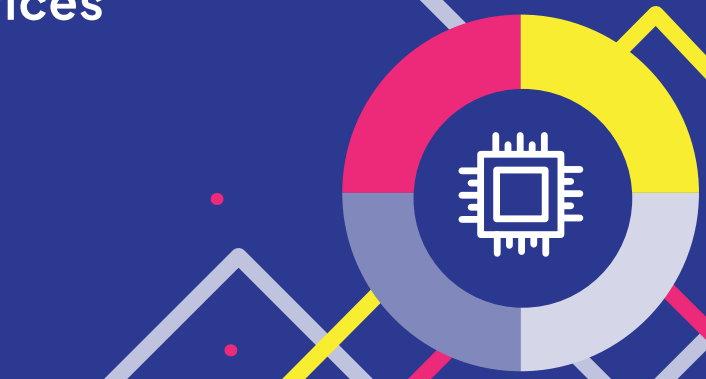
Advanced traffic management solutions for synchronized and resilient multimodal transport services

SYNCHROMODE



D2.2 Multi-actor cooperation and governance models for integrated multimodal transport systems - Version 1

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Executive Summary

This deliverable describes the methodology for defining multi-actor cooperation and governance models for integrated multimodal transport systems and the results thereof. This deliverable is a part of Work Package 2 titled 'Users' needs, system requirements definition and governance models', and follows a participative approach developing suitable multi-actor governance models.

The analysis of multi-actor cooperation schemes and governance structures will enable the project to define new arbitration models that facilitate the consensus among actors on what solution(s) offer the most appropriate trade-offs among performance areas (e.g., capacity, safety, environment) and balance between individual vs. collective needs. This will constitute a key input to guide the technical implementation of the SYNCHROMODE toolbox (WP3-WP6).

Key findings from user needs and system requirements definition will assist in defining a structured cooperation process to enable a successful implementation of the project's solutions and case study evaluation. This is the first version of the deliverable and will be later revised in future editions during the project timeline.

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Summary sheet

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Project partners

Organisation	Country	Abbreviation
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UNIVERSIDAD DE LA IGLESIA DE DEUSTO ENTIDAD RELIGIOSA	Spain	DEUSTO
NOMMON SOLUTIONS AND TECHNOLOGIES SL	Spain	NOMMON
YUNEX GMBH	Germany	YUNEX
MAP TRAFFIC MANAGEMENT BV	Netherlands	MAPTM
AIMSUN SLU	Spain	AIMSUN
BE-MOBILE	Belgium	BE-MOBILE
VMZ BERLIN N BETREIBERGESELLSCHAFT MBH	Germany	VMZ
ARRIVA PERSONENVERVOER NEDERLAND BV	Netherlands	ARRIVA NL
RUPPRECHT CONSULT-FORSCHUNG & BERATUNG GMBH	Germany	Rupprecht
POLIS NETWORK	Belgium	POLIS
PNO INNOVATION SL	Spain	PNO
REGION OF CENTRAL MACEDONIA	Greece	RCM
CITYLOGIN IBERICA SL	Spain	CITYLOGIN
PROVINCIE ZUID-HOLLAND	Netherlands	PZH
UNIVERSITY COLLEGE LONDON	United Kingdom	UCL
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Version	Date	Organisation	Main area of changes	Comments
Version 0.1	26.03.2024	Rupprecht Consult	Initial draft	Initial structure and draft content
Version 0.2	22.04.2024	Rupprecht Consult	Roadmaps and Reference Frameworks	Revised chapters 1, 2 and 3
Version 0.4	24.04.2024	Rupprecht Consult	Finalisation of draft for internal review	Revised chapters 4 and 5.
Version 0.5	26.04.2023	MAPtm	Reviewed Deliverable	Reviewed
Version 1.0	30.04.2023	Rupprecht Consult	Final Deliverable	To be submitted

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List of acronyms

CAD	Connected and Automated Driving
CAVs	Connected and Autonomous Vehicles
CCAM	Connected, Cooperative and Automated Mobility
C-ITS	Cooperative and Intelligent Transport Systems
CRTM	Consorcio Regional de Transportes de Madrid
CS	Case Study
DRT	emand-Responsive Transport
EMDS	European Mobility Data Space
EU	European Union
FCD	Floating Car Data
GDPR	General Data Protection Regulation
KPI	Key Performance Indicators
MaaS	Mobility as a Service
MTM	Multimodal Traffic Management
NAP	National Access Point
NMS	New Mobility Service
NTM	Network and Traffic Management System
ÖSTO	Open, Social, Technological and Economic
PT	Public Transport
RAIM	Architectures of Intelligent Mobility Services

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RCM	Region of Central Macedonia
SM	Shared Mobility
STRIA	Strategic Transport Research and Innovation Agenda
SUMP	Sustainable Urban Mobility Plan
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TMC	Traffic Management Centre
UC	Use Case
UMR	Urban Mobility Resilience
VMS	Variable Message Signs
WP	Work Package

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1 Introduction

This chapter introduces the SYNCHROMODE project with ongoing activities in relation to the WP2 i.e., 'Users' needs, system requirements definition and governance models' and linked tasks, focusing on the multi-actor cooperation, the objectives of the deliverable, its intended audience and overall structure of the deliverable.

1.1 SYNCHROMODE and multi-actor cooperation

Advanced traffic management solutions are vital for ensuring coordinated and robust multimodal services. SYNCHROMODE, a Horizon Europe project, is designed to provide a range of services aimed at enhancing the management of the overall transport network. It encourages the cooperation of various stakeholders involved in the delivery and regulation of transport services. The services offered include:

1. Transport network-wide data exchange and integration system;
2. Cooperative dashboard for real-time monitoring and prediction of network-wide multimodal transport and traffic; and
3. Resilient multimodal transport network and traffic management support tool.

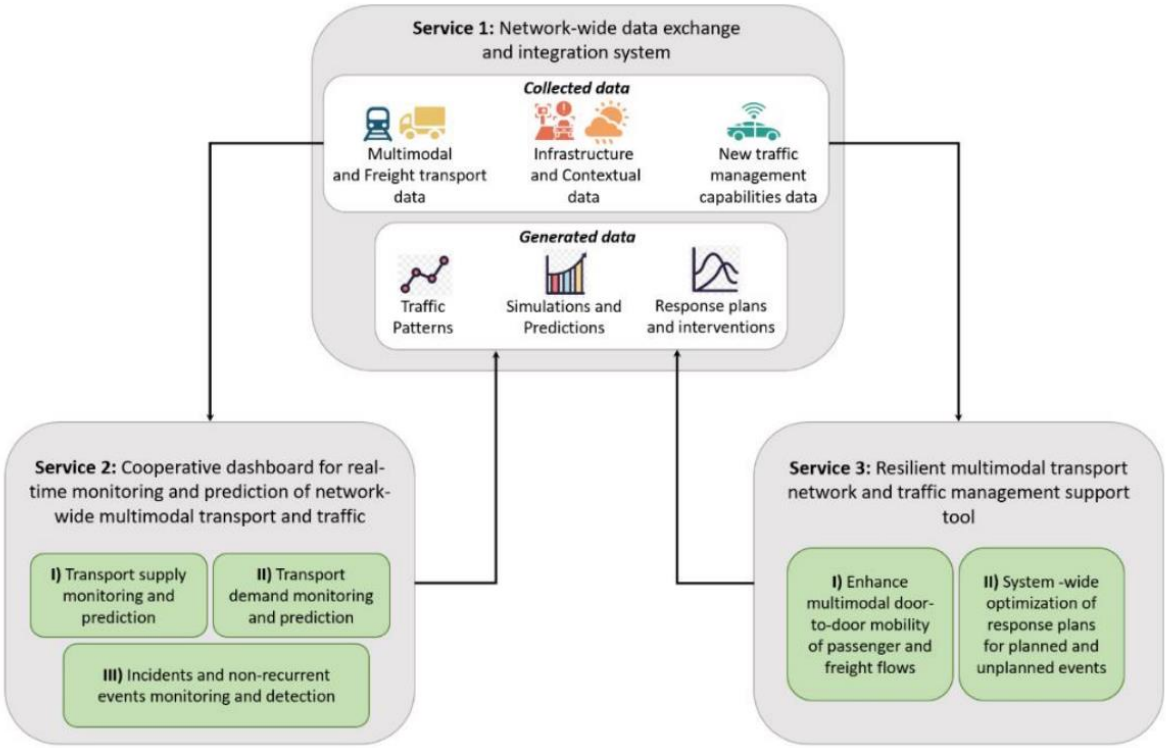

Figure 1: Flowchart showing SYNCHROMODE services for improving transport network management.

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In essence, SYNCHROMODE will empower transport managers with innovative predictive and network optimization abilities. These will aid in aligning transport supply and demand, thereby facilitating a swift and efficient response to a variety of events. By conducting three case studies and their corresponding use cases in Thessaloniki (Greece), South Holland (Netherlands), and Madrid (Spain), SYNCHROMODE will showcase the efficiency of comprehensive, multimodal, multi-stakeholder traffic and transport management solutions. This will be achieved through the SYNCHROMODE toolbox, which will facilitate the equilibrium of demand for both people and goods, while concurrently minimizing individual travel times.

Advanced network and traffic management of integrated multimodal transport system requires cooperation and coordinated decision-making of stakeholders, each having different interests, priorities, and operational capacities. A structured cooperation process is needed to enable a successful implementation of the project's solutions and case study evaluation. Relating to this, T2.2 addresses development of suitable multi-actor governance models. Governance, as a term, refers to a set of institutions and actors that are drawn from but also beyond the government. It identifies responsibilities for tackling different social and economic issues (Keping 2018). A governance model (or framework) initiates at the local level, which takes into consideration an umbrella of tools and guidelines which outlines how different stakeholders interact, support, and oversee the management of a project. By examining various cooperation schemes and governance structures involving multiple actors, the outcomes will establish arbitration models that aid in reaching agreement among stakeholders. These models will determine which solution(s) provide the best balance among different performance areas (such as capacity, safety, environment), and strike a balance between individual and collective needs.

Prior to the development of this deliverable, key takeaways from activities involving user survey and stakeholder workshops in case study areas were documented from the Deliverable D2.1. In addition, the case study definition through T2.3 assisted in the final description of the use cases and services to be tested. The co-creative and participatory approach assisted in the case study definition which was documented in D2.5. Based on the understanding of the three case study areas (i.e., D2.5), key takeaways from the user needs and system requirements (i.e. D2.1), and identification of key reference cooperation frameworks between public and private actors, the requirements for the multi-actor cooperation is identified and addressed through the evolving versions of this document. Considering this is the first version for the deliverable titled 'Multi-actor cooperation and governance models for integrated multimodal transport systems', two more revised versions will be delivered during the course of the SYNCHROMODE project (i.e. M18 and M36). The added inputs through the approach and workplan defined in this deliverable will guide the development of the governance models. The results from the WP2 deliverables define the requirements for the creation of a functional and technical reference architecture defining the functional components, roles, processes, and interfaces needed. Furthermore, the learnings through the WP2 activities and deliverables will feed into the development of a set of policy recommendations (i.e. T7.4 in WP7)

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targeting the policy makers, public authorities, and public transport operators assisting in the overall management of the complex multimodal transport network.

1.2 Objectives

Enabling successful implementation of the project's solutions through the three case studies, this deliverable aims to:

- provide guidance fostering the development of cooperation models and governance structures for multimodal traffic and network management, involving key actors in the transport system of the case studies and ensure efficient coordination among public and private actors.
- build upon the previous EU projects and roadmaps and incorporate the long-term vision of sustainable cooperation framework between different stakeholders enabling effective multimodal traffic management.
- guide SYNCHROMODE case studies to implement effective cooperation schemes derived from the policy frameworks and key initiatives in Europe.

1.3 Intended audience

This deliverable will be disseminated publicly informing all interested stakeholders about the development of the cooperation framework between different public and private stakeholders in the SYNCHROMODE case study areas.

D2.2 and its revised versions (via D2.3 and D2.4) will guide the SYNCHROMODE case studies to implement cooperation and governance models developed through the understanding of the status quo on multi-actor cooperation in multimodal traffic management identifying its relevance, requirements, and challenges. The deliverable will also provide key input to WPs, especially WP6, working on the creation and application of reference architecture within SYNCHROMODE. This will further compliment the creation of an operational toolbox for decision support.

1.4 Structure of the deliverable

This deliverable is structured into 5 chapters with the corresponding description as follows:

- **Chapter 1:**introduces the SYNCHROMODE project along with the recent activities linked with the development of this deliverable, defining its objectives, intended objectives, and structure.
- **Chapter 2:** focuses on the status quo of the multi-actor cooperation in Europe with inferences from roadmaps, clusters, and partnerships.
- **Chapter 3:** brings together the relevance and requirements inferred from the SYNCHROMODE case studies addressing its objectives, stakeholder mapping and governance model, and key requirements and challenges.

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- **Chapter 4:** addresses the methodological frameworks concerning cooperation and methodological aspects behind different management strategies via literature study involving public and private actors focusing on the multimodal traffic management. It also addresses the approach and the workplan execution during the timeline of SYNCHROMODE project.
- **Chapter 5:** summarizes the key inferences from the initial phase of multi-actor cooperation and governance model development, with the identification of next steps.

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2 Multi-actor cooperation in multimodal traffic management

This chapter focuses on the status quo of the multi-actor cooperation inferred from European project clusters, roadmaps, and partnerships.

2.1 Relevance and drivers

Developing multi-actor cooperation for multimodal traffic management (MTM) in cities allows significant benefits, improving efficiency, sustainability, and overall urban mobility. The development of an efficient and functional cooperation between different identified actors leads to:

- **Holistic and comprehensive strategy development:** Pursuing multi-stakeholder approaches involving private sectors have been seen to reach development goals, though it has its challenges (Pérez-Pineda & Wehrmann 2021). Bringing together different actors, such as government authorities, transportation companies, technology providers, and community organizations, fosters a more holistic approach to traffic management. Each individual stakeholder contributes through their distinct insights, enabling the formulation of strategies that tackle multiple aspects of transportation.

