficult to analyse due to limitations in data management and analysis capabilities. In contrast, third-party data providers such as AISIN and Valerann have developed sophisticated systems for integrating and analysing data from multiple sources, including NRA data, to generate actionable insights. This disparity hinders NRAs' ability to leverage the full potential of data-driven decision-making for road safety initiatives.

   NRAs can invest in creating a data vision and educating staff in digitization to understand the potential value of expertise, in order to adopt it. On the other hand, third-party data providers can help NRAs equip the necessary skills and knowledge to effectively utilize data-driven insights.

2. **Lack of shared understanding and definitions**

   A significant gap exists in communication and collaboration between NRAs and third-party data providers due to a lack of shared understanding of fundamental data concepts. This leads to differing definitions of data quality, ownership, value, processing methods, trust levels, and granularity. This lack of alignment hinders effective collaboration and the realization of the full potential of data-driven solutions in the road sector.

   Context: NRAs and third-party data providers often approach data from different perspectives, leading to mismatched expectations and misunderstandings. NRAs might prioritize data ownership and control, while third-party data providers might focus on data innovation and commercialization. This divergence can create challenges in establishing trust, negotiating data-sharing agreements, and developing effective data-driven solutions.

   To fill this gap, both sides should be aligned by a mutual education to get familiar with each other's definitions, functional domains, abilities, concerns, and limitations. This collaboration would help them to reach a common language to understand each other

in terms of data sources, data gathering, data quality, data processing, data integration, data value, data usability, data ownership, data privacy, data commerciality, and data market. Additionally, developing a common data vision would also help in filling this gap.

3. Data literacy

A significant gap exists in the technical knowledge and understanding of data among NRAs. Third-party data providers report that NRAs often lack the expertise in the technical domain to effectively utilize data, hindering the full realization of its potential benefits. This knowledge gap extends to technical departments within NRAs, which may lack domain knowledge specific to road-related data. NRAs and third-party data providers do not have the same rate of progress in knowledge and familiarity with novel changes in mobility, data processing methods and abilities given the big data collected in the mobility sector.

Context: Third-party data providers often possess specialized knowledge in data collection, processing, analysis, and visualization. However, NRAs may not have the same level of expertise, making it difficult for them to leverage data for decision-making, optimization, and innovation.

NRAs can invest in capacity-building programs to enhance data literacy among staff, including training on data analysis, visualization, and interpretation. On the other hand, third-party data providers can share knowledge and expertise with NRAs through training sessions, workshops, or documentation to empower them to utilize data effectively. Furthermore, providing clean and processed data and analysis via platforms is seen as a solution by some third-party data providers.

4. Lack of coordination

A misalignment exists between the geographical coverage, type, detail, and precision of data collected by third-party data providers and the specific priorities, limitations, and challenges faced by NRAs. This lack of coordination can result in third-party data providers collecting data that is not directly relevant to the NRAs' needs, leading to inefficiencies and missed opportunities for data-driven solutions.

Context: Third-party data providers often collect data across broad geographical areas and diverse use cases, aiming to serve a wide range of clients and applications. However, the specific data requirements of NRAs can vary significantly depending on their region, road network characteristics, and specific challenges they are facing.

Both parties can develop a comprehensive data strategy that clearly defines data needs, objectives, and how data will be used to achieve specific outcomes. NRAs can explore partnerships with third-party data providers to gather the data for their specific use cases.

5. Data cohesiveness

A lack of sufficient data cohesiveness exists between the datasets provided by various third-party data providers and the data needs of NRAs. This lack of cohesion stems from variations in data collection methods, precision, priorities, and formats among different third-party data providers, leading to difficulties in integrating and utilizing data effectively.

Context: NRAs often rely on data from multiple third-party data providers to gain a comprehensive understanding of road conditions, traffic patterns, and other relevant factors. However, the lack of standardization and coordination among third-party data providers can result in data that is fragmented, inconsistent, and difficult to combine. This can hinder the NRAs' ability to make informed decisions and develop effective solutions. For example, an NRA might receive traffic data from one third-party data provider that uses GPS tracking and another third-party data provider that uses cellphone data. The data from these two sources might not be easily comparable due to differences in collection methods, data formats, and levels of detail. This lack of cohesion can make it challenging for the NRA to analyze the data and derive meaningful insights.

It is important to promote the adoption of standardized data formats and protocols among third-party data providers to ensure compatibility and ease of integration.

6. Data standards

A significant gap exists in data standards between NRAs and third-party data providers due to variations in practices across different countries. While both parties acknowledge the need for standardization, there is a lack of consensus on who should lead the initiative and how to balance international standards with country-specific requirements.

Context: Data standards encompass various aspects, including data formats, collection methods, quality metrics, and exchange protocols. The lack of harmonization in these standards can lead to difficulties in data integration, comparability, and interoperability, hindering the effective utilization of data in the road sector. For example, an NRA in Germany might use different vehicle classes than an NRA in France. This can create challenges for third-party data providers who need to work with data from multiple countries, as they may need to develop custom solutions for each data format.

It is necessary to minimise tailoring needs that can be extremely costly and affect the competition. Data standards should allow the offering of off-the-shelf products from many players in the market. A clear data vision that outlines the goals, objectives, and principles of data collection and utilization can help guide the development of data standards.

