DELPHI

FeDerated nEtwork of pLatforms for Passenger and freigHt Intermodality

Grant Agreement Number: 101104263

D.2.1: State-of-the-art report in governance, relative technologies and stakeholder ecosystems in passenger and freight transport

Document Identification			
Status	Draft	**Due Date**	30/09/2024
Version	4.0	**Submission Date**	
Related WP	WP2	**Document Reference**	D2.1
Related Deliverable(s)	D2.2, D2.3, D2.5	**Dissemination Level**	PU
Lead Participant	ALICE	**Document Type:**	R
Contributors	ICCS, ICP, ATD, STASY, AUM, MM, DHL, KTEL M, NTTD, MCN, SEAB	**Lead Author**	Yanying Li, Marion Cottet
		Reviewers	Sozos Karageorgiou (eBOS)
			Giannis Kanellopoulos (ICCS)

Funded by the European Union

DELPHI project has received funding under grant agreement No 101104263. It is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Document Information

Author(s) – in alphabetical order		
First Name	**Last Name**	**Partner**
Marion	Cottet	ALICE
Yanying	Li	ALICE

Document History			
Version	**Date**	**Modified by**	**Modification reason**
0.1	04/03/2024	Marion Cottet	Initial draft: table of content and methodology
1.0	18.03.2024	Yanying Li	Update the table of contents and chapters on governance and stakeholder analysis
2.1	14.05.2024	Yanying Li	New chapters (3 & 4) added
3.2	05.07.2024	Yanying Li	Update the stakeholder analysis
3.3	05.07.2024	Marion Cottet	Chapter 5 on project mapping and technology state-of-the-art & Annex B added
3.4	10.09.2024	Sozos Karageorgiou	Peer Review 1
3.5	16.09.2024	Marion Cottet	Comments consolidation
4.0	30.09.2024	Giannis Kanellopoulos	Final version to be submitted

Quality Control		
Role	**Who (Partner short name)**	**Approval Date**
Deliverable leader	Marion Cottet	21/09/2024
Quality manager	Grigorios Koutantos (WINGS)	26/09/2024
Project Coordinator	Giannis Kanellopoulos (ICCS)	30/09/2024

Executive Summary

This deliverable is to provide a state-of-the-art in governance, technology and stakeholder analysis in traffic management, passenger and freight transport related to DELPHI's four use cases.

The methodological approach is based on mapping previous and ongoing research and innovation (R&I) projects that can provide inputs to the DELPHI project. Projects that have been mapped by the deliverable include the six other projects of the Multimodal Traffic Management Cluster: FRONTIER, TANGENT, DIT4TRAM, ORCHESTRA, ACUMEN and SYNCHROMODE. Additional European projects mapped by the deliverable focus on logistics and urban logistics: ULaaDs, LEAD, DISCO, MOVE21, FORFREIGHT and SENATOR.

Policy priorities addressed by the projects and their policy actions have been used to create a foundation for reviewing current governance in urban mobility. By analyzing the projects, key stakeholders have been identified in the ecosystem in passenger and freight transport. Technologies developed, piloted and implemented by those projects provide a sound understanding of state-of-the-art technologies in urban mobility and urban logistics.

Since urban mobility is a complex issue many European policies (e.g. Sustainable and Smart Mobility Strategy, Urban Mobility Framework) and regulations (e.g. revised TEN-T regulation, ITS Directive) have impacts on urban mobility. Policies and regulations at EU levels that have brought notable hallmarks on today's urban mobility are mapped. Key conflicting issues in governance have been identified, providing a reference to policy recommendations for the DELPHI project. Selected administrative structures of various governments have been analysed to understand who develop and implement policies and regulations on urban mobility.

Stakeholders in urban mobility cover a wide range of types of organisations and entities. All stakeholders have been categories into four high level categories: companies, governments, R&D organisations, and civil societies. By mapping project consortium members, key actors in the four categories have been identified. More detailed analysis of stakeholders under each of the four categories have been carried out.

The technology mapping focused on previous Horizon 2020 (H2020) and Horizon Europe (HE) projects, with technologies innovations related to DELPHI's use cases. The deliverable dives into key individual technologies from both urban mobility & traffic management as well as logistics & urban logistics. It provides a wide overview of what current and past projects developed and where DELPHI aims to take on these technologies.

The deliverable dives into a state-of-the-art in individual technologies for passenger and freight. It represents a first milestone, background material for discussion, as further elements will be implemented in the following deliverables, including multimodal and combination of passenger and freight trends, as well as multi-level governance schemes.

Table of Contents

List of Tables

List of Figures

Abbreviations & Acronyms

Abbreviation / acronym	Description
EC	European Commission
D1.1	Deliverable number 1 belonging to WP 1
T1.1	Task number 1 belonging to WP 1
WP	Work Package
MTMC	Multimodal Traffic Management Cluster
NoP	Network of platforms
EU	European Union
EC	European Commission
ITS	Intelligent Transportation Systems

Abbreviation / acronym	Description
TEN-T	Trans-European Transport Network
SUMP	Sustainable Urban Mobility Plan
UCC	Urban Consolidation Centre
LEV	Light Electric Vehicle
DOT	Department of Transportation
NYC	New York City
UVAR	Urban Vehicle Access Regulation
ERP	Electronic Road Pricing
CCZ	Congestion Charge Zone
LEZ	Low Emission Zone
ULEZ	Ultra Low Emission Zone
SULP	Sustainable Urban Logistics Plan
FQPs	Freight Quality Partnerships
DfT	Department for Transport
BCR	Brussels Capital Region
AOM	Organising Authority for Mobilities
MTM	Multimodal Traffic Management
OEMs	Original Equipment Manufacturers
AI	Artificial Intelligence
ML	Machine Learning
UAS	Unmanned Aerial System
CAV	Connected Automated Vehicle
PMA	Polycentric Multimodal Architecture
MTMR	Traffic Management Ecosystem
API	Application Programming Interface
ANTME	Automated Network and Traffic Management Engine
VMS	Variable Message Signs
COP	Common Operational Picture
TNTM	Transport Network and Traffic Management
ERC	European Research Council

Abbreviation / acronym	Description
CBD	Central Business Districts
MaaS	Mobility-as-a-Service
LMD	Last-Mile Delivery
ODD	Operational Design Domains
B2C	Business to Consumer
B2B	Business to Business
C2C	Consumer to Consumer
ICT	Information and Communications Technology
KPI	Key Performance Indicator
DSS	Decision Support System
R&D	Research & Development
STRIA	Strategic Transport Research and Innovation Agenda

1. Introduction

Nowadays, the overall transportation industry is rather complex and challenging, both for passenger and freight mobility, affected by several factors related to technical and operational aspects, but also to governance and regulatory issues. In parallel, the modern lifestyle and the continuously evolving societies and urban environments lead to new needs and requirements related to the transportation of people and goods. Innovative transport solutions are implemented trying to handle these needs and requirements. However, in most cases these innovative solutions and solutions are implemented in a fragmented way and focused on a specific need or challenge, leaving aside a more holistic and orchestrated approach.

Among others, some of the most critical challenges include:

- increasing complexity of stakeholder landscape, their roles and interactions;
- high fragmentation in transport domain, with highly disconnected systems of various modes and operators;
- unavailability and low quality of data both on urban freight and passenger transport;
- pressures or willingness to reduced energy consumption and emissions.

To overcome these challenges, DELPHI aims to deliver the enablers, both on technical and governance/regulatory level, towards a federated network of platforms for green, multimodal passenger and freight transport, capable of sharing in a seamless and secure manner, cross-sectoral, multi-modal passenger and freight transport data, as well as traffic management systems information, as if those were part of a single system.

The DELPHI project is envisioned as a network of platforms (NoP) designed to integrate information in a multimodal transportation network. DELPHI platform will unify data and operations from central, intermediate, and last-mile warehouses, as well as from various transportation modes like trucks, buses, metros, and bikes. By synergizing these independent systems, DELPHI aims to create an efficient, real-time managed, and sustainable transportation, logistics and delivery ecosystem. This requires a clear governance system, both for technologies and between stakeholders.

The first and necessary step towards the design, development, and validation of the envisioned DELPHI NoP federation, is the design and implementation of a comprehensive Coordination and Governance framework that will manage the highly challenging ecosystem of multi- and inter-modality operations that will involve heterogeneous ecosystems, stakeholders (including citizens), systems, data, policy and regulatory frameworks. Therefore, DELPHI will work on several Governance and

coordination perspectives; indicatively, the overall multilevel governance and coordination model and regulatory framework.

This deliverable will review and summarize state-of-the-art in governance, relative technologies, stakeholder ecosystems in passenger and freight transport which will support building the DELPHI NoP and implement the DELPHI's use cases.

Deliverable D2.1 does not cover state-of-the-art of multimodal of passenger transport, traffic management, and data sharing in passenger transport or freight transport. Those contents are covered by in deliverables produced in T2.2 and T2.3.

Deliverable D2.1 will serve as a foundational input for task T2.2 and T2.3 providing a basis for further mapping of governance structures in passenger and freight transports as well as stakeholders and available technologies. D2.1 will also provide inputs for tasks T2.4 and T2.5.

The document consists of 5 chapters as:

Chapter 1: The Introduction section provides an overview, introducing the primary objectives and scope of the document.

Chapter 2: The Methodology chapter delves into the specific approaches and methods employed in defining a state-of-the-art in governance, relative technologies, stakeholder ecosystems in passenger and freight transport.