- **Enhanced data integration:** Effective MTM heavily relies on the exchange of data from diverse sources, including sources from the private sectors (STRIA 2016). Collaboration among different stakeholders enables the merging of information from various modes of transport. This integration supports the real-time regulation of traffic and enhances forecasting capabilities, resulting in more fluid movement of traffic and a reduced number of bottlenecks.

- **Innovative solutions and technology:** Cooperation between public and private actors can accelerate the adoption of innovative solutions, with private sector expected to contribute with its technical, financial and innovative capacities, resources, and infrastructure (AMEXCID 2017, AMEXCID 2018), such as prioritisation at smart traffic lights, applications/dashboard platforms providing real-time traffic updates and route optimisation. Improving the user experience through developed technological solutions across different modes enhances the overall efficiency of the transport system.

- **Policy alignment and regulatory frameworks**: Multi-actor cooperation assists in aligning policies and regulations across different levels of government and sectors. The alignment is

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crucial to implement strategies supporting effective MTM, ensuring regulations facilitate and not hinder the adoption of new technology and practices.

- **Stakeholder engagement and public acceptance:** By involving multiple types of stakeholders, including the public (i.e. citizens/users), in the planning and implementation phases, cities can ensure that the solutions are accepted on a larger scale and user requirements are met (Rupprecht et al. 2019, Taborda et al. 2023). The inclusive and holistic approach fosters public support for new initiatives and increases the probability of successful and long-term implementation.

2.2 Challenges and risks

The development of multi-actor cooperation offers many benefits as mentioned above, such as holistic strategy development, enhanced data integration, innovative technological solutions, and better alignment of policy and regulatory frameworks. However, the approach involves many challenges and risks, especially when it includes multiple stakeholders. Some of the key challenges and risks are mentioned as follows:

- **Coordination complexity, alignment, and communication:** Coordinating multiple stakeholders with varying agendas and capabilities can lead to potential administrative overhead and complexities. With different actors often having varying priorities (Pérez-Pineda & Wehrmann 2021), it is difficult to align objectives and strategies effectively. In addition, with different organisational cultures, multi-disciplinary jargons, and operational practices.

- **Consensus building and decision-making delays:** With diverse stakeholders, achieving consensus can be time-consuming with potential delays and slow decision-making (Papadimitriou et al. 2023) in critical decisions and milestones. Conflicting interests can also lead to a standstill, where no decision is reached stalling projects and solution implementation.

- **Financial and resource allocation:** Determining how costs are shared among stakeholders can be disputed if the benefits are not equally distributed. In the long-term, securing consistent resource commitment from all actors can be challenging.

- **Data privacy, security, ownership, and quality:** Ensuring security and privacy of shared data is challenging and crucial. Complying with data protection laws and regulations (e.g., GDPR) requires robustness. Through the lack of standardised data formats, integration issues and unreliable analytics is a concern. In addition, disputes over data-ownership and who can access, modify, or delete the data complicates the cooperation (de Souza et al. 2017, Sabouni et al. 2023).

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- **Change resistance:** Resistance to changes within the public/private organisation can hinder the adoption of new strategies and solutions agreed upon in the cooperation. Supporting fundamental changes in traffic management, strong change management support has to be provided (STRIA 2016).

While multi-actor cooperation has the potential to transform public and private sectors through collaborative effort and shared expertise, managing the complexities inherited through the cooperation and mitigating the risks associated with it is important. Clear agreements, robust data governance frameworks, effective conflict resolution mechanisms, and transparent communication channels are some of the essential factors responsible for the success of multi-actor partnerships.

2.3 Policy background and relevance of MTM in Europe

This subchapter reflects upon the status quo/initiatives at the European level focusing on the key insights related to multimodal traffic management. Key insights from these roadmaps and partnerships are mentioned as follows:

2.3.1 STRIA Roadmap and the Multimodal Traffic Management Cluster

STRIA Roadmap

Identifying key areas for action within the domain of transport research is instrumental to guide and deliver short-term and long-term solutions via new traffic management strategies. Following this vision, Strategic Transport Research and Innovation Agenda (STRIA) identifies areas where the EU needs to act together with the EU countries and different stakeholders to bring changes in the transport domain. Guiding these changes, seven roadmaps prioritise different areas of work with network and traffic management being one of them.

The STRIA Roadmap (Kearns, S. et al. 2016) foresees a paradigm change where, in the era of Cooperative and Intelligent Transport Systems (C-ITS) and Connected and Automated Driving (CAD), the potential of direct interaction with vehicle's control intelligence is put in the disposal of network and traffic management. Considering the top 10 priorities for research and innovation within the STRIA, they are categorised in three phases i.e. design, optimisation and execution. Considering the long-term timeframe for the STRIA priorities, these fall under the execution phase with R&I themes such as large-scale demonstration of fully Multimodal Network and Traffic Management capability in any operating environment (urban or non-urban); resource and asset management optimisation for advanced Network and Traffic Management Systems; and piloting efficient multimodal NTM system across EU hubs or nodes (including non-EU traffic integration).

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Considering the methodology for the roadmap development, the move towards multimodal operation is prioritised. This includes improving the interface between different modal NTM systems i.e. walking, road, rail, aviation and water. It also involves freight movement and considers the relationship between public and private sector. Furthermore, the roadmap identifies major challenges that the NTM is facing. These include (but are not limited to):

- existing administrative, managerial and organisational barriers between different actors and stakeholders (at political and organisational level) of diverse transport modes. There is a lack of cooperation in planning between public and private sector.

- short-term agendas of cities and metropolitan areas. These are seen as a major challenge for NTM. It is especially true when cities' strategies have a 3–5-year time horizon and dynamic changes take place with political transformation, allowing quick projects being given priority.

- lack of regulations for exchange of open data between different stakeholders and actors from different transport modes. This has a negative impact on the overall quality of the available data and requires data handling and exchange strategies to support requirements for the digital infrastructure.

Addressing these challenges, several milestones were set up until 2050. These include identifying and defining key indicators and data sources required to assess in a reliable and consistent manner throughout the EU (for 2020), availability of highly automated and modernised transport infrastructure (for 2025), finalisation of TEN-T core network (for 2030), automated, coordinated and harmonised transport in the EU (for 2035), and a fully multimodal and interconnected transport system (for 2050). As mentioned in the STRIA Roadmap document, multimodality is the most challenging task of the implementation plan. Therefore, it involves key focus areas as reference for the network and traffic management. These include mobility within urban areas, mobility from city to city, mobility in regional areas and door-to-door journey management.

The roadmap reflects how the two major stakeholder groups i.e. public and private transport actors are entering frequently into partnerships as compared to traditional traffic management which was more dominated by the public sector. It is therefore important to have a Network and Traffic Management system that addresses the requirements of individual travellers and the private sector, but also takes public interest and priorities into consideration. The roadmap identifies it as a challenge to understand the potential strengths and constraints for the actors in public and private sectors. Within the aspects of public-private cooperation, prioritizing quality on different set of objectives (i.e. service vs safety and security) is the outcome of different priorities which guides the work of private sector (in this case, the private traffic information service providers) and public

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sector. The roadmap provides examples of platform cooperation schemes, such as TM2.0, Lena4ITS (Vlemmings et al. 2017) or the MaaS, which doesn't take funding as a motive but bases the cooperation between actors (public or private) by aligning towards common needs of the users. These users include both the taxpayer (for whom the public sector is responsible) and a network user (for whom the private transport service provider is responsible for the services). While understanding the needs of various actors and the potential roles they assume is important to establish a successful NTM system, ensuring cooperation and mutual respect is also a priority.

Multimodal Traffic Management Cluster

With the STRIA Roadmap being published in 2016, an update on the status quo is required concerning multimodal approach towards traffic management. Regarding this, in 2022, a cluster of four projects (known as the 4FRONT Cluster) was initiated under the Horizon 2020 framework. These projects aimed to advance Network and Traffic Management for future mobility. The projects included TANGENT, DIT4TRAM, FRONTIER, and ORCHESTRA. By 2024, the collaboration expanded to encompass a total of nine Horizon projects. These initiatives enhance advanced multimodal network and traffic management for comprehensive passenger and freight transport. Notably, ACUMEN, DELPHI, and SYNCHROMODE contribute to this effort. Additionally, the cluster incorporates CCAM services into fleet and traffic management systems through projects IN2CCAM and CONDUCTOR.

Together the seven EU projects (i.e. TANGENT, DIT4TRAM, FRONTIER, ORCHESTRA, ACUMENT, DELPHI, and SYNCHROMODE) form the Multimodal Traffic Management Cluster kickstarting the revision of the Strategic Transport Research and Innovation Agenda (STRIA) roadmap in 2024. While many aspects mentioned in the roadmap document are still relevant today, changes in the traffic management sector need to be captured and addressed. These include, but are not limited to, a set of solutions which the projects believe can be implemented by a certain short-term (2030) or a long-term (2050) period. This would provide feedback to the policy makers in the EU about the strategic research needs but also implement certain mature solutions already present.

2.3.2 ERTRAC Roadmap

ERTRAC, i.e. European Road Transport Research Advisory Council, has developed several roadmaps over the years focusing on new mobility services (NMS), CCAM (i.e. Connected, Cooperative and Automated Mobility), urban mobility resilience (UMR) and more. As the NMS roadmap (2021) mentions, 'new mobility services' has not yet been regulated. As it relates to the new actors, new types of ownership and business models, new vehicles, and new uses of public spaces; new monitoring and enforcement needs are required, along with impact assessments, demand management, including new regulatory frameworks. Considering policy goals and regulatory frameworks, the impact assessment involves exchange and cooperation between stakeholders to

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collect data, as well as capacity building in the public administration, to manage the cooperation and exploit available data.

The optimal governance of NMS (NMS Roadmap 2021) identifies adoption of sustainable mobility authority over public transport authority to enable integration of all areas influencing urban mobility into transport governance. This allows SMA to cover public transport, along with parking, land-use, and public space (similar to the Transport for London approach). Furthermore, regarding governance for:

- MaaS, legal implications and operational issues were identified requiring further analysis and pilot tests to provide feedback on efficient and sustainable governance models for these services. The roadmap identifies more research is needed into barriers which hinder large-scale deployment of such mobility services, including public-private sector cooperation.
- digital infrastructure, further research was required at European level for some aspects such as evaluating level of impact of algorithms, coding protocol, regulatory frameworks for accountability for decisions taken by algorithms, and more. Algorithmic governance requires investigation in depth.

Considering resilient mobility systems (UMR Roadmap 2021), the roadmap addresses resilience of urban mobility ecosystem in times of crisis. This can be envisioned as a large-scale unplanned scenario for the traffic management. For the governance models, the roadmap identifies the need to define a model to value resilience in decision-making processes. It also takes into consideration a short-term crisis, for which communication and community building on resilience protocols requires multistakeholder discussion and process optimisation. Considering data sharing governance, recommendations for research includes:

- exploring innovative control models, such as establishing or identifying preferred institutions to govern new data control structures,
- examining IP laws avoiding barriers to data sharing and initiating discussion on ownership rights, conditions for transfer of ownership, liabilities of misconduct, and limits of liabilities (in case for co-created data), guidance on responsibilities of data providers, and data traceability,
- creating frameworks for public-private partnerships allowing mobility organisations and stakeholders for collaborations related to governing local data sharing initiatives,
- defining organisation of governing bodies which enables consistency and ensures data interoperability.

Through the key inferences listed above, identification of future research needs and domain through ERTRAC roadmaps focusing on governance models and cooperation frameworks assist in narrowing down the pathway for future works which impacts the traffic management systems involving multiple stakeholders in a multimodal transport ecosystem.

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2.3.3 CCAM Partnership

The Strategic Research and Innovation Agenda (SRIA) for CCAM highlights that "advancing CCAM is a multi-stakeholder effort (…) involving public and private stakeholders across industries and value chains" (CCAM Partnership, 2021).

In the pursuit of a user-centred and inclusive mobility system, the CCAM Partnership aims to coordinate actions through collaborative research, testing, and demonstration projects. This effort seeks to eliminate barriers and facilitate the acceptance and efficient rollout of automation technologies and services, recognizing that effective multi-actor cooperation is essential.

To enable the readiness of CCAM solutions for deployment, a synchronized progression of research and innovation, standards, and regulations is necessary. The optimal strategy involves fostering flexible and closely aligned cooperation among the diverse actors and users involved. This collaboration is vital for accelerating the deployment process while simultaneously fostering demand from users and society. Stakeholders involved in the design and deployment phases express varying perspectives, needs, and requirements, which can differ significantly. These differences must be thoughtfully considered in the design and development of CCAM solutions to ensure their acceptability.

Consequently, the CCAM Partnership brings together a diverse group of stakeholders, coordinating engagement and cooperation towards a unified research and innovation agenda for CCAM. Figure 2 illustrates the sectors and stakeholder types involved in this process, providing a useful basis to understand the ecosystem of actors in CCAM, their roles, and needs.