7. Data collection

A significant gap exists in the understanding and coordination of data collection methods between NRAs and third-party data providers. Both parties acknowledge the need for standardized practices but face challenges in identifying data needs, understanding existing data resources, and aligning data collection efforts with specific objectives.

Context: Third-party data providers express frustration with the abundance of available data from NRAs, often lacking clarity on where the actual needs lie. This overabundance can lead to inefficiencies in data collection and analysis, as valuable resources may be spent on collecting data that is not directly relevant to the NRAs' goals. On the other hand, NRAs may struggle to determine which data should be collected by third-party data providers or how to process and utilize the data they receive effectively. This lack of clarity can result in missed opportunities for data-driven

insights and solutions. Additionally, NRAs state that they lack control over the selection of data collected from third-party data providers, as these providers primarily decide on what data and from where will be collected.

It is essential to maintain collaboration between NRAs and third-party data providers to address the data requirements. NRAs could describe their data needs and requirements, and the innovative private players could plan and decide on how to best match those needs. This would incentive the market into new innovations to gain competitive advances.

8. Privacy and data security

A gap exists between the cautious approach of NRAs towards data privacy and anonymity and the third-party data providers' perspective on the practicality and security of modern data-sharing practices. NRAs express valid concerns about safeguarding sensitive information, while third-party data providers perceive some of these concerns as exaggerated, particularly regarding cloud-based data sharing.

Context: NRAs, operating within strict legal frameworks and entrusted with sensitive data, prioritize data privacy and anonymity. This often leads to stringent security measures and reluctance to adopt new technologies like cloud storage, which some perceive as less secure than traditional on-premises solutions. Third-party data providers, on the other hand, operate in a data-driven landscape where cloud technologies are commonplace. They view cloud storage as a secure and efficient means of data sharing, often exceeding the security measures of many on-premises systems.

For instance, an NRA might hesitate to share traffic data with a third-party data provider via the cloud due to concerns about unauthorized access or data breaches. However, the third-party data provider might utilize robust encryption, access controls, and regular security audits, making the cloud environment arguably more secure than the NRA's own infrastructure.

NRAs can invest in education and awareness programs to better understand the security features and benefits of cloud technologies. On the other hand, third-party data providers can clearly communicate the security measures and protocols in place to protect data stored and shared on the cloud.

9. Hesitance towards new technologies

A gap exists between the NRAs reliance on existing heavy infrastructure for data collection e.g., loops and the potential of alternative, cost-effective methods offered by third-party data providers. NRAs, having invested heavily in physical infrastructure over time, may be hesitant to adopt new technologies, fearing additional costs and disruption. However, third-party data providers increasingly utilize artificial intelligence (AI) and machine learning (ML) techniques that can leverage existing infrastructure and provide valuable insights at a lower cost.

Context: NRAs traditionally rely on a network of sensors, cameras, and other physical devices to collect road-related data. While this infrastructure is essential, it can be expensive to maintain and upgrade. Third-party data providers, on the other hand, are increasingly utilizing AI and ML to analyze data from existing sources, such as traffic cameras, GPS data from connected vehicles, and even social media posts.

For instance, the NRA might have invested in a network of traffic cameras to monitor traffic flow. A third-party data provider could utilize AI algorithms to analyze the video feeds from these cameras, extracting valuable insights on traffic patterns, congestion, and incidents without the need for additional hardware installation.

NRAs should embrace a more open mindset towards innovative data collection methods, exploring the potential of AI and ML to leverage existing infrastructure and reduce costs.

Technical fit is crucial for successful collaboration between NRAs and 3rd party data providers. However, several gaps exist. There's a lack of data integration expertise in NRAs and a mismatched understanding of data concepts between the two parties. Additionally, there's a gap in data literacy among NRAs and a lack of coordination in data collection efforts. Data cohesiveness and standardization are lacking, and NRAs are hesitant to adopt new technologies. Moreover, there are concerns about data privacy and security, particularly with cloud-based sharing.

One aspect of technical fit of third-party data into NRAs internal planning processes is the fact that planning and decision-making processes have been designed to utilise the data that NRAs are able to collect themselves. An example of this are many service level definitions for e.g. road maintenance and winter maintenance that are defined merely from the road class and traffic volume (ADT). When an NRA gets access to various third-party datasets that may give more detailed insights into the subject, NRAs should be flexible to align their planning guidance and decision-making principles accordingly. Otherwise, the benefits from the new datasets remain limited.

6.3 Business viability aspect

Business viability is a third aspect, which, together with desirability and technical fit, sets an environment for the successful exchange between NRA and 3rd party data providers. Business viability refers to the ability of a business to sustain its operations and generate profits over the long term. In this section, we analysed the best practices and challenges in the current business interactions and agreements. A few gaps identified in the business viability domain are as follows:

1. **Uncertainties in business models and agreements**

   A gap exists between the expectations of NRAs and third-party data providers regarding the longevity and stability of their collaborations. NRAs often express concerns about the uncertain business models of some third-party data providers, fearing service disruptions or the disappearance of providers from the market. Meanwhile, third-party data providers seek clarity and stability in agreements, avoiding vague or arbitrary tasks that can arise due to changes in NRA management or policies. Some NRAs prioritize securing maximum amounts of data through long-term contracts as a precautionary measure, driven by concerns about third-party data providers stability and data availability. However, this approach often leads to overspending on data acquisition, leaving limited resources for data analysis, interpretation, and integration into actionable solutions.