Chapter 3: The governance of passenger and freight transport that provides the description of the current practices in regulation and policy making at EU, national and local level: "what policy is made by whom, for what". It also various structure of local governments of those cities that are active in innovation of mobility and logistics.

Chapter 4: Analysis of the stakeholder ecosystems in passenger and freight transport.

Chapter 5: The project mapping and state-of-the-art of technologies in passenger and freight transport related the use cases of the DEPLHI project.

2. Methodology

Policy review and literature review

The state-of-the-art analysis starts from review of EU policies related to sustainable urban mobility. The review will include key EU policies and regulations that have enabled urban mobility from a car-centred system to people-centred, sustainable mobility. A literature has been carried out to review current regulations and their impacts on sustainable urban mobility (enablers or barriers).

Project mapping

Mapping of related recently concluded and ongoing research and innovation projects has played a key role in this study. The first step for performing this analysis is to elaborate an extensive list of R&I projects, innovative solutions and real implementation cases across Europe and worldwide on urban freight and passenger mobility. Given that there are numerous research projects and case studies dealing with these domains, the implementation of high-level criteria for selecting the most critical and relevant cases to be analysed is considered necessary to narrow down the topic and perform efficient research. For the research projects, these criteria were related to the proximity of the case study in time and the focus points in the transportation universe, while for the implementation cases the involvement of associated areas in green transport and smart cities initiatives was considered. More specifically, the following criteria were implemented:

- EU-funded research projects starting from 2020 and onwards, considering that earlier projects findings and technologies have been already considered in these projects
- Focus on the dimension of individual passenger and freight transport fields, covering governance structures, available technologies, stakeholder groups and interactions
- Exploration of Mission Cities [1]
- Relevance with DELPHI uses cases and respective technologies. The analysis focused on the technologies used in the DELPHI uses cases.

2 types of projects have been mapped by this study, projects on urban mobility and traffic management, which are part of the Multimodal Traffic Management Cluster (MTMC) and other projects related to logistics and urban logistics. The following table summarizes the Horizon 2020 and Horizon Europe projects studied.

Table 1 European projects mapping

Scope of project	Project name	Project funding programme (including Grant Agreement ID)	Period
Urban Mobility & Multimodal Traffic Management	FRONTIER	H2020 (ID 955317)	01.05.2021 - 30.04.2024
	TANGENT	H2020 (ID 955273)	01.05.2021 - 30.04.2024
	DIT4TRAM	H2020 (ID 953783)	01.09.2021 – 01.09.2024
	ORCHESTRA	H2020 (ID 953618)	01.05.2021 – 30.04.2024
	ACUMEN	HE (ID 101103808)	01.06.2023 – 31.05.2026
	SYNCHROMODE	HE (ID 101104171)	01.05.2023 – 30.05.2026
Logistics & Urban Logistics	URBANE	HE (ID 101069782)	01.09.2022 – 28.02.2026
	DISCO	HE (ID 101103954)	01.05.2023 – 31.10.2026
	LEAD	H2020 (861598)	01.06.2020 – 30.09.2023
	SENATOR	H2020 (ID 861540)	01.09.2020 – 31.08.2024
	ULAADS	H2020 (ID 861833)	01.09.2023 – 29.02.2024
	MOVE21	H2020 (ID 953939)	01.05 2021 – 30.04.2025
	FORFREIGHT	HE (ID 101069731)	01.09.2022 – 31.12.2025

3. Governance of urban mobility – passenger and freight transport

Definition of governance of urban mobility

There may be many different understandings of 'governance.' In this deliverable, governance is to answer the follow questions:

- **Who** set **which** rules and **how** those rules were decided
  - Rules here include both policies and regulations
- **Who** implements those rules
  - Implementation here includes financial commitments, enforcement and impact monitoring and assessment

Rules here include policies and regulations. Policy refers to a set of principles, guidance or documents adopted by a government while a regulation is a binding legislative act that may be contained in law or other form of administrative issuance that has been approved by the relevant authorities. Policy and regulations on urban mobility can be set by European Union, national governments, and local authorities.

***Who** implements those rules:* Implementation here includes a wide range of actions such as financial commitments, enforcement of a regulation, impact monitoring and assessment of policies. Government bodies that implement rules may be different from those who set the rules.

Governance models have significant impacts on implementations of innovation in the transport and mobility domain. Policies and regulations can on one hand facilitate innovation uptakes, e.g. EU policies on climate actions have fuelled development and deployment of electric buses and cargo-bikes in European cities. However, governance models can also be obstacles to innovation. For examples, micro-hubs cannot be set up in residential areas due to planning regulations in some countries. This analysis aims to develop a comprehensive understanding of governance issues that may be related to the DEPHI project's use cases. The analysis will later provide inputs to developing policy recommendations and exploitation plans.

Who set which rules and how those rules were decided?

Various government organisations that set rules on urban mobility (policy and regulation) include:

- European Commission (EC) (with approval of the member states and European Parliament) set policies and regulations at EU level;
- National governments set policies and regulations at national level;

- Local governments (regional governments or municipalities) set policies and regulations at local level (regional or city level).

Roles of various governments are evolving and there is no clear definition of judicial or administrative powers regarding different aspects of the mobility sector (e.g. who can set what rules). Mixed functionalities for the same subject may occur. For example, setting up low emission zone is under judicial power at municipal level. However, national governments are able to set up minimum standards (e.g. in the Netherland) and define enforcement mechanisms (e.g. in France).

Polices and regulations related to urban mobility may regard many different subjects. There are dedicated sustainable urban mobility policies at various levels. However, in recent years, climate and environmental policies play an important role in urban mobility, particularly in facilitating transition to electric vehicles, modal shifts to more sustainable modes (e.g. use of public transport, cycling and walking). Regulations on spatial planning and land use have set rules on locations and logistics properties.

The following figure shows various governments and some examples of policies and regulations related to urban mobility.

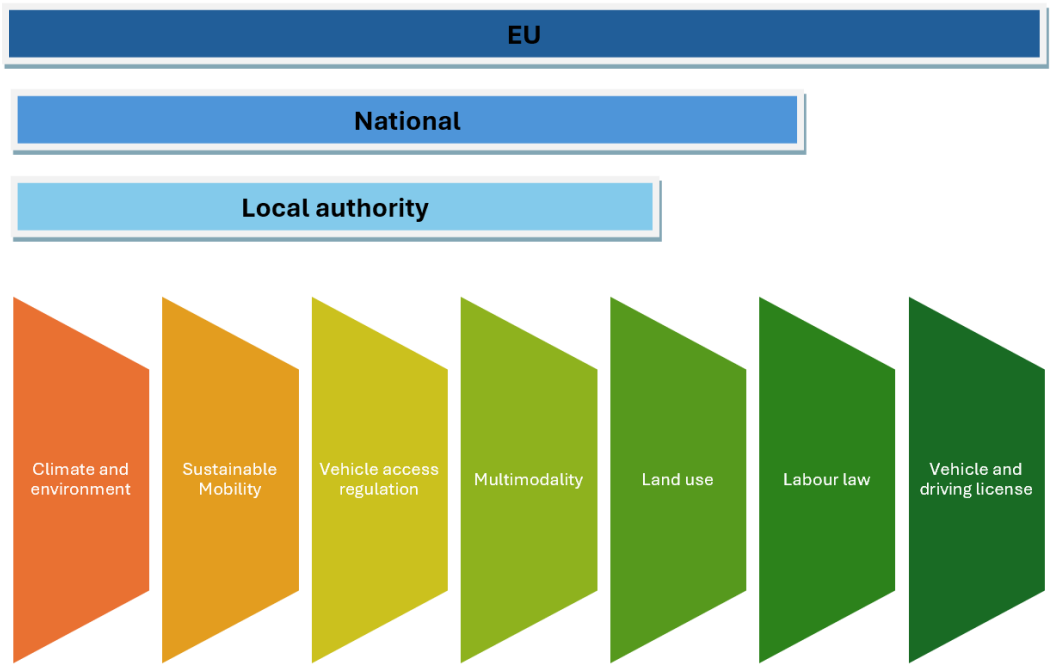


Figure 1 Various organisations and various rules

Review of EU Urban Mobility and Freight Transport Policies and Regulations

Since urban mobility is a complex issue many European policies and regulations have impacts on urban mobility. This chapter focuses on policies and regulations that have brought notable hallmarks on today's urban mobility are considered.

This section provides a brief overview of the key mobility and freight transport policies and regulations at EU levels that have brought an evolution in the European Unions from car-central transport policies in the post-war era to sustainable urban mobility, and alongside those major actions at various formulations.

Table 2 Terminology of governance at EU level, refer to EU's type of legislation[1]

Regulation	A "regulation" is a binding legislative act. It must be applied in its entirety across the EU. For example, when the EU's regulation on ending roaming charges while travelling within the EU expired in 2022, the Parliament and the Council adopted a new regulation both to improve the clarity of the previous regulation and make sure a common approach on roaming charges is applied for another ten years.
Directive	A "directive" is a legislative act that sets out a goal that EU countries must achieve. However, it is up to the individual countries to devise their own laws on how to reach these goals. One example is the EU single-use plastics directive, which reduces the impact of certain single-use plastics on the environment, for example by reducing or even banning the use of single-use plastics such as plates, straws and cups for beverages.
Policy	Refers to a set of principles, guidance or documents adopted by a government. Regulations pertain to rules or directives of a government, which may be contained in law or some other form of administrative issuance that has been approved by the relevant authorised government body

The following figure shows timelines of the key EU policies and regulations related to sustainable urban mobility in the past 15 years.