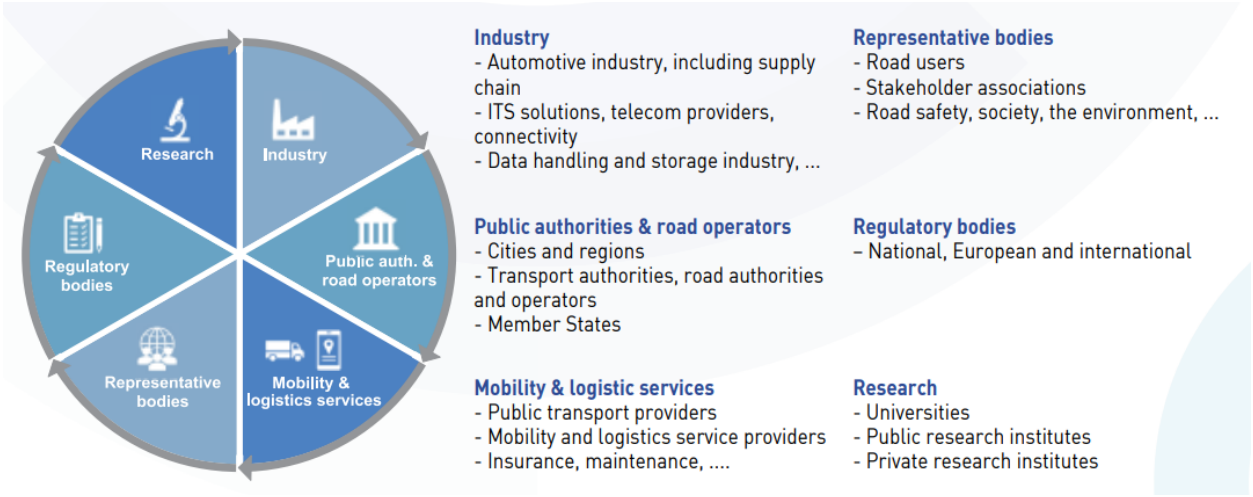

Figure 2: Sectors and types of stakeholders contributing to the Partnership and to the SRIA (CCAM Partnership, 2021).

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2.3.4 EU Directive on Intelligent Transport Systems (ITS)

In 2023, the Directive (EU) 2023/2661 of the European Parliament and the Council amended Directive 2010/40/EU on the framework for the deployment of ITS in the field of road transport and for interfaces with other modes of transport. Considering information and data related topics, the directive redefines road data as 'data on road infrastructure characteristics, including fixed traffic signs and their regulatory safety attributes as well as infrastructure for recharging and for refuelling with alternative fuels'. In addition, it defines terms like multimodal digital mobility service, i.e., 'a service providing information on traffic and travel data, such as the location of transport facilities, schedules, availability or fares for more than one transport mode, which may include features enabling the making of reservations, bookings or payments, or the issuing of tickets', accessibility of data, availability of data, and corresponding terms crucial for addressing data exchange between different stakeholders. It aims at harmonising the provision of ITS services and data access based on common standards. The directive mandates member states to make data accessible via national access points (NAPs), i.e. a digital interface set up by a member state which constitutes a single point of access to data (e.g., speed limits, dynamic data for parking areas). Projects like NAPCORE (a CEF-funded project), involving all member states and associated partners, focuses on increasing access and availability to mobility related data through coordinated data access and harmonisation of European NAPs. These NAPs, along with local and regional access points are crucial building blocks of the common European Mobility Data Space (EMDS) (COM/2023/751). EMDS falls under the European strategy focusing on the accessibility of data, where a common EMDS will reduce the current fragmentation in the sector and improve access to mobility and transport data by actors (both public and private) and provide cross-sectoral benefits through its synergies with data spaces from other sectors.

The directive is in force and ensures that the ITS applications within the domain of road transport enable seamless integration with other modes of transport i.e. addressing the multimodal perspective, which fosters the shift to sustainable modes like rail or active modes, in turn improving its efficiency and accessibility. Considering the four priority areas within the directive which are essential for the development and use of specification and standards, the first two include 'information and mobility ITS services' and 'travel, transport, and traffic management ITS services'. This includes specifications for EU-wide multimodal travel information services, where the definition of necessary requirements (making these services accurate and available across borders to ITS users) is based on:

- availability and accessibility of existing and accurate multimodal traffic and travel data
- facilitation of data exchange between public authorities and stakeholders and ITS service providers

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- timely updating by public authorities and stakeholders of available multimodal traffic and travel data, and
- timely updating of multimodal travel information by the ITS service providers.

This supports the increased availability of data, which also leads to further development of new ITS services and tackles a major challenge and risk setting up multi-actor cooperation within the traffic management ecosystem.

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3 Relevance and requirements for multi-actor cooperation in SYNCHROMODE

This chapter focuses on the importance of the cooperation between different actors especially public and private, including end users, reflecting upon their perspectives in different SYNCHROMODE case study areas i.e. Madrid, Netherlands, and Thessaloniki.

Based on the activities corresponding to WP2 i.e. 'User needs, system requirements definition and governance models', a series of two workshops and user surveys were executed. The result from these activities defines the functional components, roles, processes, and interfaces assisting in the creation of a functional and technical reference architecture in WP6, i.e. 'Integration of SYNCHROMODE solution & testing in the Case Studies'.

The cooperation framework defined for the case study areas for the multimodal traffic management system between public and private actors will be expanded in WP6 and adapted towards multimodal use-cases in the SYNCHROMODE project. This will be facilitated further through the creation of an operational toolbox for decision support system through T6.2 in WP6.

3.1 Multi-actor cooperation in the SYCHROMODE case studies

This subchapter summarises the three case studies i.e. Madrid, the Netherlands, and Thessaloniki, highlighting their corresponding overview and objectives, stakeholder mapping and key requirements and challenges. For further in-depth details, please refer to deliverable "D2.5 Case Studies Description" within WP2.

3.1.1 Madrid

Overview and objectives

The Community of Madrid, a densely populated region in Spain (8,030 km²; 6.8M inhabitants) that encompasses the capital city (604 km²; 3.2M inhabitants), presents a unique blend of urban, peri-urban, and rural environments. Its vibrant transport innovation ecosystem and the availability of high-quality transport supply and demand data make it an ideal testing ground for mobility innovations. The region's robust multimodal transport network provides ample opportunities to experiment with various load-balancing strategies and establish multi-actor cooperation frameworks, with the goal of reducing traffic congestion and enhancing the efficiency of passenger and freight transport operations.

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This case study (CS) aims to model solutions for integrating urban last-mile parcel delivery with public transport services and coordinating these with other transport modes to facilitate more efficient multimodal trip chains. The key concepts include:

- Leveraging the excess capacity of public transport vehicles during off-peak hours for last-mile parcel delivery to mitigate delivery-related traffic.
- Developing alternative transportation services, such as Shared Mobility (SM) or Demand-Responsive Transport (DRT) services, to supplement public transport in areas and at times where they are most effective, for both passenger and parcel transportation.

The primary challenge of this CS is ensuring compliance with the needs and requirements of the main stakeholders involved (i.e., public transport operators and logistics companies), which may sometimes be at odds with each other. This compliance is crucial for ensuring adoption. Therefore, it is necessary to understand its impact on the quality of both services and the implications for individual stakeholders' costs.

Stakeholder mapping and governance model

The various stakeholders identified in this case study are:

- Public transport passengers: These are the users of the targeted public transport services, which include buses as well as Demand-Responsive Transport (DRT) and other modes.
- Parcel receivers: These are the customers of the parcel delivery service, primarily end-users of e-commerce.
- Last-mile logistic companies / parcel delivery operators: These are the operators of logistic delivery services. They manage fleets that deliver parcels from logistic services to parcel receivers.
- Public transport operators: These are the operators of public transport services. They are tasked with providing and managing the public transportation services in the region. This category also includes DRT operators.
- Coordinator agent / transport authority: This is an overarching traffic management administration or an independent entity that coordinates and manages the collaboration between logistic companies and public transport operators. The scope and specific role will be defined during the project.

In the current governance structure in Madrid, public transportation and logistics delivery are treated as independent entities with minimal cooperation between them. There is currently no overarching traffic management administration that coordinates the cooperation between these transportation services. While the metropolitan bus routes and the general level of service for public transport are defined by the Regional Public Transport Administration of Madrid (CRTM - Consorcio Regional de Transportes de Madrid), the public transport operator granted the concession contract is responsible for specific schedules and day-to-day operational decisions. On the other hand, last-

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mile delivery operators in logistics are private companies that operate freely within a competitive market, without concessions or public funding.

Key requirements and challenges

Considering the requirements for the overall evaluation for the Madrid case study, following points are identified:

- Collaborative Framework: This case study's development necessitates a collaboration between passenger and freight transport operators, especially for last-mile delivery services. Techniques that enable this collaboration need to be devised and put into action.
- Governance Model: A governance model must be established to facilitate effective collaboration between passenger and freight transport operators.
- Vehicle Adaptation: This case study aims to utilize the surplus in public transport for last-mile delivery tasks. As such, public transport vehicles should be adaptable to carry both passengers and freight, ensuring the safety of both passengers and goods.
- Passenger Comfort: The primary focus of the public transport service is passenger transport. Therefore, the case study should at least maintain the level of service and overall experience for passenger travel.
- Stakeholder Involvement: The case study involves a broad spectrum of stakeholders, including local mobility operators, transport authorities, traffic management entities, transport technology providers, research institutions, and civil society associations. Effective communication and collaboration with these stakeholders are essential for the case study.

3.1.2 Netherlands

Overview and objectives

The Province of South Holland, situated in the western part of the Netherlands, is home to the cities of Rotterdam, The Hague, and Leiden. Each of these cities hosts a university and a large student population. The Port of Rotterdam, one of the world's largest ports, facilitates extensive goods transportation to the hinterland. The province's coastline, featuring popular destinations like Hoek van Holland, Scheveningen, Katwijk, and Noordwijk, draw a large number of visitors, particularly on warm, sunny days. In the province's northern region near Lisse, the internationally acclaimed Keukenhof flower park opens for eight weeks each spring. The region's primary mobility challenges are associated with Keukenhof, the coastal beaches on warm and sunny days, and planned large-scale roadworks, especially when these three major events coincide.

The primary objectives of this case study are:

- Optimizing the use of existing infrastructure,
- Encouraging sustainable mobility habits,

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- Integrating programming, traffic, and mobility management,
- Adopting innovative and data-driven solutions,
- Leveraging shared ambitions among partners to promote closer regional cooperation,
- Establishing connections with adjacent regions and countries.

Three primary disruptive scenarios are under consideration:

- Roadworks: Extensive infrastructure projects significantly affect regional mobility. From 2024 to 2027, multiple roadworks from various road authorities will occur simultaneously. A smart multimodal approach is necessary to maintain the area's regional accessibility.
- Beaches: On warm and sunny days, the Dutch coast attracts numerous day-visitors, some even from Germany. Parking spaces tend to fill up quickly, leading to congested roads to the coast and significant delays in public transport.
- Keukenhof: Each spring, the road network experiences additional pressure when the internationally famous Keukenhof flower park attracts millions of local and foreign tourists. During Keukenhof's 8-week opening period, the park welcomes approximately 1.5 million visitors.

Stakeholder mapping and governance model

Different stakeholders are identified and divided based on the areas in the CS as follows:

Considering all areas:

- The Province of South Holland: This entity oversees the management of provincial roads and plays a coordinating role in collaborating with municipalities for roadworks planning, specifically through RegioRegie.
- Zuid-Holland Bereikbaar: This is a collaborative initiative between the Province, large municipalities, Rijkswaterstaat, ProRail, and the Port of Rotterdam aimed at enhancing the province's accessibility. RegioRegie is a part of this collaboration.
- Rijkswaterstaat: This is the national Road authority responsible for managing the national highways. A crucial component of Rijkswaterstaat in this region is the Traffic Management Centre Rhoon (Regiodesk), which oversees Traffic Management for key motorways like A4, A44, and incident management, among others.
- Public Transport operators (specifically ARRIVA NL, Qbuzz after 2024, and possibly other PT operators): These operators, who manage mobility in the area, are crucial. Public transport operators are assigned to specific areas through concessions, necessitating multiple operators for complete coverage.
- SYNCHROMODE partners: These partners play a vital role in the development of the toolbox and the provision of expertise.

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Keukenhof: The additional stakeholders include Keukenhof/Bulb region, Province of North Holland, Bulb region municipalities, tour operators, tourist organisations, traveller's organisations, and bike renting services.

Beaches: The additional stakeholders include entrepreneurs in the beach area relying on beach visitors, local municipalities, and parking area owners.

Roadworks: The additional stakeholders include relevant road authorities, Zuid-Holland Bereikbaar/RegioRegie, traffic control centre (IC desk and desk room), and construction companies.

Considering the current governance structure, Zuid-Holland Bereikbaar is responsible for coordinating logistics and traffic management in the province. This is achieved through an area-specific approach, with each of the five sub-areas having its own dynamics. For each area, an analysis is conducted to understand the tasks related to the planning of roadworks, traffic management, mobility management, and communication. This implies that for each area, the following are necessary:

- Regular meetings for regional coordination of roadworks
- An "Area table" where companies, municipalities, partners, and other stakeholders can voluntarily participate.
- The organization of a structured area approach involving partners and municipalities around traffic management, mobility management, and communication
- Communication with mobility advisors who have expertise in each area, for employers and logistics.
- The organization of meetings for companies in the area to inform them about ongoing activities in the area and upcoming roadworks.

In some areas, company communities are established to facilitate knowledge sharing, inspiration, and activation. The Bulb region/Keukenhof has implemented a traffic management script aimed at enhancing traffic flow by redirecting road users to alternative routes during congested traffic situations. Construction companies are obligated to adhere to the roadworks planning they provide during the quotation period within the framework of the request for quotation.

Key requirements and challenges

Considering the requirements for the overall evaluation for the Netherlands case study, adequate execution of the evaluation for each distinct traffic management measure is necessary. Each measure will be designed with evaluation as a key consideration. Specific Key Performance Indicators (KPIs) will be established and measured during the operation of the traffic management measures.

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3.1.3 Thessaloniki

Overview and objectives

The broader Thessaloniki Metropolitan Area's transport network provides an ideal setting for addressing various research objectives within SYNCHROMODE. Its unique 'butterfly' shape funnels most through traffic into four main arteries, making it vulnerable to both planned and unplanned events that significantly affect overall traffic conditions (UC T.1). Moreover, the widespread use of secondary roads, in addition to major arteries, presents a need and opportunity for area-wide monitoring with synthetic KPIs (UC T.5).

As a significant regional multi-modal hub featuring a port, railway station, and airport, Thessaloniki extensively employs combined passenger and freight transport (UC T.2). In terms of public transport and Mobility as a Service (MaaS), the city boasts an extensive bus network, multiple micro-mobility options, and anticipates the introduction of its first two Metro Lines (UC T.3). These options, along with efforts for multi-modal load balancing, have the potential to significantly enhance the network capacity utilization (UC T.7).