   Context: NRAs rely on third-party data providers to provide valuable data and insights that inform decision-making and improve road infrastructure. However, the dynamic

nature of the third-party data providers landscape can create uncertainty for NRAs, who may be hesitant to invest in partnerships without assurances of long-term stability. For example, an NRA might partner with a third-party data provider to develop a real-time traffic monitoring system. If the third-party data providers face financial difficulties or undergo a change in ownership, the NRA's investment could be jeopardized, leaving them without a critical tool for managing traffic flow.

NRAs and third-party data providers could investigate an in-between solution. While making a contract intended for longer-term cooperation, they can include evaluation moments with go/no go decision to proceed to the next stage based on clearly communicated evaluation criteria at the start. Another suggestion is that both sides should clarify at the beginning if they want to collaborate based on a project led agreement (fixed timeline) or a problem-based agreement (conditional timeline).

2. Local policies and stakeholder dependencies

A significant gap exists between the expectation of streamlined data access from NRAs and the complex reality of multi-stakeholder ecosystems in the road sector. In certain use cases, such as road user charging and tolls, data access, ownership, and privacy are not solely controlled by NRAs if at all. Other stakeholders, including municipalities and police, play a crucial role, adding layers of complexity to the bureaucratic process. Often the stakeholders who are not a direct beneficiary of NRA – third-party data provider collaboration hampers the growth.

Context: In countries like Germany, France, and the UK, charging and tolls systems often involve multiple stakeholders with varying interests and responsibilities. Municipalities may be responsible for setting tariffs, while police may enforce regulations and collect fines. This fragmented landscape can make it difficult for third-party data providers to obtain the necessary data for their solutions. Regulations such as European Electronic Toll Service (EETS) are aimed to simplify such data exchange but this is for a revenue driven context.

Identifying all relevant stakeholders involved and their roles and responsibilities regarding data access, ownership, and privacy can help in effective stakeholder management. On the other hand, transparent communication regarding multi-stakeholder nature of the use case would help in the long run.

3. Data ownership and rights

A significant gap exists in the understanding and agreement between NRAs and third-party data providers regarding data ownership, rights to reuse data for other purposes, data reselling, and responsibilities for data errors. This ambiguity can lead to misunderstandings disputes, and hinder collaboration between the two parties.

Context: Both NRAs and third-party data providers express concerns about the lack of clarity regarding data ownership and usage rights. NRAs may be hesitant to share data without clear agreements on how it can be used or resold. Third-party data providers, on the other hand, may be reluctant to invest in data processing and analysis without assurances of ownership or the ability to reuse the data for other purposes.

Involvement of legal departments within both organisations could help in avoiding such conflict of interest.

4. **Costs**

A gap exists between the expectations and realities of data supply and demand in the relationship between NRAs and third-party data providers. Third-party data providers face challenges in managing costs associated with multi-layered data acquisition and processing, while NRAs grapple with budget constraints and concerns about the value and granularity of the data provided. This mismatch often results in a focus on cost reduction rather than data quality and utility.

Context: Third-party data providers often need to aggregate data from multiple sources to provide comprehensive and accurate information to NRAs. This process can be time-consuming and expensive, especially when dealing with complex data sets or real-time data streams. However, NRAs may not always be willing or able to pay for the full value of this data, leading to tensions and compromises on data quality.

Shifting from a purely cost-based approach to a value-based pricing model that considers the quality, relevance, and potential impact of the data on achieving specific objectives can help fill this gap.

5. **Trust and market competition**

A gap exists in trust and transparency between NRAs and third-party data providers regarding data accessibility and competition. Both sides hold concerns about the other's intentions, leading to hesitancy in data sharing and collaboration. NRAs may fear losing control over data or being replaced by third-party data providers, while third-party data providers may worry about their competitive position if they share too much data with NRAs.

This mutual distrust can create a barrier to effective collaboration and hinder the development of innovative data-driven solutions in the road sector. NRAs might be reluctant to share data with third-party data providers, fearing that they might use it to compete directly with them or develop services that render the NRAs' role obsolete. Third-party data providers, on the other hand, might be hesitant to share their data and insights with NRAs, fearing that it could be used to benefit their competitors.

Clearly communicating each other’s intentions and concerns, emphasizing that collaboration is not a threat but an opportunity to leverage expertise and achieve shared goals, could help fill this gap. In addition, clear data-sharing agreements that outline the terms and conditions of data access, including restrictions on data use and redistribution would solve the concerns. Respecting each other’s intellectual property and confidentiality would ensure that data is not used for unauthorised purposes.

6. **Effective collaboration**

A gap exists in understanding and collaboration between NRAs and third-party data providers. NRAs perceive some third-party data providers as not adequately addressing their specific needs and limitations, while third-party data providers view some NRAs as resistant to innovation and stuck in traditional data practices. This disconnect hinders the development of tailored data solutions and limits the potential for data-driven advancements in the road sector.