[1] https://european-union.europa.eu/institutions-law-budget/law/types-legislation_en

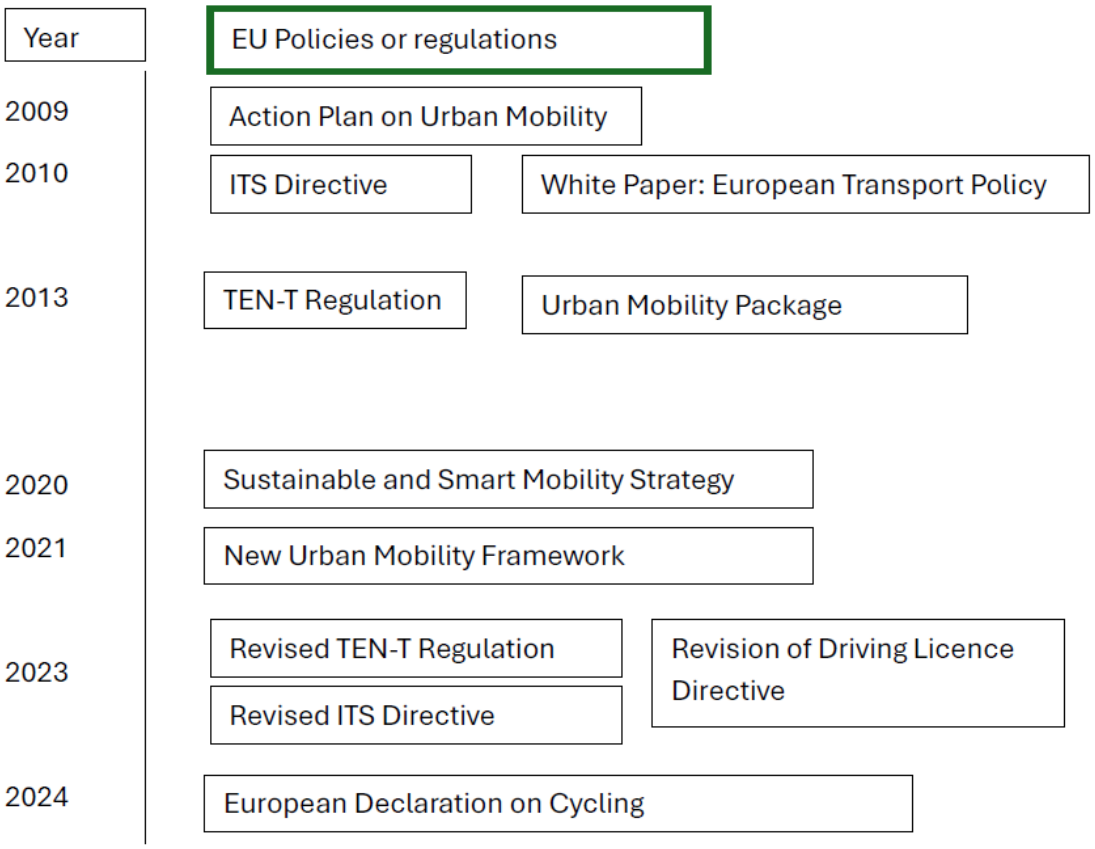


Figure 2 EU policies and regulations on urban mobility (2009 – 2024)

2009, Action Plan on Urban Mobility

The Action Plan [2] provided a guideline on sustainable urban mobility and has proposed 20 practical actions including short- and medium-term actions that will be launched from 2009 in the 3 years' time frame. Those actions aim to address specific issues on urban mobility, such as aging society, needs for mobility of persons with disabilities, and low-income householders. Through the Action Plan, EC aims to build a partnership among local, regional and national authorities. The Action Plan identified 20 actions under 6 themes: Promoting integrated policies, focusing on citizens, Greening urban transport, strengthening funding, Sharing experience and knowledge, and optimising urban mobility.

2010 and 2023, ITS Directive

The ITS Directives [3][4] is an important instrument for the coordinated implementation of ITS in Europe. It aims to establish interoperable and seamless ITS services. Under this Directive the EC adopted common European specifications (i.e. functional, technical, organisational or services provisions) to address the compatibility, interoperability and continuity of ITS solutions across the EU. The first priorities were traffic and travel information, the eCall emergency system and

intelligent truck parking, followed by real-time traffic information and multimodal travel information.

The Directive ensures all member states to organise the access to and reuse of transport-related data to help support the provision of EU-wide interoperable travel and traffic ITS services to end users. This transport-related data should be available in machine-readable format to the extent provided by this Directive. The Directive however leaves Member States the freedom to decide which systems to invest in.

2010 White Paper on Transport Policy

The White Paper [5] proposed measures for all types of transport modes. It set a framework to reduce congestion and negative impacts on environment from the transport sector, improve safety and set up a network of charging infrastructure to enable electrification of the road transport.

2013 Urban Mobility Package

The 2013 Urban Mobility Package [6] aims to support European cities for addressing challenges in urban mobility, such as air pollution, congestion etc and to ensure that European cities will develop at a sustainable way. The 2013 Urban Mobility Package first time presented a concept for Sustainable Urban Mobility Planning (SUMP) which was well received by local authorities across Europe, catalysing the preparation and update of hundreds of urban mobility plans. Soon after the 2013 Urban Mobility Package, the first edition of Guideline on SUMP was published in the same year.

The Package also calls for coordination and partnership between public and private sectors among all types of stakeholders to achieving a systemic change towards sustainable urban mobility. It also calls for more action on urban logistics and recognised the importance of urban logistics, indicating that "*urban logistics are essential for cities to function successfully*"[2]

2020, Sustainable and Smart Mobility Strategy – putting European transport on track for the future

The strategy [7] aims to use the recovery from the crisis caused by the COVID-19 pandemic to accelerate the decarbonisation and modernisation of the entire transport and mobility system, limiting its negative impact on the environment and improving the safety and health of our citizens. The strategy lists a set of measures to creating the sustainable, smart and resilient mobility system of the future and bringing about the fundamental changes needed to achieve the objectives of the European Green Deal. The strategy defines a set of goals such as that by 2030 at least 30 million zero emission

[2] EUR-Lex - 52013DC0913 - EN - EUR-Lex (europa.eu)

vehicles will be in operation on European road, 100 European cities will be climate neutral, automated mobility will be deployed at large scale, by 2050, nearly all cars, vans, buses as well as new heavy-duty vehicles will be zero-emission and the multimodal Trans-European Transport Network (TEN-T) equipped for sustainable and smart transport with high speed connectivity will be operational for the comprehensive network.

2021, the New Urban Mobility Framework

The EU's New Urban Mobility Framework [8] is aimed at helping European cities develop sustainable, safe, resilient and emission- and pollution-free urban transport systems, thus meeting the EU's climate targets. Having learned lessons from the effects of COVID-19, the framework also addresses social challenges in urban living and citizens, behavioural changes brought by the pandemic. The framework gives equal importance to freight and passenger transport as part of urban mobility[7]. It calls for integration of passenger and freight transport in urban planning, traffic management and sustainable urban mobility policy-making. The framework also addresses challenges in urban logistics and proposes actions to make the sector smarter and more sustainable. It also indicates that last-mile delivery will continue to grow as a result of the increase in e-commerce activity, in turn a result of behavioural changes caused by the pandemic. The framework highlights the important roles cities and regions play for 'first and last mile' connections in the Trans-European Transport Network (TEN-T).

2013 TEN-T Regulation & 2023 Revised TEN-T Regulation

The aim of the TEN-T Regulation 2023 [9] was to build an effective EU-wide and multimodal network of rail, inland waterways, short sea shipping routes and roads which are linked to urban nodes, maritime and inland ports, airports and terminals across the EU.

The EC proposed to revise the TEN-T regulation 2013 to support the transition to a cleaner, greener and smarter mobility in line with the European Green Deal and the Sustainable and Smart Mobility Strategy, the Commission proposed to revise the TEN-T Regulation of 2013. The revised TEN-T Regulation, adopted in 2023, puts the transport sector on track to cut its emissions by 90%. It responds to the need to increase connectivity across Europe, to foster the resilience of the transport system, to shift more passengers and freight to the sustainable modes of transport and to focus more on sustainable urban mobility. Of all the mandatory targets set by the new regulation, a key target related to urban mobility is that "*All 430 major cities along the TEN-T network will have to develop Sustainable Urban Mobility Plans to promote zero and low emission mobility*."

2023, Revision of the Driving Licence Directive

The revision of the Driving Licence Directive [10] has brought many changes to the drivers' training and safety issues. A key element is the permission to drive a vehicle weighing up to 4 250 kg with a B-category driving licence if the alternative vehicle is powered (the current weight allowed for this category is 3 500 kg). This change is mainly intended to encourage the purchase of or conversion to electric propulsion, the battery pack of which is heavier than a conventional internal combustion engine. This change is particularly seen as an incentive to increase market share of electric vans in the urban logistics sector.