While the regional Traffic Management Centre (TMC) manages most of the traffic, additional TMCs exist or are planned. This, coupled with the presence of multiple service providers, highlights the need for a coordination framework (UC T.6). Various stakeholders contribute data, which can be valuable if their exchange is properly facilitated (UC T.8). Among these data sources, floating car data (FCD) allows for experimentation with higher fidelity traffic management and more accurate traffic pattern predictions (UC T.4). Lastly, existing simulation assets form the basis for exploring how emerging traffic modes, such as Connected and Autonomous Vehicles (CAVs), can be effectively managed (UC T.9).

Stakeholder mapping and governance model

Key stakeholders for the Thessaloniki use case include:

- Traffic Management Centre (TMC): Operated by the Region of Central Macedonia, it collects and processes traffic data and formulates traffic management plans.
- Technology Providers: Companies like Yunex Traffic, Swarco, and Scae that develop and supply technology solutions for traffic management.
- Data Providers: Organizations like the National Access Point, CERTH-HIT's open data portal, TomTom, and commercial fleets providing real-time Floating Car Data (FCD), which collect and distribute traffic-related data.
- Emergency/First Responders: Specialized units like Traffic Police, Fire Brigade, EKAB - National Emergency Centre, and the Civil Protection that respond to emergencies affecting the transportation network.
- Fleet Managers/Operators: Entities like OASTH, Taxiway, KTEL, and urban delivery companies that manage vehicle fleets.

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- Railroad Operators: Entities like Hellenic Train that manage and operate passenger and freight train services.
- Parking Service Providers: Entities like OtoParking, the Port of Thessaloniki, and municipal off-street parking services that manage parking spaces supply.
- Shared Micromobility Fleet Operators: Organizations like Brainbox, HOP, and FreeNow that provide shared transportation options such as bicycles, electric bikes, and scooters.

In Thessaloniki and the wider Central Macedonia region in Greece, several key organisations contribute to transportation governance and public service delivery. These include regional administrative authorities, public transportation operators, rail transport providers, port services, intercity bus service providers, traffic police, emergency assistance coordinators, metro system operators, and taxi fleet operators. In the dynamic environment of Thessaloniki and the broader Central Macedonia region in Greece, several organizations play key roles in transportation governance and public service delivery. These include:

- Region of Central Macedonia (RCM): A major regional administrative authority in Greece, responsible for operational traffic management in the wider Thessaloniki metropolitan area among other governmental functions.
- OASTH: The primary public transportation bus operator in Thessaloniki, managing a comprehensive network of buses serving urban and peri-urban areas.
- OSETH: Responsible for developing and managing public urban transport in Thessaloniki, with a focus on sustainable mobility.
- Hellenic Train: Greece's primary rail transport provider, offering urban, regional, and international passenger and freight services.
- ThPA S.A. – Port of Thessaloniki: Specializes in port services at the Port of Thessaloniki, including handling containers and conventional cargo, and providing logistics solutions.
- KTEL MACEDONIA: A major intercity bus service provider based in Thessaloniki, Greece, managing the largest bus terminal in Greece.
- Traffic Police: Responsible for managing and regulating traffic in the region.
- EKAB: A Public Legal Entity operating under the Greek Ministry of Health, coordinating the provision of immediate assistance and urgent medical care in emergencies.
- THEMA: A newly founded company created to operate the upcoming Thessaloniki Metro System.
- Taxiway: The largest taxi fleet in the Balkans with 1200 vehicles.

Key requirements and challenges

The prerequisites for the evaluation framework are structured to bolster the objectives by offering explicit criteria and methodologies for evaluation. These prerequisites encompass:

- Ongoing surveillance of the network.

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- Real-time collection of traffic-related data.
- Employment of traffic simulation models to forecast results and evaluate the potential effects of diverse traffic management strategies under a variety of scenarios.
- Establishment of suitable performance indicators.
- Involvement of stakeholders.
- Acceptance by users.

3.2 Key conclusions from user needs and system requirements definition

This subchapter focuses on the key conclusions inferred from the first set of workshops in the SYNCHROMODE case study areas i.e. Madrid, Netherlands, and Thessaloniki; and the user survey gathering feedback on their needs and opinions towards traffic management strategies. This task was part of the WP2 T2.1 titled 'User needs and system requirements definition'. For further in-depth details, please refer to deliverable "D2.1 Report on user needs and system requirements definition for each case study" within WP2.

3.2.1 Key takeaways from initial workshops

In the initial phase, two workshops were held in each case study area except for the Netherlands case study where an additional workshop was organised due to its diverse applications to be considered within the SYNCHROMODE toolbox.

Madrid case study: Considering Madrid case study, the workshops included SWOT analysis on the case study solutions and Enabler's analysis in World Café format. Expected impacts, along with challenges and risks for different stakeholders such as transport authority, public transport operator, last-mile delivery operator, public transport user, parcel receiver user, and citizens were collected. For instance, in Madrid the solutions presented an expected impact of potential resource reduction for public transport operators due to increased revenue for them from parcel delivery. For the last-mile delivery operator, reduction in the travelled distance was foreseen mitigating occupational risks due to road accidents in busy road links. For public transport user, increased bus peak hour frequency due to parcel allocation in buses, and better service to rural areas was expected by making use of DRT services and demand prediction. Regarding the users receiving parcels, reducing environmental impact through longer delivery times had the potential to attract new users who did not use the service due to environmental concerns. For citizens, expected benefits included traffic alleviation, travel time improvement and emission reduction. Maintaining and increasing community engagement in rural environments was foreseen through involvement of small businesses (working as hubs or lockers).

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Regarding challenges, definition of legislation and policies determining eligible goods to be transported with passengers was identified. Installation of lockers in transport hubs, terminals and/or bus stops was also a challenge for the transport authority. Negative impact of parcel delivery in buses regarding punctuality and bus waiting time at stops was a concern for public transport operators. In addition, considering transport of passengers and parcels together, new insurance agreements would potentially make it more expensive. For the last-mile delivery operators, sharing business data with external entities was a challenge. Responsibilities surrounding parcel custody between various stages of the delivery required clarity (this also included situations managing non-delivered parcels). For the public transport user, maintaining level of service was identified as a potential barrier. While for the end users receiving parcels, behavioural change towards receiving parcels from a locker than a home delivery was a challenge. Overall, for the citizens it was important to make sure that there is efficient coordination and cooperation between different agents, from public transport operator to logistic operator. Strict EU directives determining disposition and characteristics of peri-urban and inter-urban buses was another challenge which would have an impact on the public.

A data and decision flow were proposed by different groups for the Madrid case study (as seen in the figures below). Following the results from the first workshop, the second workshop focused on stakeholder preferences and needs considering SYNCHROMODE tool usage, design and upscaling, operational and technical aspects and multimodal network and service models. The services and functionalities of the toolbox were to be defined in accordance with the 3 main services i.e. discussing necessary data connections, data governance, access conditions for Service 1, selecting relevant visualisations, indicators to show and scope of prediction for Service 2, and gathering restrictions and priorities for optimisation processes and selecting parameters to optimise based on service indicators relevant for users and operators for Service 3.

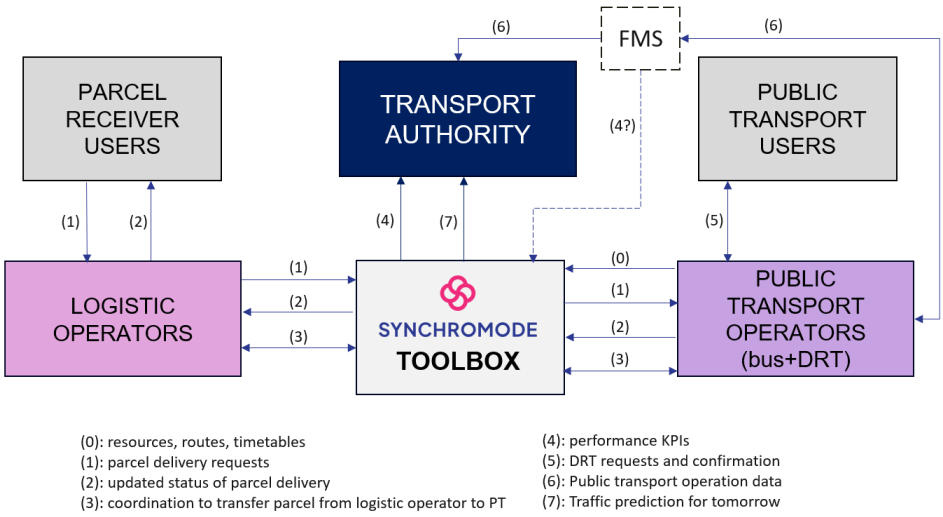

Figure 3: Proposed data flow for Madid case study.

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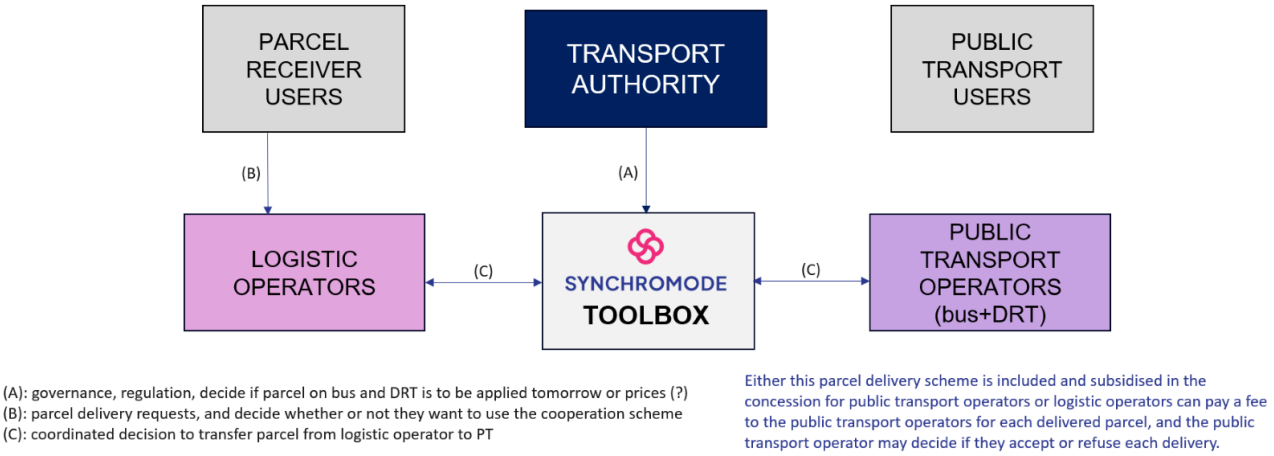

Figure 4: Proposed decision flow for Madid case study.

Netherlands case study: The first stakeholder workshop was organised near Keukenhof, where the workshop was split in three parts focusing on problems pertaining to different organisations, impact canvas, and overall organisation, information and implementation. Considering current problems and bottlenecks from regional stakeholders, filling up of arterial roads towards Keukenhof (especially on N207/208, where accidents add to the congestion), Stationweg and Lisse were a concern for the municipalities. This in turn has an impact on the economy of Lisse with commuters leaving or returning in the evening hours. The dense traffic also increases probability of congestion in different smaller roads in the network. Following this, the Lisserbrug bridge operations has an impact on traffic jams potentially leading back to the highway. Absence of measurements on the municipal roads was also identified as a challenge. For Arriva, major barriers included lack of reliability on real-time data, delayed services, bridge operations, and longer travel times for the road users. For the province of Zuid-Holland (regional coordinator and IC desk), rat running (e.g., a small road used by many vehicles to avoid traffic on major roads), cut-through traffic (causing road safety issues for other road users such as cyclists) and lack of clarity for car users at the entrance of Keukenhof were some of the identified problems. Maintenance on highways like A44 will have a major impact for Rijkswaterstaat, where maximum capacity will be 75%. From the perspectives of traffic model developer, development of housing was another factor which was important to be considered while addressing the case study solutions.

Considering the expected impact from the proposed solutions in the Netherlands case study, various aspects were taken into consideration. These included solutions influencing pre-trip activities, on-trip activities, parking, dynamic traffic management, modal shift and safety. For the pre-tip activities, traffic alarm for residents or people working in the areas to reduce overall traffic was envisioned. This would assist Arriva in maintaining timetables, leading better informed travellers. For the on-trip activities, aligning information on text cars and navigation apps presented opportunities for VM-IVRA (sending text car info through DIB). Spreading traffic earlier according to

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currently used traffic management scenario, would allow less vehicles on N207/N208, which potentially results in higher throughput in and out, and higher MFD flow. The opportunities related to it included using RWS-PZH web-applications for incidents or traffic jams and in-car information. The solutions were expected to allow clear information for travellers resolving miscommunication in parking areas and entrance of Keukenhof. This presented an opportunity to adjust addresses in navigation systems (via open street maps, Keukenhof website, etc.). Through dynamic traffic management involving scenario advice, the benefits included less traffic jams with opportunities identified as there was enough knowledge (including data) and technology for its implementation. Considering bridge opening in Ringvaart, via earlier communication of bridge opening, and not opening bridge during busy traffic had expected benefits of less stand-still traffic around the intersections near the bridge. This would influence water traffic and bridge operations. Focusing on the modal shift, the solutions involved making more shared bikes at Hillegom station, making renting easier, sharing information on Keukenhof website about public transport and bike sharing, combining tickets and providing facilities such as P+R. This presented opportunities of implementing P+R in navigation systems and informing people on road. Lastly, considering safety while some of the actions were out of scope within the case study, ideal measures were discussed. These included changing advised routes to avoid busy routes reducing conflict points with cyclists and providing clear area for pictures by providing photo-tours and reducing parking possibilities at unsafe spots.