Context: NRAs responsible for managing and maintaining road infrastructure have specific data requirements and limitations based on their unique contexts and

challenges. However, third-party data providers, driven by innovation and market trends, may not always align their data offerings with these specific needs. This misalignment can lead to frustration and missed opportunities for both parties.

For example, an NRA might require highly specific data on road surface conditions to optimize maintenance schedules. However, a third-party data provider might offer a standardized data product that does not fully address this specific need, leading to dissatisfaction for the NRA. Conversely, a third-party data provider might develop an innovative solution for real-time traffic prediction using AI, but an NRA might be hesitant to adopt it due to unfamiliarity with the technology or perceived risks.

Openness to innovation, clear communication, and collaborative learning could help in resolving issues related to collaboration.

In summary, the explored business viability gaps include uncertainties in business models and agreements, complex stakeholder dependencies, unclear data ownership and rights, mismatched cost expectations, distrust and competition, and lack of effective collaboration. Addressing these challenges will enhance collaboration in the evolving data landscape.

6.4 Other challenges

1. **Visibility**

   A significant gap exists in the awareness and understanding between NRAs and third-party data providers regarding each other's capabilities and services. This lack of visibility is exacerbated by technical complexities, competitive pressures, and restrictive project policies, making it difficult for NRAs to identify suitable third-party data providers for collaboration. Additionally, the scope of third-party data provider services is often contingent on the level of data access and openness granted by NRAs, further complicating the selection process.

   Context: NRAs, particularly those operating on a European or international scale, may not be fully aware of the diverse range of services offered by third-party data providers. This lack of knowledge can hinder the adoption of innovative solutions and limit the potential for data-driven improvements in road infrastructure and management.

   One potential solution could be developing a centralized repository or directory that lists third-party data providers operating in the European market, highlighting their services, expertise, and case studies. In fact, the European Commission’s delegated regulations for SRTI and RTTI data already addresses this issue as also service providers and holders of vehicle-generated data are required to publish information on their datasets in the national access points. In addition, NRAs could consider adopting more adaptive procurement approaches that accommodate the evolving landscape. This could involve launching small pilot projects with third-party data providers, agile contracts or focusing on outcome-based procurement.

2. **Trust in Data quality**

   A disconnect exists between the perceived data quality by third-party data providers and NRAs. Third-party data providers express confidence in their ability to deliver high-quality data, while NRAs remain uncertain and see room for improvement. This

misalignment in expectations can hinder collaboration and impede the effective utilization of data in the road sector.

Context: Third-party data providers often invest in data cleaning and processing to ensure the accuracy and reliability of their data. However, NRAs may not be fully aware of these efforts or may have different standards for data quality. This can lead to misunderstandings and mistrust, as NRAs may question the validity of the data provided by third-party data providers.

As part of the data vision, NRAs can get a sharper view on the value of particular data sets, and how that relates to quality levels. Furthermore, increasing understanding of data can help in developing trust.

3. **Unclear ownership**

A gap exists in the clarity of ownership and responsibility for certain road assets, such as bridges or road sections. In some cases, ownership is unclear, disputed, or assigned to multiple agents who lack effective collaboration. This ambiguity can lead to neglect of maintenance, delayed repairs, and potential safety hazards, as responsibility for data provision, updates, and investment decisions remains unclear.

Context: Road infrastructure often involves complex ownership structures, with different entities responsible for various aspects of asset management. This can lead to confusion and inaction, especially when assets are jointly owned or when responsibilities are not clearly defined. For example, a bridge might be jointly owned by a NRA and a local municipality. If the bridge requires repairs, it might be unclear who is responsible for funding and overseeing the work. Similarly, if the bridge is equipped with sensors for data collection, it might be unclear who is responsible for digitising, maintaining, updating and sharing the data.

Developing precise ownership maps that clearly delineate the ownership of each road asset, including any shared ownership arrangements, could help in filling this gap. In addition, creating detailed charts outlining the rights and responsibilities of each owner, including maintenance, data provision, and investment decisions can help in avoiding conflicting situations.

7 Use cases for detailed investigation.

Based on the workshop discussion, interviews and identified gaps, four use cases are identified for detailed investigation. These are as follows:

1. **Traffic Management using Floating car/vehicle data (C-ITS)**

   From the discussed use cases in the workshop and identified gaps, "Traffic Management using floating car/vehicle data " is a strong use case for a deep dive with NRAs. This use case has a wide range of applications, including traffic management, incident management, and asset management. It can provide valuable insights into road conditions and potential incidents, making it highly relevant to NRAs' operational needs.

   FCD/FVD is increasingly available as more vehicles become connected. This data includes location, direction, speed, and density of vehicles, providing a rich source of real-time information for traffic management. Using FCD/FVD for traffic management can provide numerous benefits to the NRAs as they can leverage third-party data in combination with latest technologies such as AI and Machine learning. Furthermore, fusion of FCD/FVD with induction loop data can be investigated. This use case can also explore potential solutions to fill identified gaps.

2. **Using in-vehicle data collected by a fleet of vehicles**

   Using in-vehicle data from third-party data providers beyond C-ITS was another most common request from the NRAs, as seen in multiple use cases discussed during the workshop. In-vehicle data can be utilized in a variety of use cases within all three focal ecosystems, ranging from traffic management, asset management, winter management, traffic safety applications and road user charging and toll collections.