2024, European Declaration on Cycling

The Declaration [11] acknowledges that sustainable forms of transport are essential for achieving the EU's climate, zero pollution and energy efficiency objectives and cycling is one of the most sustainable, healthy and efficient, with considerable potential to support the decarbonisation of urban transport and help achieve the EU-wide target of reducing net greenhouse gas emissions by at least 55% by 2030 compared to 1990 and climate neutrality by 2050. Further developing cycling is in particular key for European towns and cities as part of our climate objectives. The Declaration acknowledges the important roles of cycling in the urban logistics, in particular parcel deliveries and shopping (cargo bikes and alike). To reach the full potential of cycling, cycling policies should reflect this diversity.

Analysis of Governance on Urban Logistics

Urban logistics activities are complex, requiring facilities normally located outside cities and but also having logistics vehicles in traffic flow inside cities. The urban logistics remains largely ignored by the legal and policy framework, at the national and at the local level. There is lack of a clear dedicated organisation to urban freight activities in municipalities.

Continuing increased traffic flow of home delivery due to increased e-commerce in the post COVID era has brought new challenges to urban regions concerning economic and social development, e.g. jobs, local business and property development, and transport and environmental impacts, e.g. congestion, road safety, noise, pollutions and CO2 emissions. Recent policy development, that moves towards low or zero emission zones, and climate neutral cities, have brought revolutionary changes to urban logistics in terms of location choice of warehouses, employment, schedules and delivery frequencies and vehicle types. Availability of new types of delivery vehicles, charging infrastructure and digital platforms has been enablers to such changes. However, legal and policy framework as well institutional structure do not reflect such changes.

This section aims to review the current legal and policy framework and subsequent governance arrangements in urban logistics, thus identifying needs for changes to fit current logistics development.

Spatial planning and land use related to freight infrastructure

Urban logistics activities require construction and operation of warehouses, distribution centres and terminals in large urban regions often located outside the cities. Development of such logistics infrastructure is traditionally in the 'industrial zone' of a city located outside the city. In recent years, distributions using smaller vehicles have increased sharply. Therefore, logistics centres close to city centres are needed.

Micro hub

In recent years, research and innovation projects, e.g. the LEAD project [12] and the ULaaDs project [13] have set up micro-hubs in city centre areas. A Micro Hub is a logistics facility where goods are clustered within city limits to serve a limited geographic area around it and allow a smooth shift to low-emission vehicles and/or cycle and walking-based solutions for last-mile deliveries. The concept is intended to ensure use of low-emission vehicles (e.g. cargo-bikes) for inner-city logistics. The LEAD and ULaaDs projects converted existing buildings that have been under-used or empty to be micro-hubs. For example, in the LEAD project, a micro-hub had been established in a car park inside the Madrid's low emission zone that traditionally for passenger cars' parking. Demand for parking space for passenger cars has decreased due to implementation of the low-emission zone in Madrid's city centre and good connections of public transport. Part of the car park has been used for logistics as deport including storage, office, drivers' resting area and charging facility for electric cargo-bikes. Rest of the car park is still used as park.

In 2021, the city of Mechelen, Belgium make a building, owned by the city (the Vlaco building) in its city centre area to BPost to serve as a micor-hub for electric vans and cargo-bikes. "*The very centrally located building has recently been renovated. Pending the future use, part of the ground floor will be temporarily used by bpost. Bpost wishes to use the space to distribute mail and packages. By making city buildings available to companies that can use them, we prevent vacancies and set a good example*," says Alderman Koen Anciaux of Buildings and Properties [14]. The function of this centrally located site is to consolidate flows into and out of the city centre throughout the day. This is where mail carriers load up their bikes with parcels for last-mile delivery on their round and bring their return parcels, which are picked up by electric vans and taken to Mechelen Mail Center on the outskirts of the city. The micro hub is open to third parties for the full-scale consolidation of parcel and goods flows [15].

However, use of existing buildings for logistics hubs has not always been successful. On-demand grocery service companies in the Netherland had used empty retail spaces

as micro-hubs for grocery delivery that were closed to residential areas to enable fast delivery (e.g. delivering in 10 min). Such micro-hubs were regarded as 'dark stores'. At a dark store, many delivery workers were waiting outside and their working hours were longer than normal retail shops, resulting in significant numbers of complains from local residents. To response to the complains, many cities in the Netherland imposed restrictions to ban warehouses in a residential area. For example, Amsterdam councillors have now voted [16] that except in exceptional circumstances, the warehouses will only be permitted on industrial estates due to the associated nuisance. Since the City of Amsterdam's goal is to supply the city with CO2-neutral goods from 2025 to 2030 the increasing demand for city distribution centres is anticipated. Amsterdam has worked with private sectors to plan urban distributions centres at strategic locations.

Urban Consolidation Centre (UCC) in industrial zone

Urban Consolidation Centre (UCC), also called Urban Distribution Centre (UDC), is the name given to a logistics facility for the consolidation of urban freight flows, possibly across companies, with the aim of reducing freight traffic. UCCs are thus transshipment points near (usually major) cities. Freight destined for the city is delivered, bundled according to the local delivery destination and characteristics, and then transported further into the city (as CO2-neutral as possible) for delivery. Therefore, UCCs are regarded as a suitable solution for reducing traffic congestion in cities. The Urban Mobility Framework 2023 has proposed "*sufficient number of multimodal terminals and freight consolidation centres is needed*". Depending on the location of the UCC, the large vehicles transporting larger volumes of freight can be removed completely from the city centre, as the final miles can be completed by smaller vehicles like LEVs, Vans or even bikes. As a result, the carbon footprint is decreased by reducing the distance of freight travel through route optimisation, as well as the use of e-mobility, LEVs and white label deliveries. Because of environmental benefits, many of UCC initiatives received huge government subsidies to implement. However, due to lack of viable business models and support of big logistics service providers, authorities tried to implement a city consolidation centre in industrial zones outside cities several times over the last two decades, but without success [17].

An early example of UCC is in Monaco, initiated by the Monaco government in 1989 in combination with strict truck regulations and the provision of huge subsidies. As a result, the governmental subsidy per delivery did exceed the price customers pay per delivery. In that sense, urban delivery has become a part of the public service. However, the successful implementation of UCC in Monaco was not transferable because 1) Monaco has its unique governance structure of the independent sovereign state; 2) the state government of Monaco is able to provide huge financial support to its UCC [18].

Another implemented UCC initiative comes from La Rochelle. An UCC was set up in 2001 with a considerable starting subsidy. From the UCC, electric vehicles supply the

historical city centre of La Rochelle in response to the city's regulation to ban heavy vehicles to enter. However, due to lack of efficient enforcement and insufficient numbers of appropriately sized electric vehicles, the initiative has increased urban congestion. The decision of denying access for non-UCC users has been legally challenged. The initiative eventually failed when no tendering for the UCC management was submitted.

Another example of failed UCC initiative occurred in Leiden. The urban consolidation centre opened in 1997 to improve the quality of life in the historical centre of Leiden However, eventually, the number of customers for the UCC did not reach the sufficient volume when parcel delivery companies decided not to join the initiative. The UCC stopped operation in 2000.

In literature, many research has been carried out to analyse failure factors for UCC [19] and summary of the key factors is:

- Location of UCC was too far away from the highway and from the city centre;
- Inappropriate supporting policy measures, i.e. time-windows and vehicle restrictions, resulted in opposition against the UCC;
- Unprofitable UCC replied on continuing government subsidies;
- Reluctance of logistics service providers to use UCC due to thin margins in profits and protection in brands.

Discussion on role of government in spatial planning regarding urban logistics services.

The failed UCC projects have raised serious questions: whether regulatory powers should prohibit or impose the patterns of private activities? whether the provision of urban logistics service should governments organise - directly or through a private sub-contractor, an urban service?

Freight activities in cities is always evolving, particularly in the post-COVID era with sharp increased e-commerce. Government policies may not be able to meet from the sector. Therefore, policies for urban logistics may provide an enabling framework to support the evolving, while aiming to mitigate any negative impacts on urban life. Lessons learnt from the UCC projects should not be forgotten when government involves with urban logistics service provision.

Public lockers for e-commerce

Increased e-commerce has resulted in increased emission from the last mile delivery. Studies compared the sustainability performance between home service delivery and pick-up point service delivery using parcel lockers, showing that the pick-up point can reduce CO2 emission by about 40% through reduced travelled from the home service delivery[9]. Because of the emission saving, some cities have started to consider that provision of lockers to residents is one of public urban services, just as access to public transport.

New York City's DOT (Department of Transportation) has launched an initiative, 'LockerNYC' pilot programme that allows New Yorkers to conveniently receive and send packages using secure lockers on public sidewalks. The pilot initially included 15 locations and offer customers free 24/7 access and is available across multiple delivery carriers, including UPS, DHL, and Pitney-Bowes. Locations were selected based on land use, concentration of buildings lacking mail or package rooms, and New York City (NYC) Police Department package theft data, among other criteria. Other priorities in the selection process included providing adequate circulation space, avoiding conflicts with street furniture, ensuring smooth pedestrian flow, and avoiding the obstruction of windows, fire escapes, or public art [20]. The public lockers are under a private management. The lockers are operated and maintained by GoLocker, the vendor selected by the city for this initiative, and GoLocker will oversee customer support and overall management of the technology.

However, to avoid private management of a public service, city of Mechelen in Belgium has been in cooperation with BPost to set up a network of lockers throughout the city to allow residents to access lockers in walking distance. However, different from NYC, lockers in Mechelen are BPost lockers but they are not exclusive for BPost but open to third parties.