Following this, the second workshop was organised at ARRIVA bus depot, with the agenda focusing on regional traffic insights, variables impacting traffic demand and predicting traffic demand. Considering regional traffic insights, important intersections or busy roads were identified and ideas for analysing the traffic flow in the area were gathered. This was followed by identification of data sources that could be used for analysis of traffic patterns in the area, as well as prediction of traffic demand on a long and short-term basis. Key traffic insights included considerations regarding Duinrell and Kagerplassen, understanding of the overnights stays, assessment of parking lots, leveraging timing variations considering commuting hours and holiday traffic. Different variables impacting traffic demand were identified. These included data sources and variables, Keukenhof bloom visibility, coast guard predictions for emergency services, challenges with train OD relationships, understanding diverse traveller types, and Arriva's insight into passenger movement. Lastly, for predicting traffic demand, integration of information, ARRIVA's capacity optimisation, provincial goals, Strandradar example, dual information streams, time scale considerations, traveller communication channels and influencing user behaviour were identified as major key points. Due to the Dutch case study having wide variety of applications, a third workshop focusing on data-driven roadworks planning was organised. The results from the workshop were used to define user stories and will be utilised as discussion points for WP4 and WP5 as the use case is supported via traffic modelling and optimisation approach.

Thessaloniki case study: The first stakeholder workshop focused on fostering engagement and validating requirements identified for the Thessaloniki case study. The workshop included interactive sessions via serious game and SWOT analysis approach. Considering the use cases for the case study, the SWOT analysis included (6 in total) resilient TM – event management, combined

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passenger and freight transport management, traffic management and MaaS, coordination between multiple TMCs and/or TMCs and service providers, multimodal load balancing, and real-time data exchange between various actors.

Based on the analysis for the use cases, the three key points were suggested towards expediting first use case i.e. resilient TM-event management. These involved enhancing data reliability, inclusive technology adoption and improved stakeholder collaboration. For the second use case i.e., combined passenger and freight TM, five key points were identified supporting its execution. These included addressing weakness of information reliability by enhancing data reliability via data verification methods (improving decision making and public trust), strengthening stakeholder collaboration, balancing transport needs of public, private and freight transport, implementing data-driven decision making, and monitoring consumer behaviour trends. For the third use case i.e., TM and MaaS, three key steps fostering its execution included increasing public engagement and education, integration of different transport modes and user experience, and promoting infrastructure development. For the fourth use case i.e., coordination between multiple TMCs and/or TMCs and service providers, four key measures were identified to accelerate use case implementation. These included integration strategies developing standard protocols for data integration, advocating for regulatory frameworks facilitating collaboration (while ensuring GDPR compliance), building trust addressing mindset differences through regular stakeholder meetings, and leveraging strengths by utilising capabilities of private entities in data processing and technology. Steps to expedite application of the fifth use i.e., multimodal load balancing included exploiting new metro systems, increasing public transport options, addressing inclusivity in transportation by developing strategies, collaboration with private sector and managing system maturity levels by addressing the threat of varying service levels in different transport modes. Considering the sixth use case i.e., real-time data exchange between various actors, steps fostering its implementation included creating data sharing incentives, establishing a coordinating body for data exchange standards/protocols, cultivating cooperation culture by implementing initiatives and workshops, leveraging underutilized data enhancing planning quality and situational awareness, and integration of big data and AI to improve predictive capabilities and service quality.

Considering the second digital workshop, the agenda included evaluation of the services of the SYNCHROMODE toolbox. Based on the analysis and insights from the ranking-based responses, priority towards data of different nature, priority towards use cases, and priority towards SYNCHROMODE services were reflected. Considering priority towards data types in terms of their importance to the TMC, data regarding planned events (e.g., road works), followed by data regarding unplanned events (e.g., road accidents) and public bus-related were ranked the highest. The data types ranked at the bottom included rail transport related-data and shared vehicle-related data. This shows a contrast between the public transport modes of bus and rail service. Emergency service ranked access to parking-related data as their top priority, suggesting their perception of off-road parked cars as obstacles when they attempt to reach their destination. For the six use cases, real-time data exchange between various actors and resilient TM-event management were ranked the highest. Considering the SYNCHROMODE service prioritisation, transport network-wide data

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exchange and integration was prioritised the most followed by real-time monitoring and prediction of network-wide multimodal transport and traffic.

3.2.2 Inference from user survey

Referring to the user survey (i.e. SYNCHROMODE Deliverable D2.1), the results address the public opinion towards traffic management strategies and their multimodal needs, expectations, and concerns.

Madrid case study: Access to real-time traffic information is viewed positively by most survey participants, with 73% believing it could decrease city traffic congestion. Additionally, 64% think it could alleviate travel stress, and 58% feel it could cut down travel time. A small minority (1-3%) expressed concerns about privacy threats, increased traffic congestion, or no impact on traffic. This highlights the generally positive attitude towards real-time traffic information as part of an intelligent transport system.

In terms of data privacy, which is protected under GDPR, the survey revealed varying attitudes towards data sharing. A majority (56%) disagreed with sharing data with private companies. However, over 60% were somewhat agreeable to sharing data with public authorities, road authorities, or municipalities. When it came to sharing data with other road users, the responses were mixed, with 47% agreeing to some extent and 34% disagreeing. Regarding the role of various institutions in improving local traffic conditions, a significant majority (84%) viewed the role of public authority as important. The EU's role was seen as important by 53% of respondents. The roles of international organizations like the UN or OECD were viewed as slightly important (24%) or not important (35%).

The primary solution under consideration is the use of public transport for parcel delivery. A substantial majority (over 50% of respondents) concurred that this approach would lower greenhouse gas emissions, be more eco-friendly, and mitigate road congestion due to freight traffic. However, there was no clear agreement among respondents about potential cost savings in parcel shipping. When it comes to actions by end-users, such as receiving parcels on public transport, there was a consensus among respondents in favour of all measures associated with using public transport for parcel delivery.

The survey reveals a positive outlook towards the use of real-time traffic information, with most participants believing it can reduce congestion, stress, and travel time. However, there are mixed feelings about data sharing, especially with private companies. Most respondents see a significant role for public authorities and the EU in improving traffic conditions, but the roles of international organizations are viewed as less important. The results indicate strong support for using public transport for parcel delivery, with most respondents believing it can reduce greenhouse gas emissions, be more eco-friendly, and alleviate road congestion. However, opinions vary on potential cost savings. There is also general agreement on end-user actions related to parcel delivery on public

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transport. Preferences for public transport frequency during peak hours vary, with different preferences noted among public transport users, individuals with mobility impairments, and urban, suburban, and rural residents. The results underscore the importance of considering diverse perspectives in traffic management.

Netherlands case study: In the survey, 45% of participants reported no issues with traffic to and from amusement parks in their vicinity. This stands in contrast to the inconvenience caused by roadworks, which was more frequently experienced by 71% of respondents. Nuisances related to beach areas (48%) and Keukenhof (43%) followed. Many user groups, including car drivers, cyclists, pedestrians, other micro-mobility users, and public transport users, reported frequent nuisances from roadworks. This highlights the widespread impact of roadworks on different modes of travel in the Netherlands.

The survey also identified the frequency of various nuisance impacts. These included air quality issues, extended travel times, vehicle noise, and rat running (the use of smaller roads to avoid major road traffic). 'Longer travel times' were frequently experienced by 77% of respondents, contrasting with other types of nuisances. Respondents also mentioned other impacts, such as larger vehicles blocking smaller ones, air traffic, improper driving behaviour, limited parking availability, bridge openings causing delays, single-lane two-way traffic, unsafe areas for cyclists, tourist traffic influx, and speeding vehicles.

To cope with these nuisances, respondents shared various strategies. Leaving home early to avoid traffic jams (used 47% of the time when faced with nuisance) and changing travel routes to avoid nuisance (used 49% of the time when faced with nuisance) were frequently employed. Changing travel modes or working from home was not applicable to many users (more than 50%), due to inflexibility in changing travel modes and work conditions (such as not allowing a hybrid working lifestyle or being unemployed). In terms of addressing traffic inconveniences, respondents showed a preference for a notification service about expected nuisances. While 34% of participants were not interested in this service, the remaining 66% showed varying levels of interest.

The survey reveals that while a sizeable portion of respondents experience no traffic issues related to amusement parks, nuisances from roadworks are more prevalent and affect various modes of travel. Impacts include longer travel times, air quality issues, and vehicle noise, among others. To cope, respondents often leave home early or change their travel routes. A notification service for expected nuisances is preferred by many, though its implementation would require careful consideration of privacy and data-sharing guidelines. These findings contribute valuable insights for addressing traffic management challenges in the Netherlands.

Thessaloniki case study: A significant majority of respondents (79%) were confident that real-time traffic information could ease urban congestion. Furthermore, 74% thought it could lessen stress related to travel, and 69% expected a reduction in total travel time. A small percentage (3-10%) expressed concerns about privacy risks or potential increases in traffic congestion due to such

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access. These results, like those from the Madrid case study, highlight the positive attitude towards using real-time traffic data among various user groups, with the aim of benefiting from an intelligent transport system.

In the context of GDPR ensuring data privacy, the survey explored participants' willingness to share data with different entities. Thirty percent of respondents disagreed with sharing data with private companies. In contrast, over 70% showed some level of agreement to share data with public authorities, road agencies, or municipalities. As for sharing data with other road users, 44% agreed to some extent, while 18% disagreed. When asked about the role of various institutions in improving traffic conditions in their residential areas, the majority (74%) of respondents considered the role of the public authority to be important (either very important or extremely important). Thirty-three percent found the EU's role to be important. The roles of international organizations like the UN or OECD were seen as slightly important (38%) or not important (15%). The role of private companies was considered moderately important by 59% of the survey respondents.

In terms of proposed traffic management solutions, a significant majority of respondents (87%) expressed approval (with 62% strongly agreeing and 25% somewhat agreeing) for prioritizing buses at signalized intersections to minimize delays and enhance service quality. This was followed by approval for dynamically changing speed limits (77%), which involves adjusting vehicle speed limits in certain areas to manage congestion and facilitate smoother traffic flow, and dynamic parking pricing (72%), which involves varying parking charges based on demand to optimize parking space use, reduce congestion, and promote alternative modes of transportation. Dynamic congestion charging, which involves imposing higher fees for vehicle use and services in congestion-prone areas, received some form of approval from 46% of survey respondents. However, 33% of respondents, of which 39% were car users, expressed some form of disagreement with the dynamic congestion pricing approach.

Regarding comfort levels with data sharing services, the majority of participants (over 50%) expressed some level of comfort (either extremely comfortable or somewhat comfortable) for all mentioned conditions. These conditions included using the data for improved traffic management by the traffic authority (87%), using data to provide offers (e.g., cheaper or free parking, priority at traffic light junctions) (85%), and using data to offer personalized information and services (69%). In terms of the importance of different groups having access to information focusing on congestion and traffic management measures, nearly all respondents (99%) believed it was either extremely or very important for emergency response agencies to have such access. This was followed by 82% for transport service providers and 49% for freight/commercial logistic vehicle/companies. When collecting opinions on the importance of the basis for traffic management strategies, increasing road safety was the top priority for almost all (97%) of the survey respondents.

The survey indicates a strong belief among respondents that real-time traffic information can alleviate urban congestion, reduce travel-related stress, and decrease overall travel time. However, there are some concerns about privacy and potential increases in traffic congestion. When it comes

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to data sharing, there is some resistance to sharing data with private companies, but a willingness to share with public authorities and road agencies. The role of public authorities is seen as crucial in improving traffic conditions, while the roles of the EU and international organizations are seen as less important. The results reveal strong support for traffic management solutions such as bus priority, dynamically changing speed limits, and dynamic parking pricing. However, there are mixed feelings about dynamic congestion charging, especially among car users. Most participants are comfortable with data sharing for improved traffic management, providing offers, and personalized services. Nearly all respondents believe it's crucial for emergency response agencies to have access to traffic management information, with significant importance also placed on transport service providers and freight/commercial logistic vehicle/companies.

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4 Methodology

This chapter focuses on the status quo of the cooperation frameworks and methodological aspects behind different management strategies via literature study involving public and private actors focusing on the multimodal traffic management. It also addresses the approach and the workplan execution during the timeline of SYNCHROMODE project.

4.1 Key reference frameworks

Considering different cooperation frameworks (involving different stakeholders) identified through literature and practice, this subchapter addresses the frameworks as follows:

4.1.1 SOCRATES 2.0

The SOCRATES 2.0 EU project promoted continuous deployment of EU-wide traffic management measures and mobile/in-car services for road users. The cooperation framework, developed in the project, is a type of governance model for collaboration between public and private actors. The idea is generated from recent developments in digitalisation and traffic management. Before, traffic management control centres dominated the data collection aspects on the roadside systems, having information on the road network and conveying information to the road user through Variable Message Signs (VMS) or other types of information provision methods. With the onset of technological advancements in the smartphone and in-car navigation systems, a new set of data collection is being undertaken by private actors. As an example of a scenario, in the Netherlands, there are interfaces available to notify the road user of approaching emergency vehicles (e.g., ambulance). To have such an advanced mobility ecosystem, the sharing of information plays a key role between diverse users and actors, i.e. public and private.

This led towards the development of a framework for cooperation with new and improved traffic and navigation services. The SOCRATES 2.0 cooperation framework focuses on shared benefits involving three important stakeholder groups i.e., the end users (i.e., the road users), the road authorities (i.e., traffic centres) and the service providers (e.g., the automotive industry). While the road users prioritise, better services allowing them fast and efficient transport from A to B, road authorities prioritise on effective traffic management, and service providers usually focus on better business opportunities.

The SOCRATES framework aims to align these goals in a win-win-win scenario within the traffic management. It involves three models of cooperation from simple to complex. The first level focuses on the exchange of data where different actors within the traffic management ecosystem can exchange their data based on the agreed protocol. The second level of the framework adds to the exchange of data and includes a shared view which involves developing a common viewpoint of

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agreed information (e.g., environmental zones and road works). Furthermore, the third level (in addition to the exchange of data and shared view perspectives in first two levels) takes coordinated approach into consideration, where the end user services are coordinated (e.g., smart route advice).