   This presents an opportunity to deep dive into a use case where in-vehicle data from a fleet of vehicles can be investigated on how it can improve the services offered by the NRAs. One application would be in the domain of asset management, where in-vehicle data could offer numerous benefits to NRAs, bringing the maintenance costs down. It is also possible to investigate the solutions to various gaps identified, such as privacy and trust (GDPR), business models for utilizing such datasets and what technical capabilities does NRAs need to maintain to effectively utilize such data.

3. **eCall data use for Road safety improvement**

   Improving road safety is one of the key priorities within the NRAs. A use case related to effectively utilizing the eCall data can be deep-dived to understand how NRAs can improve traffic safety within their roads. This use case also offers opportunities to investigate various gaps from desirability, technical fit and business viability perspectives. Also, this use case also offers opportunity to use the knowledge gathered in the CEDR SHADAR[18] project.

[18] https://www.cedr.eu/peb-call-2019-safe-smart-highways

4. Leveraging new technologies for Road user charging and Tolls

New technologies such as machine learning and AI can be utilized to effectively improve road user charging and tolling operations. This use case offers an opportunity to dive deep into what benefits new technologies might offer to NRA in this ecosystem. In addition, this use case would also offer opportunities to investigate what technological infrastructure and business models would NRAs need to have, potentially filling a few identified gaps.

8 Conclusion and recommendations

NRAs are increasingly reliant on data to optimize traffic flow, enhance safety, and minimize environmental impact. While NRAs collect some data themselves, a wealth of complementary information resides with data from third-party sources. This deliverable D3.3 Report on Gap Analysis, investigated the current and desired state of third-party data utilization by the NRAs. The research focussed on three ecosystems, namely C-ITS, Road Safety and Road user charging and tolls. Building upon the information captured during the WP2, additional information was captured by conducting workshops with NRAs, interviews with third-party data providers and sending out questionnaires to many stakeholders.

Current state of third-party data utilization

The current state of third-party data usage in NRAs is complex and multifaceted, with both significant opportunities and challenges. NRAs are increasingly leveraging this data for various use cases, as mentioned in section 4.1.

While the quality of third-party datasets is generally perceived as high in terms of relevance and timeliness, issues with accuracy, reliability, and consistency remain. Challenges such as unclear roles and responsibilities, the need for strong agreements, commercial and privacy concerns, and difficulties in establishing public-private partnerships also hinder the effective utilization of third-party data. Despite these obstacles, NRAs are actively exploring ways to overcome them through collaborative efforts, technological advancements, and clearer regulatory frameworks. The ongoing development of standardized data formats and improved data-sharing mechanisms are also expected to facilitate the wider adoption and effective utilization of third-party datasets in the future.

Desired state of third-party data utilization

The workshop also revealed a strong desire among NRAs to leverage third-party data for enhancing C-ITS, road safety, and road use charging and tolls. NRAs see the potential of detailed, real-time data to improve traffic management, incident response, and road user charging. However, several challenges need to be addressed. Ensuring data quality, privacy compliance (especially GDPR), and compatibility with existing systems are key concerns. There is also a need for standardized terminology and clear agreements on data definitions to ensure smooth data exchange and integration.

NRAs are particularly interested in in-vehicle data and environmental data, recognizing their potential for real-time monitoring and proactive safety measures. However, navigating the balance between data utility and privacy protection remains a critical challenge.

Identified gaps

The research also identified several significant gaps between NRAs and third-party data providers in the context of desirability, technical fit and business viability.

In terms of *Desirability*, mismatches in data visions, desired levels of detail, and data access speed create challenges. Conflicting interests regarding data storage, privacy, and commercial use further complicate the relationship.

On the *Technical Fit* side, NRAs lack data integration expertise and struggle with the technical aspects of data utilization. Misaligned understanding of fundamental data concepts and varying data standards create further obstacles.

Whereas from a *Business Viability* perspective, uncertainties in business models, complex stakeholder relationships, and unclear data ownership rights pose risks.

To overcome these gaps, a multi-faceted approach is necessary. This includes fostering a shared understanding of data concepts, investing in data literacy and technical infrastructure, developing standardized data practices, and establishing transparent and equitable business models. By addressing these challenges, NRAs and third-party data providers can unlock the full potential of data-driven solutions, leading to safer, more efficient, and innovative road systems.

Based on the information gathered from the research, the deliverable research questions mentioned in section 3 are reviewed as follows:

Desirability

- *Is the desired data per ecosystem or use case available? How is the data made available in the more mature NRAs? What are the use cases that show best practise in the use of the data?*

  Most NRAs desire data from various sources. Similarly, third-party data providers also seek to establish a similar setup, creating a large network of data sources and integrating data available from NRAs. Additionally, there has been a growing demand for real-time data readily accessible in the market. Both third-party data providers and NRAs recognize the value of real-time data, especially for C-ITS use cases.