Key policy measures on urban mobility

Urban Vehicle Access Regulation (UVAR)

Urban Vehicle Access Regulation is an efficient tool for local authorities to reduce traffic flow including trucks and delivery vehicles flow. It comes in various forms such as: Urban Traffic Restrictions (for pedestrian zone), Congestion Charging, Low Emission Zone and Zero Emission Zone.

Traffic restriction rules

Almost all cities have regulations to limit vehicles access to pedestrian zone in city centre areas, e.g. time frame, type of vehicles etc. Below there is a summary of various cities in Flanders, a region of Belgium:

Table 3 Vehicle access rules in selected cities in Flanders

City in Flander	Vehicle access rules
Ghent	Obtain permit for car-free zone and enter all day, except pedestrian zone not between 11:00 and 18.00
Antwerp	Deliver between 07.00 and 11.00. Deliveries after 11.00 are possible, but must request a permit
Hasselt	Deliver between 07.00 and 11.00 in pedestrian zone & also between 18:00 and 20:00 in car-free zone
Leuven	Deliver between 06.00 and 11.00 & 18:30 and 20:30 in pedestrian zone / (un)loading all day in car-free zone

	+ different rules for Bondgenotenlaan / Martelarenplein

The various forms create difficulties for business that operate at a regional or national level. Those forms are not in digital format, making automatic use of such information in navigation systems or route planning tools impossible.

Congestion charging

Congestion charging is another form of vehicle access regulation, initiated in London in 2003. The London congestion charge, inspired by Singapore's Electronic Road Pricing (ERP), is a fee charged (current fee is £15) on most cars and motor vehicles being driven within the Congestion Charge Zone (CCZ) in Central London between 7:00 am and 6:00 pm Monday to Friday, and between 12:00 noon and 6:00 pm Saturday and Sunday. According to impact study done by Arup, the congestion charge led to a 15% reduction in traffic in 2003 and traffic has fallen in central London since then [21]. Although the scheme was justified in terms of its congestion benefits, over time these have been eroded despite traffic remaining stable - because road space was reallocated to more sustainable modes. As a result, traffic speeds in central London are now as low as they were when the congestion charge was introduced in 2003, although the volume of traffic has fallen significantly.

Congestion charge currently is only in operation in London and Stockholm.

Low emission zone and zero emission zone

In recent years, many European cities imposed low emission zones or zero emission zones to reduce air pollution in cities due to public awareness of negative impacts of air pollution on health. Low emission zone or zero emission zone policies have also been used as a key measure of cities' climate action policy. Such policies have been made at the local level, often being used as a key political statement for local election campaigns. Many cities provide financial supports for local residents and business for replacing vehicles that do not meet emission requirements of low (or zero) emission zeros. However, financial issues reminds and in recent years, implementation new or extension of low emission zone has been a controversial topic in local elections in many European countries.

Since implementation of low emission zone is at local level, there are lacks standardization in sign and information provision at national or EU level. Business, particularly multinational corporations call for a more harmonised way in traffic sign designing and information provision.

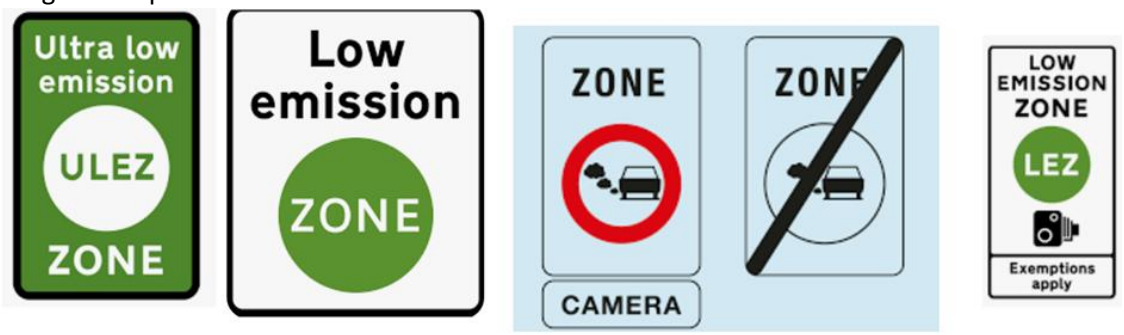


Figure 3 Signs of low emission zones[3]

Some European countries took actions to address the fragmentation of low emission zone implementation and created unified signs and names. For example, France introduced the standard road sign for Low Emission Zones (called "Zones à Faible Emission" in French) and 6 types of the environmental badge (called "Crit'Air"). Sign of ecological zones on the road signs indicating the beginning and end of the ecological zones is standardised as shown below:

Figure 4 Sign of low emission zone in France[4]

On the top of each badge, there is the French word "Crit'Air". The badge should be placed in vehicles according to the environmental pollution level that allow

[3] Signs for Low Emission Zones and Pedestrian Zones | Transport Scotland, LEZ road signs - Transport for London (tfl.gov.uk), Verification in the low-emission zone | Stad Gent

[4] Journal officiel électronique authentifié n° 0150 du 30/06/2019

enforcement of Ecological zones in various cities. Such standardisation avoids that vehicles have to have different badges for different cities or register themselves online when visiting a new city with a low emission zone regulation. There is a strong call for an EU wide standardisation on urban vehicle access regulation, particularly from multinational corporates.

The Netherlands also has a national framework for Low Emission Zones (called 'milieuzone' in Dutch). The low emission zones only apply to diesel vehicles. Vehicles using other fuels are always allowed to enter. Access is regulated on the basis of the Euro standard for light duty vehicles on the one hand and heavy duty vehicles and/or coaches on the other. The national framework in the Netherland requires neither stickers nor registration. Cameras and special enforcement officers ensure compliance.

In 2021, the Netherland national government announced a new plan of zero emission zone to eliminate harmful emissions and particles from lorries or commercial vans in cities. Across the entire nation, 29 cities currently [22] will be implementing zero emission zones with effect from 2025, that aims to zero emission urban logistics. Financial supports will be provided to help companies switch to clean delivery vans or lorries. Cities will thus become healthier and more comfortable places in which to live and work, whilst reducing the emission of harmful gases and particles.

Sustainable Urban Mobility Plan (SUMP) and Sustainable Urban Logistics Plan (SULP)

A sustainable urban mobility plan is a strategic plan from local authorities (cities and towns) to address all aspects for mobility of people in a city or town's functionality area, to ensure sustainable development of the city or town as well as quality of life of its citizens. It builds on existing planning practices with new guidelines on integration and evaluation principles. A SUMP normally should cover the entire functional urban area (a city and its commuting zone). A SUMP should be an instrument to foster cooperation and synergies among all levels of government, local, regional, national and across different policy areas. Development of SUMP must engage citizens and other stakeholders, e.g. local businesses. SUMP aims to promote sustainable transport options while enhance transport safety and improve air quality.

The first guideline on SUMP development to advice cities on a process for preparing and implementing their SUMPs was published in 2013 and the second edition of guideline was published in 2019. The original concept was updated in 2023, integrating new EU strategies and policy priorities. The EC has also set national SUMP support programmes to support member states to help cities in developing SUMPs.

Sustainable Urban Logistics Plans (SULPs) come much later than SUMPs. A study done by the CIVITAS SUMPS-UP project [23] shows that till 2020, only 13% European cities

have a dedicated SULP, while 58% of cities have logistics elements in their SUMPs. The first guideline on SULPs was published in 2018, 5 years after the guideline of SUMP published. The first guideline on SULPs was done by the NOVOLOG project funded by Horizon 2020.

Public and private partnership

To facilitate co-create policies, particularly on urban logistics, many cities set public private partnership to facilitate dialogues between the public and private sectors. Freight Quality Partnerships or FQPs in London is one of examples of such partnership. The FQP gather transport operators in London and various government agencies dealing with freight transport to discuss urban access and deliveries for freight vehicles.

Another good example of such partnerships is the Brussels Green Deal. In 2023, more than 50 companies and players from the Brussels Capital Region (BCR) signed an agreement - the so-called "Brussels Green Deal on Zero Emission Urban Logistics" - committing themselves to more sustainable urban logistics.

Government agencies for urban mobility (who set the rules)

Governance for passenger and freight transport in different cities, regions and countries varies. This chapter analyses selected examples of national, regional and local governments to analyse the current institutional structure of governing urban mobility.

Transport agencies at local governments

Typically, transport is managed at local level by:

- Transport department of local authority
- Public transport operator

Transport department exists in most cities and countries in the EU as a part of local authority. Such a transport department is responsible for transport and mobility planning, management and operation. The transport department may have joint functionalities (e.g. urban planning, infrastructure development, environment etc) of the local authorities. Examples of transport departments in various European cities are:

Table 4 Examples of transport departments in various European cities

City/Region	Department responsibility for transport
Stockholm	Transport
Madrid	Transport & Infrastructure
Brussels Capital Region	Transport and Mobility
Roma	Transport and Main Roads
Breme	Mobility and Transport

Such a transport department is responsible for:

- Urban road networks maintenance and development
- Transport access regulation (e.g. low emission zone), often cooperation with Environment department
- Street parking management and enforcement
- Development and implementation of Sustainable Urban Mobility Plan (SUMP) and Sustainable Urban Logistics Plan (SULP) if applicable
- Taxi licensing
- Vehicle taxation enforcement
- Freight transport licensing and enforcement
- Funding for public transport development and operation

In some cities, transport departments are also responsible for public transport operation, e.g. OASA in Athens. However, in most major cities in EU, their public transport operators may be a dedicated government agency for public transport or managed by the transport department directly (e.g. Transport for London). However, most public transport operator companies are an independent entity owned by city or regional authorities. Some examples of dedicated public transport operators in various cities are shown below:

Table 5 Examples of public transport operators in European cities

City/Region	Public transport operator
Roma	Atec
Brussels Capital Region	STIB
Budapest	BKK
Madrid	CRTM
Gothenburg	Västtrafik

The public transport operators are responsible for all types of public transport services in their cities and regions, e.g. bus, metro, waterborne transport (e.g. Västtrafik has water bus services) and issue tickets. Some of them have additional services, e.g. CRTM also operates parking facilities owned by the city authority.