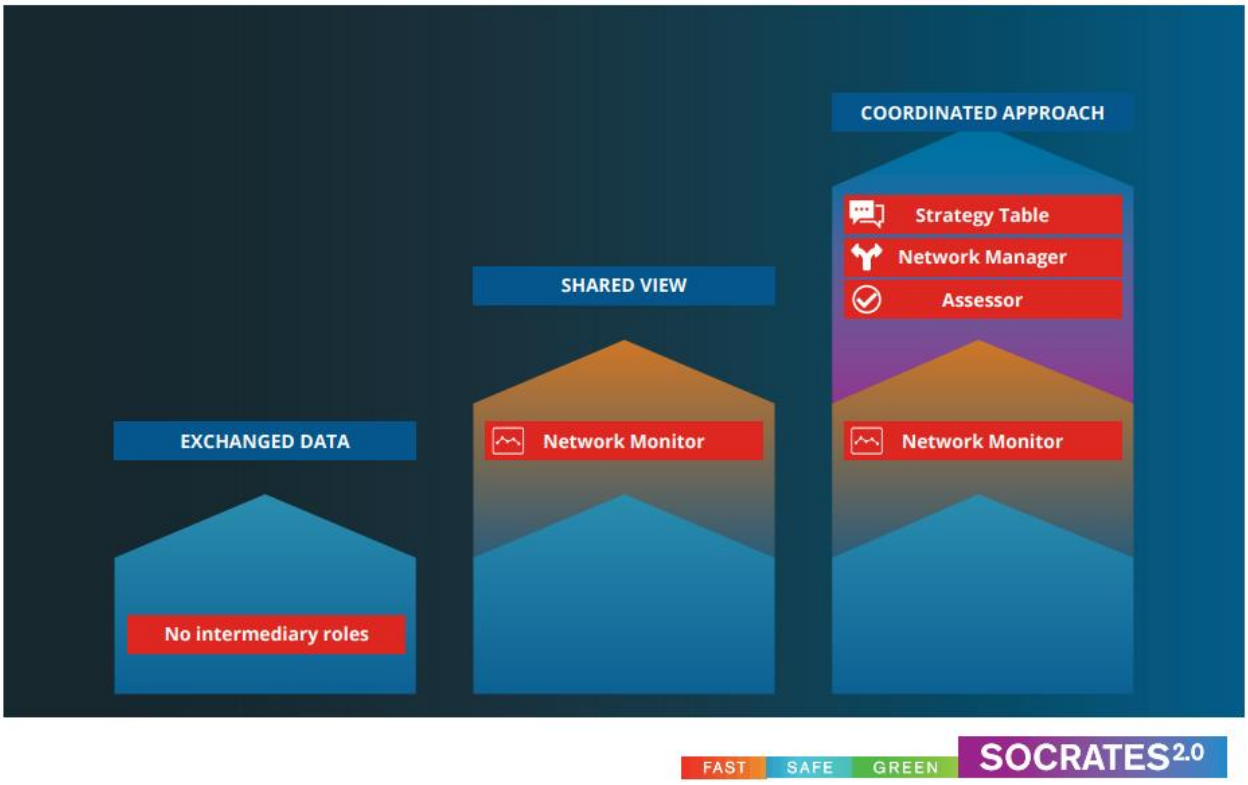

Figure 5: Cooperation models in SOCRATES 2.0.

The SOCRATES 2.0 framework defined a series of new intermediary roles for the effective implementation of the MTM cooperation models (Figure 6):

- Network Monitor
- Network Manager
- Assessor
- Strategy Table

Within the network monitor role, data is collected leading to the completion of datasets, following which the data is used to determine the current network state in form of a common operational picture, which is then distributed to the relevant stakeholders. On the other hand, the network manager uses the common operational picture to detect problems, propose solutions, and request the traffic management centres (e.g., the road authority) and service providers (e.g., the automotive industry or navigation providers) to activate certain services. The other roles, i.e. the assessor and strategy table provide key inputs towards the end of the role flowchart (as seen in the figure below). The assessor ensures performance monitoring and provides a neutral assessment of the impact, while the strategy table is the place where goals are aligned, collaborative strategies are formed

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and triggers and KPIs are determined between the stakeholders within the cooperation. Addressing public-private objectives, by taking joint action and developing a common language, a sustainable cooperation is foreseen to best serve the road user and community.

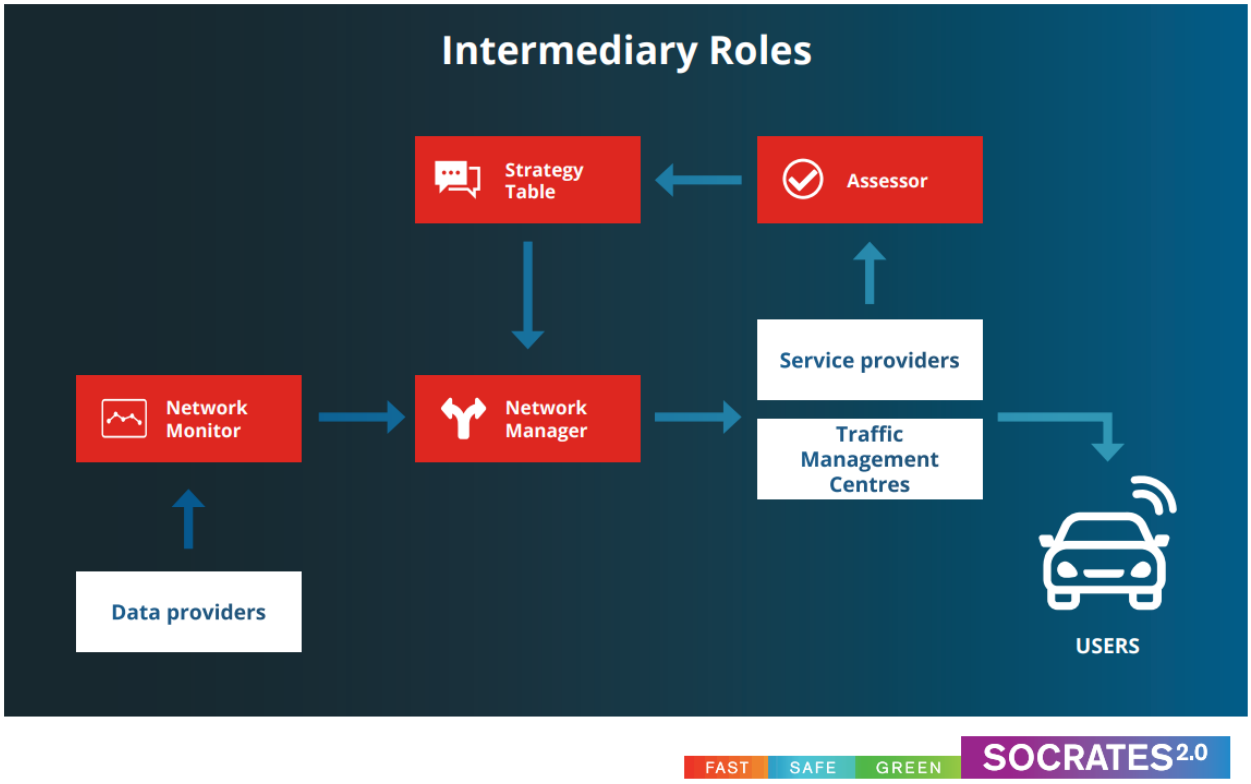

Figure 6: New intermediary roles for MTM (SOCRATES 2.0).

As seen in Figure 5, not all intermediary roles are required for all models of cooperation defined in SOCRATES 2.0. In fact, no intermediary roles are required for the 'Exchanged data' model, while only the network monitor role is involved in the second level of cooperation, 'Shared view'. The network monitor has the function of combining all the data into agreed KPIs and visualisations that the stakeholders can access. The third level, the 'Coordinated approach', includes all four roles i.e. strategy table, network manager, assessor, and network monitor. In summary, the framework supports data exchange between different partners (level 1), assists in enriching data for creating a shared view (level 2) and coordinates actions of traffic management centres and service providers (level 3).

The advantages of the first cooperation model (data exchange) involve both back-end and front-end perspectives, i.e. improved information coverage for public and private actors and enhanced service quality for end-users. On the other hand, the challenges include agreement on a standard for multiple partners, agreement on the ways of using the standard, keeping the use case scope manageable and cooperation from partners allowing data available and accessible. Regarding the second level of shared view cooperation model, the benefits (in addition to ones identified in the

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first level) include having a trusted intermediary entity operating as a network monitor enabling data sharing, establishing the same foundation for taking actions for all actors, and alignment of information provided to the users. The challenges for the shared view model include scaling of standardisation aspects from regional to national and EU-level, agreement on terms and conditions for sharing, modifying, and merging data, harmonised use of identified standards, agreement on a business model for data sharing and establishing trust between different actors. Lastly, for the coordinated approach within the cooperation model (level 3) identified benefits (in addition to the ones identified in the first two levels) include identification of common goals, agreed services per partner, and KPI framework as a common framework for operation; neutral assessment of performance indicators per partner for impact-driven business model, and enabling operation of coordinated actions. The challenges for the third level of shared view cooperation model include (in addition to the ones identified in the first two levels) appropriate governance and business models, tendering process, and establishing strategies motivating end users to behave in accordance with the common goals.

4.1.2 RAIM

RAIM (Albrecht Consult, Rupprecht Consult and Marketing Flow (2021)), a German framework for Architectures of Intelligent Mobility Services (translated from German), provides a guide for design planning, as well as the functional, technical, and economic implementation of intelligent mobility solutions. RAIM supports smooth communication between the actors involved on contractual, organisational, and technical levels.

The RAIM framework can be applied to structure existing services in the transport sector and facilitate cooperation between private and public actors in creating intelligent mobility services or enabling integrated management. It underscores the importance of promoting dialogue and consensus among stakeholders, especially when introducing new mobility services. The framework is primarily intended for mobility service providers, public transport companies, navigation service providers, app operators, regulators, authorities, and urban actors.

Rupprecht Consult, a partner in the RAIM project funded by the Federal Highway Research Institute (BASt) and co-author of the RAIM guidelines for implementation, will leverage this experience to enhance multi-actor cooperation and coordination efforts in SYNCHROMODE.

For the implementation of SYNCHROMODE's multi-actor cooperation processes and governance model, the RAIM framework serves as a valuable guide. It directs engagement efforts and addresses key topics and questions in a structured manner, managing typical uncertainties and challenges inherent in cooperative processes, particularly in a data-driven and highly innovative field with numerous actors.

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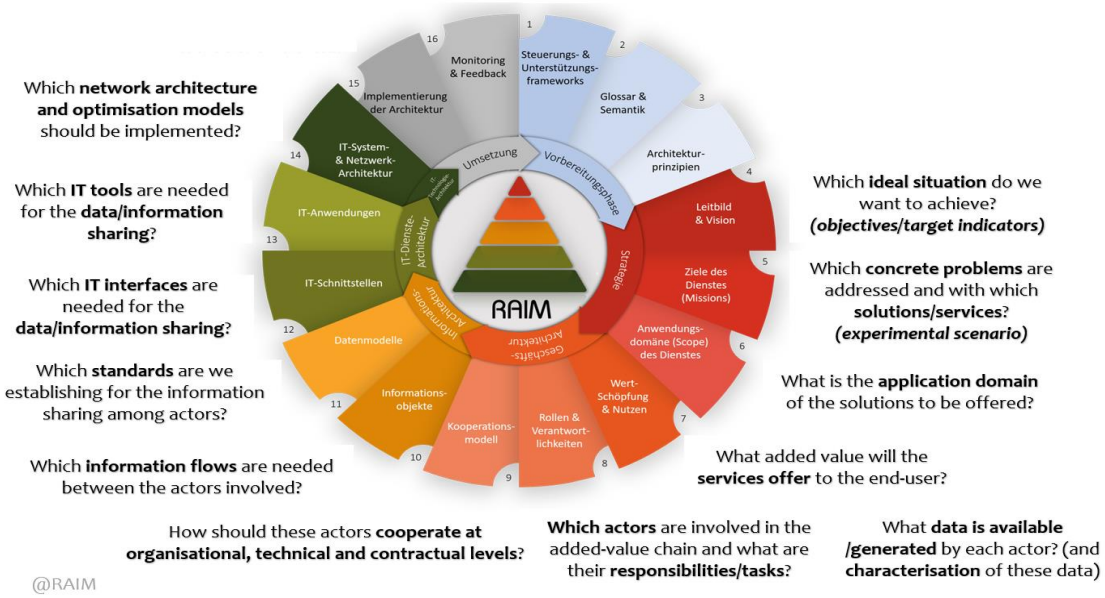

Figure 7: RAIM process.

The RAIM model is structured into sequential modules that guide the preparation, planning, and implementation of innovative solutions and service architectures. This methodology brings together key actors to achieve reliable compromises and design optimal cooperation models. It utilizes general building blocks that can be tailored to the specific objectives of each case study, along with tools to address data-based services, including data exchange between actors in the mobility sector. The planning process starts with a shared vision and defined goals, progressing through the delineation of individual processes, data exchanges, and agreements. It culminates in the selection of hardware, software, data sharing protocols, cooperation models, optimization measures, and network architecture.

4.1.3 SUMP

A transition towards sustainable mobility requires active support from stakeholders and the wider public. It is essential to involve all relevant stakeholders throughout sustainable urban mobility planning processes and, thus, address their specific requirements. The *Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan – SUMP* (Rupprecht Consult, 2019), promoted by the European Commission as a cornerstone for the implementation of sustainable urban mobility in Europe, have detailed recommendations when it comes to stakeholder engagement and participatory processes. A dedicated strategy is needed for the involvement of stakeholders, drawing on different formats and techniques when dealing with authorities, private businesses, civil society organisations, or all of them together.

Different involvement tools and methods for SUMP development exist (see Figure 2), some of which can be relevant in the context of SYNCHROMODE, especially for the implementation of the Toolbox and its services in each Case Study. Establishing involvement activities as part of standard planning

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practices and identifying the participation methods suitable for stakeholders is essential for the implementation of Multimodal Traffic Management solutions.