  For the desired use cases, NRAs mentioned various datasets which are required to achieve its objectives (Section 5.1). Interviews with third-party data providers also showcased their capabilities to bring and fuse data from various sources. Currently, it is somewhat unclear which specific data is available or desired across NRAs for this. Both third-party data providers and NRAs believe that the market would benefit from an initial collaboration between parties, which would focus on creating an overview of available data and standardizing the available data for all users.

  Although the desired datasets are available (or can be made available) by third party data providers, NRAs needs to overcome a few challenges related to collaboration with third-party data providers, standardisation, privacy, establishing trust, setting up sustainable business models, and data literacy.

  More mature NRAs are moving from infrastructure-based data to newer technologies such as vehicle data which also requires a shift in the mindset within the organisations. Investing in knowledge and developing capacity to understand new technologies would benefit in developing trust and effect collaboration with NRAs.

  There are various use cases shared by the third-party data providers which showcases the best practices in use of data. One such use case is about utilizing real-time data fusion, AI, and machine learning to provide comprehensive insights into road networks. This enables proactive identification and mitigation of risks, such as accidents, hazards, and traffic congestion. Another use case identifies high-risk areas on roads by analyzing real-world driving behaviour data, allowing for proactive safety measures and targeted interventions. Furthermore, providing real-time digital alerts to drivers about potential hazards, such as emergency vehicles, roadwork zones, and accidents, enables them to react earlier and make safer decisions.

- *Which use cases show the most immediate need and are the low-hanging fruits to focus on or further investigate?*

  Using third-party data like floating car / vehicle data and In-vehicle information for C-ITS applications such as traffic management, asset management, incident management etc. showcase tremendous potential in predicting the traffic situation and providing accurate traffic information to drivers. In addition, these datasets also showcase potential benefits to road safety use cases like winter management and fast detection of incidents.

  NRAs that have invested heavily in infrastructure over the years are now seeking simpler ways to utilize new data types. Currently, there is significant interest in using artificial intelligence (AI) engines and machine learning (ML) methods, which are more cost-effective than traditional approaches such as sensor installations. Furthermore, using AI and ML for road user charging and tolls also promises significant benefits to the services provided by the NRAs.

  Another significant opportunity arises from the challenge of providing data across borders, particularly for use cases on road use charging and tolls. Additionally, there is room for business expansion in less developed areas where data availability is limited or non-existent.

  By focusing on these high-impact, low-hanging fruit use cases, NRAs can quickly demonstrate the value of third-party data and pave the way for broader adoption and innovation in the future.

Technical fit

- *Is the data available in the NRA or in combination with 3rd party data provider, sufficient to fulfil their needs with regards to quality aspects based on the EU EIP Quality of RTTI Practical Guidelines, which define 5 major criteria, namely: Timeliness, Latency, Location accuracy, Classification correctness, and Event coverage?*

  Within EU, different NRAs have different maturity levels, which means that the demand for the quality differs per party. For some NRAs quality of data would be sufficient, while the others would aim for the higher quality. During the workshop, NRAs indicated the quality of third-party data on a range of average to high, depending upon the use case and their experience. Third-party data providers express confidence in their ability to deliver high-quality data, while NRAs remain uncertain and see room for improvement.

  A lack of sufficient data cohesiveness exists between the datasets provided by various third-party data providers and the data needs of NRAs. This lack of cohesion stems from variations in data collection methods, precision, priorities, and formats among different third-party data providers, leading to difficulties in integrating and utilizing data effectively. Furthermore, a misalignment exists between the geographical coverage, type, detail, and precision of data collected by third-party data providers and the specific priorities, limitations, and challenges faced by NRAs.

  The scope, nature, depth, and accuracy of data collected by various third parties vary and may not always align with the priorities, constraints, and challenges faced by NRAs. It is advisable for NRAs and third-party data providers to initially coordinate their data efforts before making any commitments.

  It is imperative for both parties to engage in mutual learning and coordination to ensure

alignment in definitions, operational areas, capabilities, concerns, and limitations prior to engaging in data sharing. This includes establishing a shared understanding of data sources, quality standards, processing methods, and ownership.

- *Is the technical infrastructure on the asset and in-house data architecture available at NRAs to meet their needs from an NRA perspective?*

  Many road operators are facing challenges in their development process to become more digital road operators. This is reflected in shortcomings in data systems and architecture and shortage of staff with the right skills and competences that is needed to further develop them as a digital road operator.

  NRAs recognize the need to enhance their information management practices. Their in-house systems currently struggle to handle the diverse data formats provided by third-party data providers. This creates a missed opportunity to maximize the potential of available data for improving road safety outcomes. Additionally, some NRAs lack the necessary technical infrastructure, capacity, or knowledge to handle dynamic data.

  Third-party data providers report that NRAs often lack the expertise in the technical domain to effectively utilize data, hindering the full realization of its potential benefits. This knowledge gap extends to technical departments within NRAs, which may lack domain knowledge specific to road-related data. NRAs and third-party data providers do not have the same rate of progress in knowledge and familiarity with novel changes in mobility, data processing methods and abilities given the big data collected in the mobility sector.

  NRAs can invest in creating a data vision and educating staff in digitization to understand the potential value of expertise, in order to adopt it. On the other hand, third-party data providers can help NRAs equip the necessary skills and knowledge to effectively utilize data-driven insights.