Transport agencies for logistics

A dedicated agency at the local level for freight transport is not common. Often, freight transport is seen as private matter, rather than one of public services. In the POLIS – ALICE Joint Guide [24], the following elements regarding freight transport governance have been indicated:

- Few cities think of freight as a priority and have defined clear objectives and targets, although there are clear signs of growing awareness.
- Few cities have SULPs and fewer have actual action plans to implement them.
- SULP guidelines may need to include the perspective and strategic input from companies.

- Lack of inhouse staff with freight skills working there.

In France, the Modernization of territorial Public Action and the Affirmation of Metropolitan Governments Act of 2014, known as the "MAPAM Act" [25] strengthened and broadened the missions of metropolitan transportation planning agencies, called today "Mobility Organizing Authorities". On logistics, these authorities are allowed to organise a public service of urban freight and logistics, aiming to reduce congestion, air pollution and noise from the logistics sector" in the case of "unsuitability of private initiative for this purpose. Take examples in Ile-de-France (the Paris Region), Île-de-France Mobilités is the Organising Authority for Mobilities (AOM) in Île-de-France. It is in charge of organising and developing the public transport service and coordinating policies related to mobility including logistics service at the regional level.

4. Stakeholder analysis

Research and innovation projects used for the analysis

The stakeholder analysis is based on the project mapping of relevant R&I projects and use of the consortium members of the projects to understand key actors. The project mapping starts from projects in the **Multimodal Traffic Management (MTM) Cluster**. The MTM Cluster is composed of four European Horizon 2020 projects enabling network and traffic management for future mobility:

- FRONTIER
- TANGENT
- DIT4TRAM
- ORCHESTRA

Those projects ended in 2024 and 3 new projects started in 2023 have been included in the cluster that include DELPHI and its sister projects:

- DELPHI
- ACUMEN
- SYNCHROMODE

Reference to the logistics stakeholder categories in logistics

All of the projects have large consortia that have included various types of stakeholders. In the EC portals, the following categories of stakeholders are used:

- Research organisations;
- Higher or Secondary Education Establishments;
- Private for-profit entities (excluding Higher or Secondary Education Establishments);
- Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments);
- Others

In this stakeholder analysis for the DELPHI project, first a high-level of stakeholder groups are used based on the EC's categories. The relations are shown below:

Table 6 high-level of stakeholder groups in DELPHI

Type of high-level stakeholder groups in DELPHI	Corresponding to stakeholders in EC portal	Comments
R & D institute	Research organisations; Higher or Secondary Education Establishments	
Company	Private for-profit entities (excluding Higher or Secondary Education Establishments);	

Government (including local authorities)	Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments);	"FORUM VIRIUM HELSINKI OY" is in 'others' category at EC portal. Considering it is the innovation agency of city of Helsinki, in this analysis, it is categorised as 'Government'.
Association	Others	

Stakeholder analysis:

The first step is to analyse to look into consortium members of each of the project and numbers of different types of organisations in each of the consortia:

Table 7 Stakeholder groups in R&I projects

	Total number of consortium	R &D institute including university		Company		Government (including local authorities)		Associations	
		Nr	%	Nr	%	Nr	%	Nr	%
FRONTIER	19	6	32%	11	58%	1	5%	1	5%
TANGENT	13	4	31%	5	38%	2	15%	2	15%
DIT4TRAM	20	7	35%	8	40%	4	20%	1	5%
ORCHESTRA	16	5	31%	9	56%	1	6%	1	6%
DELPHI	17	1	6%	14	82%	1	6%	1	6%
ACUMEN	15	8	53%	5	33%	1	7%	1	7%
SYNCHROMODE	15	2	13%	10	67%	2	13%	1	7%
Total	115	33	29%	62	54%	12	10%	8	7%

Of governments, regional and city authorities are active in research projects. However, national governments and European Institutions can play an important role in integrated passenger and freight transport, even though they are not in any of the project consortia.

Of associations, POLIS, as a city network, is in four projects (**TANGENT**, **DIT4TraM**, **ACUMEN**, **SYNCHROMODE**), indicating the importance of city networks. Other associations include industry-led associations, e.g. ITS – Norway, and road operator associations, e.g. International Road Federation (IRF).

Companies participating in such projects are various. Therefore, several sub-categories are needed. There are only 2 companies in more than 1 consortium. Of them, Aimsun has been in involved in 5 projects of the 7 projects while RUPPRECHT CONSULT has been involved in 2 projects.

Table 8 Companies in more than 1 project

Company	Project consortium	Type of business
Aimsun	**FRONTIER** **TANGENT** **DIT4TraM** **ACUMEN** **SYNCHROMODE**	Software provider
RUPPRECHT CONSULT	**TANGENT** **SYNCHROMODE**	Consultancy

Examples of stakeholders in those consortia include:

Table 9 Examples of companies in projects

Company	Project consortium	Type of business
DE VLAAMSE WATERWEG	**FRONTIER**	Waterway operator in Flander
Carris	**TANGENT**	Public transportation company in Lisbon, Portugal
METRO DE MADRID SA	**DELPHI**	Public transportation company in Madrid, Spain
HERE GLOBAL B.V	**ACUMEN**	Map provider
SIEMENS Mobility	**DIT4TraM**	Hardware and software provider

In DELPHI and SYNCHROMODE, a new type of stakeholders, logistics service providers, are in the consortium:

Table 10 Logistics service providers in projects

Company	Project consortium	Type of business
DHL	**DELPHI**	Global logistics service provider
KOIKI	**DELPHI**	Regional logistics service provider
CITYLOGIN IBERICA	**SYNCHROMODE**	Regional logistics service provider

Based on the analysis of the stakeholders and referring to the logistics stakeholder categories from ALICE and the BOOSTLOG project stakeholder analysis[5], stakeholder categories related to the DELPHI project is summarised below:

Table 11 Summary of stakeholders in urban mobility and freight transport

Category	Sub-category	Explanation	Examples
R&D institutions		Universities, research institutions, national laboratories, and any research organisations	ICCS
Companies	Public Transport Operators	Companies manage day-to-day operations of public transport services (buses, trams, metros, and urban rail systems) in a city.	METRO DE MADRID SA
	Infrastructure managers/operators	Organisations (that may be governance agencies or private companies) manage transport networks and infrastructure (roads, inland waterways, railways).	DE VLAAMSE WATERWEG
	Logistics infrastructures managers	Ports, airports, platforms, terminals, logistics nodes	
	Logistics service providers	Companies transporting goods, e.g. postal and parcel delivery companies, pallets, etc.	KOIKI DHL
	Micromobility providers	Companies offering services of micromobility, e.g. e-scooters	TIER
	Technology providers	Companies provide hardware or software for transport management, fleet management and operations	Aimsun
	Business consultancies	Companies provide consultancy services, e.g. helping cities to develop SUMP or SULP. Data analysts, ICT tools providers.	Rupprecht Consult
	OEMs	Vehicles manufacturers	VOLVO
	End users of logistics tools and systems	Stakeholders of the supply chain, shippers, wholesalers, retailers, freight forwarders, postal and parcel operators, carriers, transporters	

[5] https://www.etp-logistics.eu/wp-content/uploads/2022/11/BOOSTLOG_D5.1-Plan-for-Stakeholder-engagement-communications-dissemination-1st-version.pdf

	Logistics tools providers	Warehousing, transhipment and transport units	
Governments	European Institutions	European Commission's Directorate-Generals (DG), Committee of Regions, European Innovation Council (EIC)	DG Research, DG MOV
	Member States	National ministries of the 27 EU member states	Federal Ministry for Digital and Transport, Germany
	Local authorities	Individual regional and city governments	Municipality of Cluj
Associations	City network	Networks of local authorities	POLIS EUROCITIES ICLEI
	Industry association	Associations of industry companies	ACEA CLEPA
	European Technology Platform	Associations that advocate for research and innovation	ALICE ERTRAC
Civil society	Environmental and Climate NGOs	Advocating for climate actions and environment protections	WWF WRI
	Think Tanks	Advocating in R&I policy	
	Philanthropies	Funding transport programmes	
	Citizens	People that live in the city and are affected by its transport flows	
	Passengers	People that use transport services to move from one place to another	

5. State-of-the-art of technologies in passenger and freight transport

This project mapping is focused on two categories of projects: urban mobility & multimodal traffic management on one side, logistics & urban logistics on the other. The aim is to have an overview of the individual technologies used in these sectors, as DELPHI is at the crossroad of the two, integrating passenger mobility and urban freight in a common space to enhance integrated multimodal management at city level.