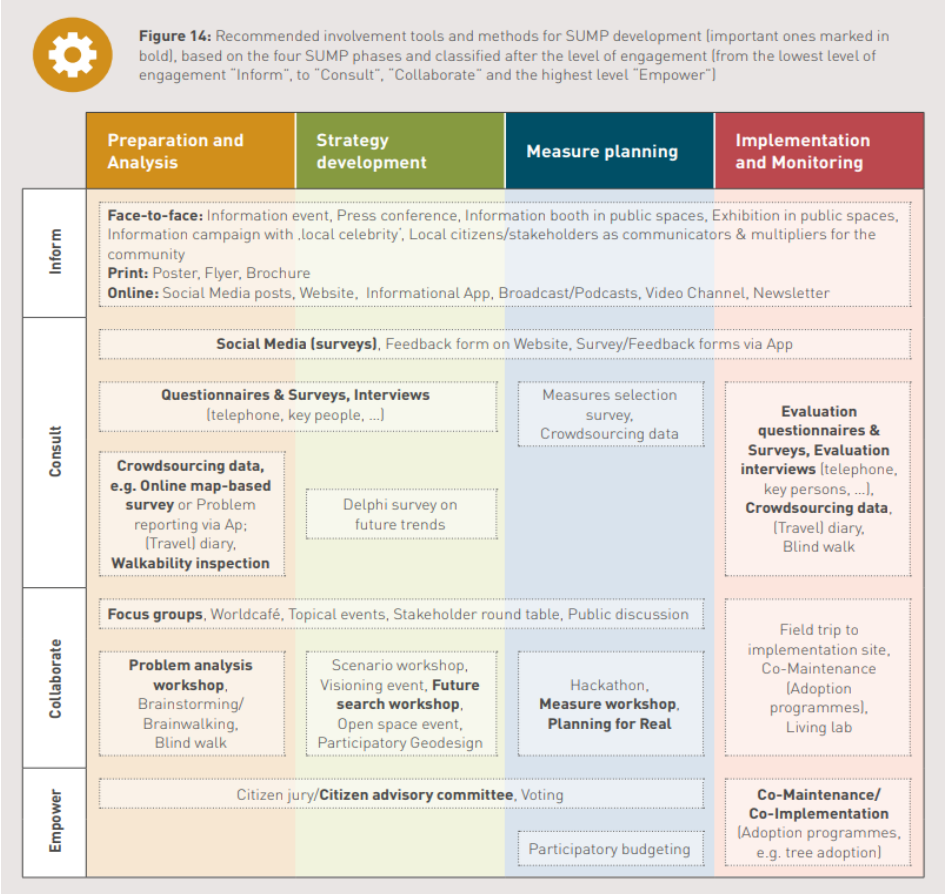

Figure 8: SUMP involvement tools and methods (Source: Rupprecht Consult, 2019).

The activities and types of engagement described in the figure above, respond to different levels of collaboration with stakeholders. Deciding which engagement to pursue with each stakeholder, requires a strategic analysis of the level of interest, capacities, and relevance of the involved actors in the planning process.

4.1.4 Change management (ÖSTO)

To guide the analysis of multimodal transport ecosystems and traffic management solutions for each Case Study, and to establish effective governance schemes and multi-actor cooperation practices, the SYNCHROMODE stakeholder cooperation and engagement efforts have utilized the OSTO System Model approach. OSTO stands for Open, Social, Technological, and Economic aspects, (based on the German term "Ökonomisch") and offers a holistic perspective.

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This methodology has recently been implemented and validated by Rupprecht Consult in projects like Dynaxibility4CE (Interreg Central Europe) and TANGENT (Horizon 2020) to support the planning of innovative mobility solutions. The Dynaxibility4CE experience demonstrated that this system-model approach allows for a structured and comprehensive analysis of the local context and conditions. This is particularly important when addressing innovative mobility solutions, given the uncertainty and complexity involved. A system-model perspective ensures that all relevant elements are considered, supporting a holistic planning process.

This approach will support the SYNCHROMODE processes, guiding the cooperative analysis of local conditions, needs (both operational and non-operational), and Multimodal Traffic Management measures.

Participative discussions and workshops, designed with the guidance of the OSTO model, focus on design elements and system behaviour to structure discussion topics and address all key aspects of the system design. To deal with the complexities of mobility innovations and their integration into urban transport systems, a structured analysis of the system's components is proposed, considering the core processes at organisational, social, and individual levels (Figure 9):

Figure 9: System-design elements (OSTO model).

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4.1.5 Conclusions and takeaways from the reviewed reference frameworks

The reviewed frameworks and methodologies provide a solid basis for the definition of a suitable approach for the set-up and implementation of effective multi-actor cooperation models in the SYNCHROMODE project.

The methodology and experience from SOCRATES 2.0 are of particular relevance for SYNCHROMODE, given the specific focus on multimodal traffic management solutions and the alignment of the multi-actor cooperation models proposed with the services in the SYNCHROMODE Toolbox. SYNCHROMODE partner MAPtm was part of the SOCRATES2.0 project and has been able to provide first-hand insights on the cooperation models and their adaptation for SYNCHROMODE.

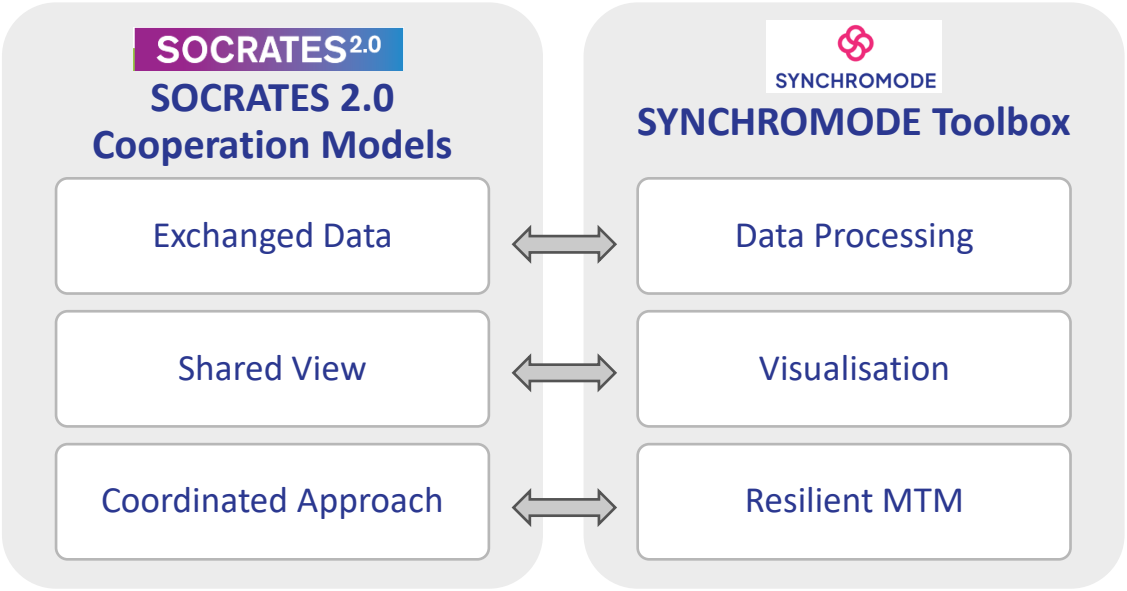

Figure 10: Alignment of SYNCHROMODE Toolbox services with the SOCRATES 2.0 cooperation models.

The SOCRATES 2.0 models provide a valuable basis for the identification and definition of the roles, tasks and interrelations among the actors involved in the MTM solutions, which construct the multi-actor governance and cooperation schemes. In SYNCHROMODE, these will serve as baseline examples to initiate the analysis of the required roles and tasks in each Case Study, to be further developed and adapted to also include the services provided by the SYNCHROMODE Toolbox and the functions of each involved stakeholder in its implementation.

Moreover, RAIM presents a planning and implementation framework for intelligent data-based mobility solutions. Following the SUMP logic, it provides a structured approach, including the definition of a common strategy, the mapping and engagement of key actors and the identification of their role in the value creation for the new service. It provides useful guidance to address central elements, such as data sharing, IT solutions, architecture, and interfaces with all involved

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stakeholders. In SYHCHROMODE, RAIM has served as guidance for the initial phases of the process, including the vision and impact canvassing and identification of stakeholder preferences and requirements. As project partner Rupprecht Consult was part of the development of the RAIM framework, it will continue to build on this knowledge to enrich activities in SYNCRHOMODE. During the next phases, the process will look into the RAIM framework for further guidance and good examples, specific discussion elements and guiding questions to address cooperation at operational, technical and contractual levels.

Besides, the tools and methods included in the SUMP guidelines (Rupprecht Consult, 2019) and the Change Management system-design approach serve to develop effective interactive formats for the direct engagement with stakeholders in each Case Study, ensuring a holistic and sustainable perspective, as well as long-term vision, are upheld.

Based on these reference frameworks, SYNCHROMODE has developed a methodology to guide the engagement of the diverse ecosystem of stakeholders involved in each Case Study and set up effective cooperations and governance schemes for their successful implementation.

4.2 Concept and work plan

During the first 9 months of the project, the initial phases of SYNCHROMODE's Case Studies multi-actor engagement and consultation processes took place. These tasks engaged with key local stakeholders and target users to present and validate the Case Studies and assess their preferences and system requirements for the SYNCHROMODE's toolbox implementation at each site.

To this end, a consecutive phased research strategy was undertaken, including different engagement and consultation formats, with a series of workshops with local stakeholders for each case study and an online survey for citizen consultation.

As described in Figure 11, these phases covered the preparatory and planning processes, the initial mapping and engagement of local stakeholders, the presentation and validation of the case studies, the assessment of the stakeholder needs and preferences, and system requirements for the SYCHROMODE Toolbox. These steps were performed within Task 2.1 (User needs and system requirements) and Task 2.3 (Case Study definition) of the project and reported on in more detail in D2.1 and D2.5.

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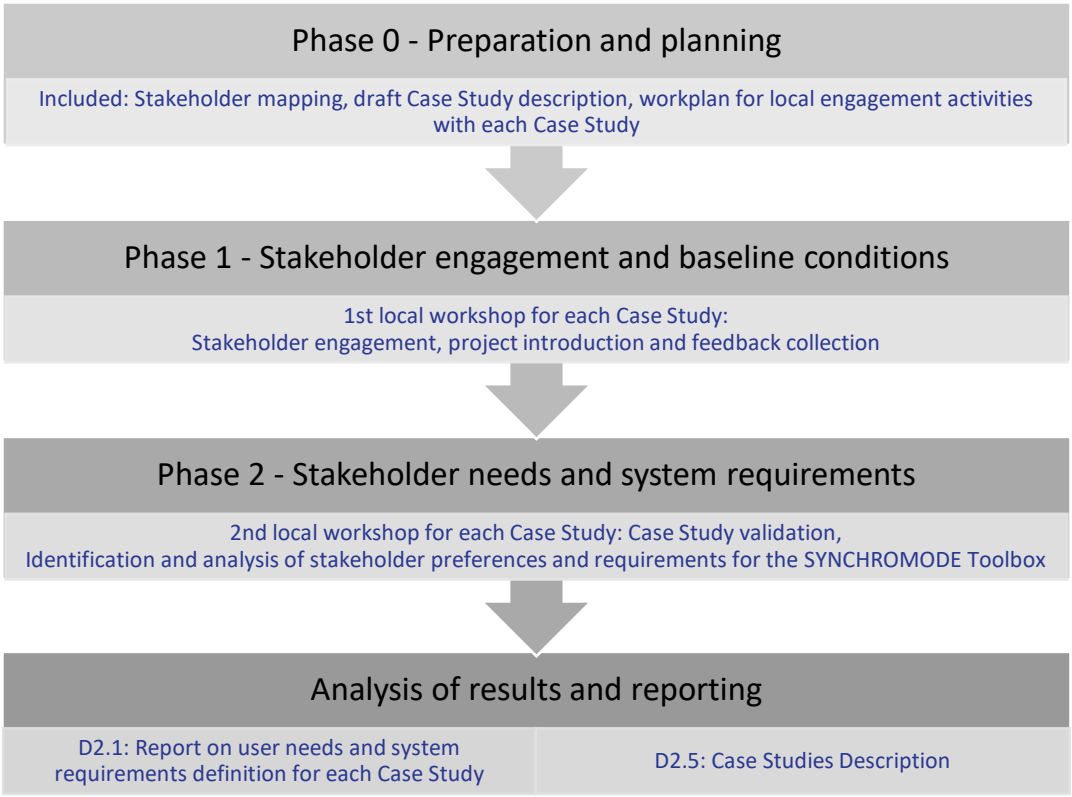

Figure 11: Completed phases of the multi-actor engagement processes in SYNCHROMODE.

The next phases of the multi-actor engagement in SYNCHROMODE focus on the establishment and evaluation of effective cooperation models and governance structures to enable the successful implementation of the project's Case Studies.

As described in Figure 12, three phases have been defined to take place between month 18 and month 36 of the SYNCHROMODE workplan.