- *Is there a mismatch or is there a lack of data exchange protocols or standards needed for specific sharing and maintenance of data?*

  Both NRAs and third-party data providers acknowledge the need for standardization for effective data sharing. However, there is a lack of consensus on who should lead the initiative and how to balance international standards with country-specific requirements. The problem of standardisation is more prominent in international transactions. For example, an NRA in Germany might use a different data format for traffic flow data than an NRA in France. This can create challenges for third-party data providers who need to work with data from multiple countries, as they may need to develop custom solutions for each data format. The lack of harmonization in standards can lead to difficulties in data integration, comparability, and interoperability, hindering the effective utilization of data in the road sector. A clear data vision that outlines the goals, objectives, and principles of data collection and utilization can help guide the development of data standards.

  In addition, due to privacy constraints sharing of granular data is difficult. NRAs seek granular and real-time data to understand traffic patterns, optimize infrastructure, and enhance safety, while third-party data providers must adhere to strict regulations that protect individuals' privacy. GDPR prohibits third-party data providers from collecting or processing personal data without explicit consent, making it difficult to provide the

level of detail that NRAs desire. There is a need for regulations that can by law handle the traffic data collection in regard to the GDPR questions.

Furthermore, data update frequency varies among different parties due to varying task forces, responsibilities, and concerns. To ensure data quality, there is a clear need for agents to have shorter update periods.

Business viability

- *How was the procurement of the data justified for the specific use cases?*

  Both third-party data providers and NRAs agree that the current focus is more on cost efficiency rather than data quality. NRAs often have limited budgets, making cost a primary concern. This leads to a focus on cost-efficiency, sometimes at the expense of data quality. Despite budget limitations, NRAs still require high-quality data to fulfil their regulatory functions. Balancing cost and quality are a major challenge. NRAs could collaborate with third-party data providers to find ways to bring data costs down. It might also be useful to get the desired data cost in advance before the budget rounds.

  The justification for data procurement depends on the specific use cases within the NRA. Different regulatory tasks may require different types and levels of data. NRAs may consider long-term subscription contracts to ensure future data availability, but these can be inflexible with limited budgets and also limit innovation mid contract. Limited budgets may also result in harsh restrictions, which could diminish innovations in data gathering by third parties. It might be interesting to have a stepwise approach with go/no-go decision points. This would offer more flexibility and learning opportunities for both parties.

  In addition, both NRAs and 3PDPs need to develop a clearer vision of the value of specific data in terms of availability, acquisition, and quality levels. This will help justify the procurement of data for specific use cases.

- *Which features of the business case led to the decision to obtain data from 3rd parties? Which features were potential deal breakers at both sides of the table NRA and 3rd party data providers*

  NRAs approach agreements with third-party data providers cautiously due to concerns about the longevity of collaborations and stability of some providers. NRAs worry about service continuity and whether these providers will remain available in the future. Both NRAs and 3rd party data providers express dissatisfaction with the vague landscape of data ownership, rights for data reuse, data reselling, and responsibilities for data errors. This uncertainty keeps NRAs and third-party data providers at a distance.

  Additionally, third-party data providers feel that the trust level is insufficient, as NRA's understanding of the data is not comprehensive. The reason for NRAs to not go for the data of third-party data providers is because NRAs desire ownership and control for quality assurance. The process of accessing data from NRAs is often hindered by technical, institutional, and legal complexities, leading to significant delays for third-party data providers. Furthermore, the dependency of certain use cases on local policies and national mobility ecosystems can create barriers to broader data sharing.

  One of the solutions is establishing a European discussion board which could facilitate

the definition of standards for data quality, security, and the translation of data into information. Clear European regulations on data responsibility and ownership could mitigate ambiguity, while a clear distinction between raw data and processed information would clarify responsibility for final conclusions. Round table discussions could foster trust and education between NRAs and third-party data providers, while streamlining data access processes could improve efficiency.

Standardizing data definitions and encouraging third-party data providers to specify data quality levels would enhance data quality and consistency. Legal departments could play a crucial role in addressing the vague situation surrounding data ownership and rights. Lastly, clearly defining the features that would make or break data-sharing agreements for both parties could facilitate smoother negotiations.

By implementing these solutions, NRAs and third-party data providers can overcome the challenges of third-party data sharing, leading to a more collaborative and efficient environment that benefits road safety, traffic management, and the development of innovative mobility solutions.

- *Were there adjacent emerging use cases for the same data set considered?*

  Within the different use cases discussed by the NRAs, several datasets are commonly identified as valuable for improving various aspects of C-ITS, road safety and road user charging and tolls. Some datasets appeared to be relevant in multiple use cases and can serve multiple purposes.

  Floating car data, sourced from connected vehicles, has potential on providing real-time information on traffic flow, speed, and incidents. It is valuable for traffic management, incident detection, and road safety initiatives.

  In-vehicle Data includes a wide range of information collected from vehicle sensors, such as hard braking events, rain detection, and even camera images. It's useful for incident detection, road condition monitoring, and traffic light optimization.

  Real-time weather and weather forecast data is essential for winter management, road safety alerts, and optimizing traffic flow in adverse conditions.

  Road Condition Data includes data on road surface friction, slipperiness, and visibility. It's crucial for winter management, road safety alerts, and informing maintenance decisions.