For this analysis, the scope of focus is on the technologies that are directly related to DELPHI's use cases and technologies. Here is a summary of projects and technologies analysed in the deliverable[6]:

	Network Platform	TNTM optimisation	AI/ML	UAS	External interfaces	Optimisation of underused assets	CAVs	Dashboard / Visualisation tool	Blockchain	Data Space
ORCHESTRA	X	X					X			
FRONTIER		X			X		X			
TANGENT		X	X					X		
DIT4TraM		X	X							
ACUMEN			X	X	X					
SYNCHROMODE			X		X	X				
URANUS				X						
MOVE21					X	X				
ULaaDS						X				
FORFREIGHT			X			X			X	
LEAD										
SENATOR			X					X	X	
DISCO									X	X
PrepDS4Mobility										X
deployEMDS										X

[6] NB. Not all the technologies of all the projects are featured on this deliverable. The table only represents the technologies described below in the deliverable and is by no means an exhaustive mapping.

Multimodal Passenger and Freight Transport Network Platform

The orchestration of different transport mode is very challenging, and they usually work in silos, or having a hard time work together and in a synchronized way. However, to achieve more efficiency in traffic operation as well as favour the use of more sustainable solutions, appropriate coordination is key.

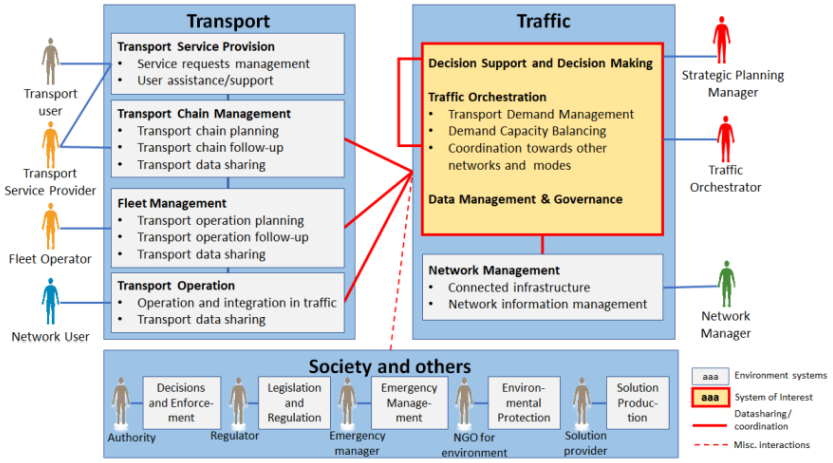


Figure 5 Orchestra's MTME reference architecture

The **ORCHESTRA** project developed a Polycentric Multimodal Architecture (PMA) [26] to try to describe the model needed for an efficient Multimodal Traffic Management Ecosystem (MTME). The PMA defines the main stakeholders' roles description and place in the ecosystem, their functional needs, requirements and their own specific drivers for change, *motivation view* (e.g. data access, sustainability, resilience, customer satisfaction, etc.). The main stakeholders identified by the project are Traffic Orchestrator, Transport Service Provider, Fleet Operator, Network User, Network manager. It also PMA defines the *context view* (functionality and environment descriptions), the *component view* (common information and system decomposition models, interfaces).

The main objective was to build a common understanding of the MTM scope, concepts and solutions, operating as a blueprint declinable to different systems. This architecture aims at going beyond traditional transportation solutions silos, to reinforce collaboration, resilience and efficiency (economic, social and environmental) of the overall transport network.

This reference architecture concept will be pushed further within the DELPHI project, which will develop novel architecture and enablers on a "Multimodal Passenger and Freight Transport Network of Platforms" (NoP). The cloud-based NoP, will enable a secure data federation in a Data Spaces-driven approach, with a centralised access and technology-agnostic interfaces (APIs and user interfaces).

DELPHI's reference architecture, multi-layered, will federate multi-modal passenger and freight transport platforms (as if they were part of a single system), enabling seamless interaction of diverse transport modes and contexts (urban, peri-urban, island), traffic management, and monitoring platforms.

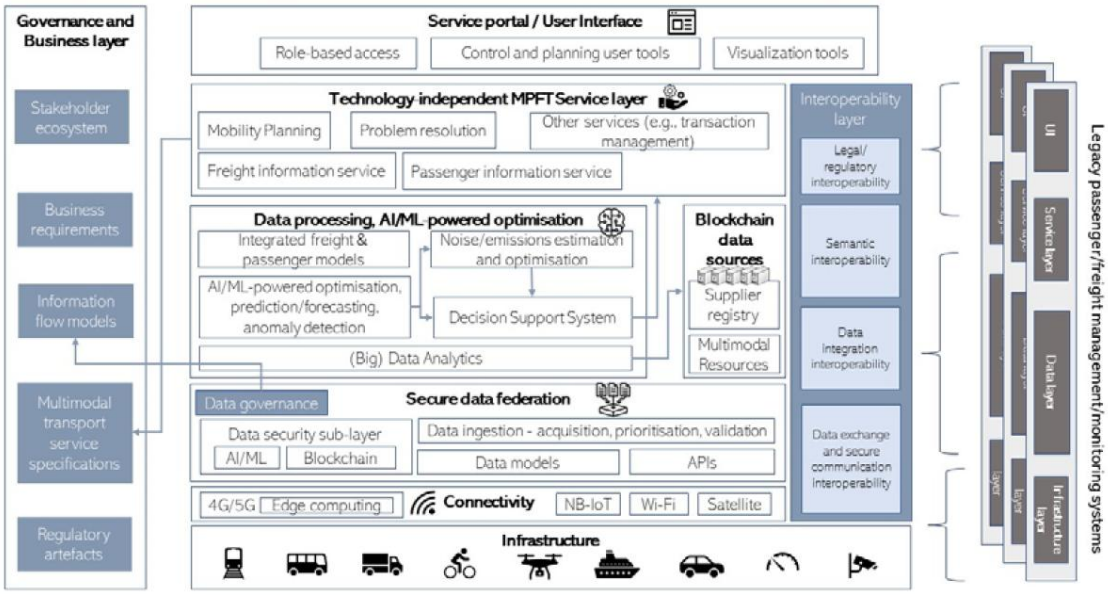


Figure 6 Conceptual overview of DELPHI platform federation with respective key enablers

It will include novel governance and regulatory schemes (stakeholder and ecosystem specifications, information flows, data sovereignty principles, regulatory artefacts), specific definition of common data models and coordinated system towards utmost interoperability, functional and technical requirements for integrated and intermodal services.

The NoP will be experimented, tested in real conditions and improved through DELPHI's different pilots. DELPHI's reference architecture for its Federated Network of Platforms will be further explored and developed in deliverable D3.5 Platform federation reference architecture design.

Transport network and traffic management (TNTM) optimization framework

FRONTIER project developed as key feature the Automated Network and Traffic Management Engine (ANTME) [27], a collaborative and evolutive platform that generates response-plans to help decision makers in case of traffic disruptions.

ANTME integrates various data sources, including sensors, GPS, traffic cameras, connected vehicles, public transport services, weather data, event information, FRONTIER mobile app and social media feeds, to provide a comprehensive view of

traffic conditions. Utilizing real-time processing frameworks, alongside big data technologies, ANTME conducts both real-time and historical data analysis for pattern recognition. Data-driven algorithms and models are used to detect anomalies (traffic flow, congestion, and incidents) and make simulations to predict cross modal traffic state to assess the real-time network's transport supply and demand, using artificial intelligence. Based on the fusion and harmonization of data from multiple sources, response plan and mitigation measures can be elaborated and chosen at system level (Response Plan Generator). Such response plans can integrate provision of on-demand services for example. Simulations are performed to test the response plans, which are also monitored once implemented.

TANGENT project [28] developed a Smart Network Load Balance service to regulate traffic in real-time and balance demand and supply across modes. It includes mitigating measures such as traffic signal timings, variable speed limits, re-routing, dynamic congestion pricing, re-routing propositions and information to users through different channels (e.g., social media, VMS, vehicular communication and journey planning applications).
Its Cooperative Incident Management builds on synchronization of public transport, on-demand transport and traffic control, to offer multiple adaptative solutions to ensure optimum in transport network efficiency and resilience.
TANGENT also developed strong travel behaviour prediction algorithms to anticipate users' reactions to regular traffic or disruptive events and adapt response plans accordingly.
TANGENT integrated information from multiple mobility stakeholders and sources into a single visualization tool, to establish a common operational picture (COP) and access predictive information, that facilitates common operational decisions and information sharing among all in real time.

Through its Multimodal Traffic Management Ecosystem (MTME), **ORCHESTRA** aims for a multimodal, connected/automated or not, rural and urban coordination scheme for transportation. [26] To elaborate the Multimodal Traffic Management Ecosystem, ORCHESTRA works on defining new transports models (including AI and Machine Learning optimization algorithms), simulations, decision-support-tools, policies, organisational and business models, with effective and seamless exchange of information through common data spaces.

DELPHI aims to create a TNTM optimization framework, gathering data from various sources and accessing it to propose adaptive responses that will allow for less pollutant emission, lower cost and improved delivery times. The objective is the integration of passenger and freight information to balance flows of passenger and flows of freight, in different modes, in as-usual situations and in case of disruptive events.

Artificial Intelligence / Machine Learning (AI/ML)

Machine Learning and Artificial Intelligence algorithms enhance urban logistics as their optimization capacities can contribute to reduction of traffic congestion, emissions and logistical costs, while enhancing customer satisfaction through reliable and timely deliveries, and improve urban quality of life by alleviating.