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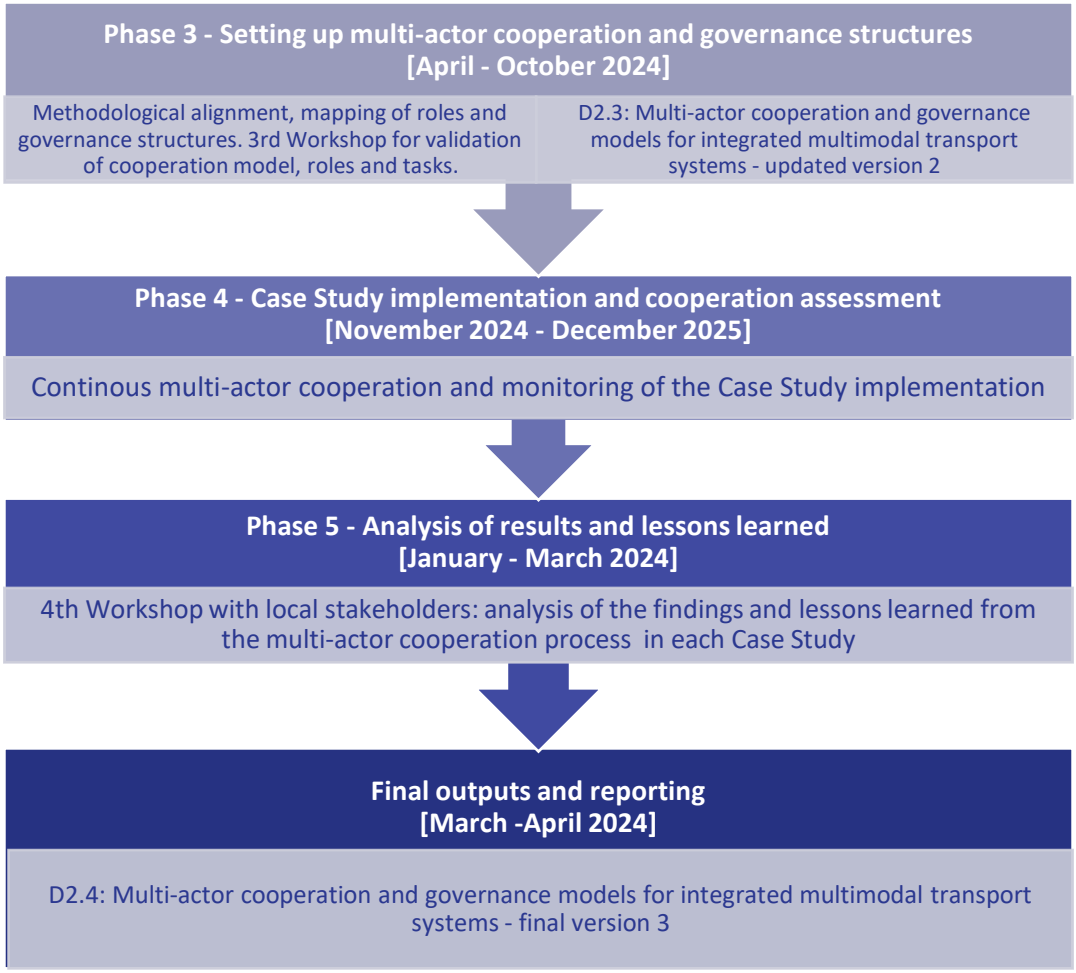

Figure 12: Next phases of the multi-actor engagement processes in SYNCHROMODE.

The following sections present the planned activities and methodological guidance for each of the upcoming phases.

4.2.1 Phase 3 – Setting up multi-actor cooperation and governance structures:

Methodological alignment and joint analysis of user needs and system requirements

To initiate this new phase in the process, it is important to ensure a common understanding and cross-WP alignment around the different activities in the proposed methodology, the preliminary timeline and the relations between the Case Studies and the work on other WPs for the SYNCHROMODE Toolbox development.

Also, since up until this point, each Case Study has conducted its local stakeholder engagement processes separately, this step also aims to facilitate knowledge exchange among the Case Studies,

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evaluating the activities performed so far, sharing good practices and lessons learned, and supporting each other in preparation for the next phases. To this end, an online workshop will take place, led by RC, to facilitate these discussions and ensure adequate preparation for the upcoming activities.

This exercise includes a reflection on the key drivers, potential challenges and risks for the multi-actor cooperation process, based on their preliminary identification in Chapter 2, aiming to raise awareness and share common strategies and perspectives on their management.

The developed methodology has been designed in consideration of these key factors and challenges to be faced, and, thus, already provides a robust framework for their management. The identification of key policy goals and local needs (from societal and individual perspectives), the project has ensured the establishment of a robust strategic baseline for multi-actor cooperation, which aims to facilitate (and guide) consensus achievement and motivate active engagement for all key actors. Since the initial outreach and workshops to kick-off the local stakeholder engagement efforts, the project has promoted the open discussion of expected benefits, impacts and challenges among all stakeholders, aiming to actively consider the needs of all involved actors, and enable the early identification of potential conflicts and their successful resolution. Besides, a clear work plan and continuous engagement, as well as transparency in the allocation of roles and expected responsibilities, aims to facilitate the continued engagement and resources management for each case study.

The developed methodology has been designed in consideration of these key factors and challenges to be faced, and, thus, already provides a robust framework for their management. The identification of key policy goals and local needs (from societal and individual perspectives), the project has ensured the establishment of a robust strategic baseline for multi-actor cooperation, which aims to facilitate (and guide) consensus achievement and motivate active engagement for all key actors. Since the initial outreach and workshops to kick-off the local stakeholder engagement efforts, the project has promoted the open discussion of expected benefits, impacts and challenges among all stakeholders, aiming to actively consider the needs of all involved actors, and enable the early identification of potential conflicts and their successful resolution. Besides, a clear work plan and continuous engagement, as well as transparency in the allocation of roles and expected responsibilities, aims to facilitate the continued engagement and resources management for each case study. Key aspects highlighted as potential challenges, such as data privacy and security, or the possible resistance to change, have been openly addressed in the conducted phases and will continue to do so, identifying contractual requirements for the data-sharing in the project (e.g., NDA) and ensuring the motivations for each involved stakeholders to participate in the case study are upheld.

Mapping of roles and governance structure for each Case Study

Following the stage of methodological planning and stock-taking of key conclusions from the user needs and system requirements for the SYNCHROMODE Toolbox, and after achieving a detailed

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definition of the use cases for each site, each Case Study will focus on mapping the roles and tasks needed for their implementation.

For this exercise, not only D2.1 and D2.5 will constitute key inputs, but also D6.1, which establishes the reference architecture and applications for the SYNCHROMODE Toolbox.

Taking the SOCRATES 2.0 framework and its defined intermediary roles for cooperative multi-modal traffic management as a basis (and using its good practice examples as inspiration), each Case Study will first define the roles needed for their implementation and the list of tasks to be fulfilled. Table 1 presents the template to be used by each Case Study in SYNCHROMODE for this step.

Table 1: Template for the identification of roles and tasks required in each Case Study.

Role	Tasks
Data Provider	
Strategy Table	
Network Monitor	
Network Manager	
Assessor	
Service Provider	
Traffic Management Centre	
Other:	

In this task, the experience from SOCRATES 2.0 provides useful guidance and illustration (see box below).

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Guidance and example from SOCRATES 2.0:

Role	Tasks
Data Provider	Provide required data to Network Monitor / clarify quality
Strategy Table	Create win-win-win / align public and private goals / define KPIs / set up toolbox / monitor (& redefine) strategic goals and KPIs
Network Monitor	Collect aggregated data from public and private data providers / fuse data / predict state of the network / assess data quality / respect data agreements
Network Manager	Configure KPIs / create problem state / identify an effective scenario to solve the problem / send service requests / evaluate and improve scenario
Assessor	Validate partner impact / report on impact and KPIs / virtual rewarding / data archiving
Service provider	Receive and assess service requests / activate routes / measure own impact and inform Assessor
Traffic management centre	Receive and assess service requests / activate routes / measure own impact and inform Assessor

Figure 13: Example of roles and task definition for MTM (SOCRATES 2.0)

Subsequently, the Case Studies will allocate leading and supporting actors for each role, detailing the tasks to be completed by the entities mapped. Besides, the involvement of the services in the SYNCHROMODE Toolbox and tasks fulfilled directly by them should be described for each role.

The involvement and relations of each actor should be mapped, describing the information flows and decision-making instances, as well as interactions with the Toolbox.

Table 2: Allocation of roles and tasks for each involved actor and each service in the SYNCHROMODE Toolbox.

Role	**Involved actors**		**SYNCHROMODE Toolbox**	
	Leader, support	Tasks	Service	Tasks
Data Provider				
Strategy Table				
Network Monitor				
Network Manager				

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Assessor				
Service Provider				
Traffic Management Centre				
Other:				

To ensure the capacity of the involved stakeholders to fulfil their roles in the long term and maximise the exploitation potential of the project's efforts, the skills and resources required for the accomplishment of their tasks will be assessed for each Case Study.

Moreover, the legal requirements for the Case Studies' deployment will be evaluated, identifying needs for agreements for data governance and sharing (e.g., NDA) and contractual requirements for the services to be tested in the Case Studies (e.g., service contracts, etc.).

RAIM Checklist for finalisation of the Business Architecture Phase:
This checklist (RAIM) serves as an example and guidance on the items to be covered by the finalisation of Phase 3 in each Case Study.

- Is the entire value chain defined?
- Have the necessary roles been identified for each phase of value creation?
- Have the core processes of the service been recorded and coordinated?
- Are the activities in the processes clearly assigned to the respective roles?
- Is it clear in the processes which information needs to be exchanged between which activities?
- Do the role descriptions correspond to the activities in the processes?
- Does the governance cover the interactions defined in the processes?

3rd Workshop with local stakeholders

Once the role and task allocation has taken place, a 3rd workshop with local stakeholders will be held for each Case Study (virtually or onsite).

This workshop will aim to:

- Present the drafted cooperation scheme and governance structure, including allocated roles, tasks, information and decision-making flows, and the reference architecture for the Toolbox implementation.
- Discuss these developments with local stakeholders and collect feedback to validate and reach a common understanding.

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- Agree on the work plan for the Case Study's implementation, including actions and schedule of activities for each involved actor.

For the discussion round, Rupprecht Consult as T2.2 leader will support Case Study Leaders in developing tailored formats and guidance material (including guiding questions and online interactive boards or templates for onsite debate).

4.2.2 Phase 4 – Case Study implementation and cooperation assessment

Once all involved actors have agreed upon the roles and action plan, each Case Study will proceed with the set-up and testing of the use cases. This stage requires close cooperation and engagement with the multi-actor ecosystem at detailed technical, operational and management levels. Flexible planning and close contact among all involved actors and WPs in the project are key to enabling an effective deployment of the MTM solutions in alignment with local needs.

T2.2 will continuously monitor the Case Studies' preparation and testing, facilitating engagement instances with local actors and alignment with other WPs as required. Meetings and working sessions on specific topics will be discussed and planned within the monthly WP2 meetings.

Furthermore, a capacity-building strategy will be deployed to support the empower local stakeholders to fulfil their roles and improve multi-actor cooperation practices on MTM in the long term. To this end, guidance will be provided by technical WPs on the usage of the SYNCHROMODE Toolbox. Also, knowledge exchange opportunities will be pursued, reaching out to relevant projects (e.g., MTM Cluster, NAPCORE).

4.2.3 Phase 5 – Analysis of results and lessons learned.

This final phase in the multi-actor engagement accompanying the Case Studies focuses on the analysis of the results of the tested use cases and evaluation of the cooperation practices, including the identification of challenges faced, key drivers and success factors.

Phase 5 will run in close cooperation with Task 6.4 (*Assessment of testing results*) and Task 7.4 (*Lessons learnt and policy recommendations*). Once the Case Studies' testing phase is finalised and the project turns into the final impact assessment and analysis stage, T2.2 will accompany this process by focusing on the evaluation of the multi-actor cooperation throughout the project for each Case Study and which recommendations and guidance can be derived to facilitate further implementation of MTM solutions across Europe through its integration in SUMP processes.

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To do so, T2.2 will prepare a questionnaire for local actors in each Case Study to share their perspectives on the process conducted, the challenges faced, good practices, and the impacts of the implementation. The questionnaire will be translated into all local languages.

4th Workshop with local stakeholders

After the testing results are available and the questionnaire for local actors has been collected and analysed, a 4th workshop with local stakeholders will be held for each Case Study (virtually or onsite).

This workshop will aim to:

- Present the results of the Case Study's evaluation and their analysis.
- Share the responses to the questionnaire on multi-actor cooperation.
- Reflect on the outcomes of the Case Study and identify lessons learned and recommendations for MTM solutions and multi-actor cooperation models.

For the discussion round, Rupprecht Consult as T2.2 leader will support Case Study Leaders in developing tailored formats and guidance material (including guiding questions and online interactive boards or templates for onsite debate).

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5 Conclusions and next steps

This document has reported on the analysis of the requirements for multi-actor cooperation in SYNCHROMODE, as well as its relevance to Multimodal Traffic Management. It aimed to define a methodology for the establishment of effective multi-actor cooperation and governance models for integrated multimodal transport systems in the SYNCHROMODE Case Studies.

The deliverable is part of Work Package 2, (*User needs, system requirements definition and governance models*), and follows a participative approach to developing suitable multi-actor governance models. It built its approach upon the results from Tasks 2.1 (User needs and system requirements) and T2.3 (Case Studies definition), seeking to tailor the process and models for multi-actor cooperation to the specific requirements and conditions for the Case Studies' implementation. Key findings from user needs and system requirements definition will assist in defining a structured cooperation process to enable a successful implementation of the project's solutions and case study evaluation.

The analysis of multi-actor cooperation schemes and governance structures will enable the project to define new arbitration models that facilitate the consensus among actors on what solution(s) offer the most appropriate trade-offs among performance areas (e.g., capacity, safety, environment) and balance between individual vs. collective needs. This will constitute a key input to guide the technical implementation of the SYNCHROMODE toolbox (WP3-WP6).

In order to develop a suitable methodology for Task 2.2, a literature review was conducted, addressing among its main sources key reference frameworks such as (1) the SOCRATES 2.0 cooperation models for interactive traffic management, (2) the RAIM framework for Intelligent Mobility Services, (3) the Sustainable Urban Mobility Planning concept to structure holistic strategic planning of mobility solutions, and (4) the ÖSTO Change Management system-design model.

Based on these reference frameworks, SYNCHROMODE has developed a methodology to guide the engagement of the diverse ecosystem of stakeholders involved in each Case Study and set up effective cooperations and governance schemes for their successful implementation. The consecutive-phased strategy initiated within T2.1 is continued, with Phases 3, 4 and 5 addressing the set-up of cooperation structures, Case Study implementation and testing, and the analysis of results and lessons learned.

This is the first version of the deliverable and will be later revised in future editions (D2.3 and D2.4) during the project timeline.

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