  Data from vehicle manufacturers can provide insights into vehicle performance, diagnostics, and even driver behavior. This can be used for safety analysis, emissions monitoring, and predictive maintenance.

  By leveraging these common datasets and addressing the associated challenges, NRAs can significantly improve road safety, optimize traffic flow, and enhance the overall transportation experience for road users.

Recommendations

For a successful collaboration between NRAs and third-party data providers and fully utilise the potential of third-party data within NRAs, several key strategies can be employed:

- *Establish a Shared Vision:* NRAs and third-party data providers should align their data visions, recognizing the value of specific datasets in relation to data quality levels. This shared understanding will facilitate a more effective partnership.
- *Invest in Staff Education:* Educating staff in digitization will help them understand the potential value of data sharing and encourage adoption across the organization.
- *Foster Collaboration and Innovation*: Regular collaborative workshops and mutual learning meetings will facilitate the exchange of ideas, the exploration of synergies, and the gradual introduction of innovative solutions.
- *Prioritize Data Coverage*: Given that certain critical data (e.g., traffic rules, infrastructure access, road work planning) can only be provided by road authorities, cooperation between NRAs and third-party data providers is crucial to ensure comprehensive data coverage.
- *Adopt a Use-Case-Centred Approach*: Focusing on specific use cases allows NRAs to assess existing data within their organization and identify gaps that third-party data providers can fill. As NRAs transition towards becoming digital road operators, addressing these gaps becomes a natural part of their development process.
- *Strategically Integrate AI and Sensors*: While AI shows promise, a gradual approach that combines AI with sensors initially is more prudent. This allows for careful monitoring, evaluation, and the gradual replacement of outdated methods with more effective ones.
- *Address Data Quality Concerns*: NRAs should be mindful of potential data quality issues in less populated regions, where third-party data providers often operate. Integrating this understanding into their data vision and collaborating with third-party data providers to identify necessary improvements will ensure data reliability.
- *Develop Standardized Frameworks and Agreements*: The development of standardized frameworks and collaborative agreements will be crucial for addressing data quality, privacy, and compatibility concerns, ensuring the seamless integration of third-party data into the transportation sector.

By implementing these strategies, NRAs and third-party data providers can work together to overcome challenges, maximize the value of third-party data, and drive innovation in the transportation industry.

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Appendix A: Breakout discussion guiding questions

The current state of 3rd party data use

- What are various use cases associated with Road safety/ C-ITS / Road user charging and Tolls in your organization(s)?
- What data do you currently use in related use cases in your organization?
- Which of the above datasets comes from a third-party data provider?
- What is your opinion on the quality of 3rd party data on these parameters?
  Please rate on a 5-point scale (1: very low and 5: Very high) and/or add a comment
  Accuracy, Reliability, Consistency, Relevance, and Timeliness
- What are the biggest challenges and barriers in using and maintaining 3rd party datasets? And why?

Desired state of 3rd party data use

Use cases: Think about a future (or hypothetical) use case where you would like to improve the Road safety/ C-ITS services / Road user charging and Tolls services using 3rd party data. This can be an ongoing initiative or a future use case in your organization where you would like to further improve the service using additional data from 3rd party.

- What 3rd party data can be useful in improving the service in this use case?
- What are the key objectives of obtaining this data? How will the data be used?
- What are the requirements for the desired 3rd party data?
  Think about - Penetration rate or geographical coverage
  How often does data need to be updated?
  Level of detail required (e.g., aggregated, detailed etc.)
  Organization requirements like data format, GDPR compliance, etc.

Challenges and Barriers

- What are the biggest challenges and barriers in working with 3rd party datasets?
- What are the challenges and barriers in working with 3rd party data providers?

Future use

- What data would you need in future to further improve the Road safety/ C-ITS services / Road user charging and Tolls services?
- What datasets from other services can be potentially useful in improving Road safety/ C-ITS services / Road user charging and Tolls services?

Appendix B: A set of guiding questions for discussion with third-party data providers

- What data related to these ecosystems does your organization provide?
    - Road safety
    - Road user charging and Tolls
    - C-ITS
- Which datasets are more often requested by the NRAs?
- Do you collect such datasets yourself, or do you have any other sources of data?
- What is the frequency and level of detail of such a dataset?
- Is the data readily available over the shelf, or is there a lead time in making data available?
- What services related to such datasets do you offer?

Producing data

- What are the biggest challenges and barriers in producing such datasets for the NRAs?
    - Technical challenges
    - Organizational challenges
- Are there any data quality frameworks in place?

Maintaining data

- What are the biggest challenges and barriers in maintaining such datasets?
    - Technical challenges
    - Organizational challenges

Sharing data

- What are the biggest challenges and barriers in sharing such datasets with the NRAs?
    - Technical challenges
    - Organizational challenges
- What data handling and security frameworks are in place?
- Are there any specific requirements that need to be met in working with NRAs?

Working with NRAs

- What are the challenges and barriers in producing, and sharing data for the NRAs?

Future data

- What datasets do you aim to provide in the (near) future?
- What are the business/ financial conditions that you think will create a sustainable marketplace/ win-win situation for 3rd party data providers and NRAs to meet their objectives?