The **SENATOR** project will use machine learning algorithms to analyse real-time traffic data to predict traffic conditions and facilitates demand/supply planning by examining historical, identifying trends to forecast the need for delivery services. It enables thereby the selection of the most efficient delivery routes, mitigating delays, and optimising fuel consumption and resource utilisation. [29]

In the Spanish use case, the **FORFREIGHT** project is using AI-based Machine Learning to optimize transport planning and logistics operations, with constant and quick adaptation to new information and inputs. [30]

DIT4TRAM's AI-Powered Traffic Prediction Models are composed of advanced artificial intelligence algorithms that analyse historical and real-time data to predict traffic patterns and optimise traffic management strategies. AI-powered models enable more responsive and adaptive traffic management, reducing congestion and emissions while improving travel times and road safety. Pilot implementations have shown promising results, with ongoing enhancements to improve prediction accuracy and computational efficiency. [31]

ACUMEN project is using Artificial Intelligence as well as Hybrid intelligence to elaborate advanced tools for monitoring and forecasting, assisting stakeholders to elaborate the most accurate and relevant traffic management strategies. [32]

TANGENT uses artificial intelligence to help stakeholders make choices to improve traffic flow, based on its current and future state through predictions and simulations of demand-supply scenarios (e.g. capacity and frequency increases in public transport, increase of shared mobilities, dynamic pricing, integration of CAVs, etc.) and/or disruptive events (e.g. congestion due to road accident), including travel behaviour models to anticipate transport user's choices and define appropriate response plans accordingly. [28]

SYNCHROMODE project will elaborate Synchromodal Planning Algorithms. Through network-wide data sharing, following Gaia-X Data Space guidelines to collect and integrate data, ensuring a trustful and environment for all stakeholders, it will generate a cooperative dashboard, "common operational picture" with the consolidated and processed data that allows for real-time monitoring and prediction of supply and demand, and incident detection for passenger and freight transport. [35]

DELPHI includes in its framework the use of AI/ML-driven real-time prediction capabilities. Integrating advanced AI-based models facilitates comprehensive monitoring and predictive modelling, ensuring real-time, data-driven decision support. DELPHI will look into robust algorithms, based on artificial intelligence, to quickly detect and adapt to anomalies in traffic, disturbances such as material failure or even attacks. DELPHI will validate its AI/ML-powered optimization framework through real-world pilots and simulation-based analyses.

Unmanned Aerial Systems (UAS): traffic and pollutants emissions monitoring

Current challenges in traffic monitoring data collection include limited coverage, high costs, and complex processing (data formats, quality, privacy, integration, and compatibility related issues). Traditional methods rely heavily on fixed infrastructure such as cameras and sensors, which are often expensive to install and maintain. Additionally, these systems can struggle to provide real-time, comprehensive coverage, especially in remote or congested urban areas. Unmanned Aerial Systems (UAS) offer a promising solution by providing flexible, mobile, and cost-effective surveillance. UAS can quickly cover large areas, capture high-resolution imagery, identify different transport modes (even soft modes) and transmit data in real time, significantly enhancing the efficiency and accuracy of traffic monitoring efforts.

ACUMEN, DELPHI's sister project will use drones to collect data and feed its traffic management monitoring in two of its pilots, Helsinki and Athens. [32]

URANUS, an ERC research project, dives into the specific topic of "Real-Time Urban Mobility Management via Intelligent UAV-based Sensing" and focuses on developing advanced technologies and operational concepts and advanced frameworks to support seamless and secure UAS integration into the airspace, facilitate real-time urban mobility management (vehicles and pedestrians) and pollution monitoring. [34]

These two projects are not yet sufficiently advanced to deliver concrete results, but they will be valuable to confront to DELPHI's results to strengthen feedback in the future.

DELPHI will experiment the use of UAS for data collection in several pilots monitoring both traffic state, and pollutants emissions as well (noise and CO2 emissions).
The former will be estimated through vehicles trajectories captured by the drone. The accuracy of the models will be evaluated by installing air quality and noise sensors on site. This will enable improvement of the AI models and elaborate emissions

estimations that are more and more accurate, to later estimate emissions at network's scale.

DELPHI aims to be in the core activities of the integration phase of drones into the Intelligent Transportation Systems (ITS) infrastructure and will utilise this technology to identify interactions of delivery vehicles with the rest of traffic during peak hours in Central Business Districts (CBDs), which is not possible to analyse with existing sensors and techniques.

External interfaces with users

Traffic management measures include directly applicable measures such as traffic signal timings, variable speed limits, dynamic congestion pricing, etc. Some other efficient measures require involvement of transport users, such as re-routing propositions. To succeed in making users aware of these propositions, information needs to reach users through efficient channels. Projects have worked on different alternatives.

FRONTIER elaborated interfaces with external stakeholders in the form of a mobile app for transport users to offer information service and proactive regulation of traffic (e.g. users can be advised to change route or mode of transport to reach their destination in case of disruptive event).

SYNCHROMODE project, to increase its responses plans' efficiency, will directly communicate with key stakeholders such as Google Maps, Waze, TomTom (connected vehicles), MaaS and logistics providers through standardized channels. This will improve reaction times and speed up the mitigation processes in case of disruptions.

ACUMEN will develop an app to communicate suggestions of alternative routes and modes of transportation choices to users as to improve the overall distribution of network fluidity and transport user experience. The AI-driven app is currently being experimented in Helsinki pilot.

In Oslo, **MOVE21** project evaluated the practicality and necessity of a MaaS API, including operator assessment scope. The initiative focused on integrating micromobility options with public transport service to provide efficient multimodal journey options. This integration aims to facilitate seamless transitions between modes of transport, such as from a bus to a city bicycle, within a single application, enhancing both user convenience and operator efficiency. [35]

The DELPHI project will work on external user interfaces to facilitate information sharing, potentially through Application Programming Interface (API). This will be applied for example to the Cluj-Napoca's pilot, leveraging public transport system

management software to optimise the city's multimodal transport network, including buses, trolleys, trams, and the local bike-sharing system. The integrated app will offer route planning, real-time localisation, and arrival times, enhancing the user experience. Additionally, DELPHI aims to support operators with advanced software for fleet management and public transport route optimisation, addressing issues like overlapping routes and network inefficiencies.

Optimization of underused assets

One of the key innovations of DELPHI relies on the optimization of existing assets, such as infrastructure and vehicles to reinforce the overall transportation system, including combination of passenger and freight solutions.

In Oslo, Norway an additional feature was added to the already existing on-demand transport service for seniors through the **MOVE21** project. While the shuttle transported people to and from the shopping centre, it also delivered goods from the shopping centre to homes in the residential areas.

In Mechelen, Belgium, **ULaaDS** project tested a cargo-hitching solution, exploring the use of an automated shuttle, operated by Easy Mile, which could contain six lockers and up to nine passengers. Results of the pilot were mixed, mainly due to the complexity of integrating an autonomous vehicle in an urban environment.

In **SYNCHROMODE**, public busses will experiment freight delivery services to balance load and mutualise trips in Madrid.

DELPHI is further developing this solution in Mykonos, where passengers' busses as well as underused taxis will also take on goods in the luggage compartment at strategic stops on the island, such at the airport and the port. This will optimize the use of vehicles on the already crowded roads of the island during the touristic season and provide more sustainable and efficient transport solutions. Taxis and buses operate as complementary options to both optimize the use of the vehicles as well as managing peak demand during touristic season.

In Madrid, the **FORFREIGHT** project runs a pilot on a digital twin and blockchain based decision-support tool to assist managing the freight transport chain from Valencia Port to Madrid city centre, including using the subway as a last-mile transport mode. [36]

DELPHI will experiment the transport of goods from a DHL warehouse outside of the city of Madrid, which are transported to a metro depot thanks to a truck, then carried in the subway to the center of the city and delivered by walking or biking for the very last mile. The results of the LMD simulation scenarios and analysis in FORFREIGHT will be insightful for the DELPHI concrete and operational pilot.

Integration of connected and automated vehicles (CAV)

The **Orchestra** project did two experiments in Heroya Industrial Park and in Malpensa Airport, to either guide lorries in the port in the first case, or to transport passengers in the second case. The vehicles allowed to collect data in real time on the road state and to detect incidents.

FRONTIER's pilot in Oxfordshire investigates the conditions of integration of CAVs in traffic and their possible use in existing management systems (aggregation of information coming from the different systems, to detect incidents and traffic state) The pilot also includes Operational Design Domains (ODDs) definition and the description of a Smart Infrastructure Classification Index on the level of readiness of infrastructures and areas to integrate CAVs. [37]

DELPHI will build up on these experiments and explore the integration of autonomous transport modes in the interconnected public transport system in Cluj-Napoca pilot.

Dashboard / visualization tool

TANGENT developed a unique dashboard "common operational picture" (real-time and predictive) to manage network traffic, identify bottlenecks, and disruptive events, and proposes appropriate response plans and policies, with arbitration models. The dashboard is linked to APIs to share information and decisions in real time with transport operators, users and providers.

SENATOR elaborated a centralized dashboard, the SENATOR ICT Platform, to visualize in real-time key operational KPIs and facilitate decision-making, with features such as "On-demand Platform Manager" to manage easily customer demand and carriers supply, "Multimodal Fleet Manager" to manage fleet resources, and optimize routes, distances as well as environmental KPIs, "Smart Routes Manager" for route optimization, including real-time information (incidents, congestion, weather elements, etc.) and "Diagnosis of Urban Infrastructure" for public information sharing both real-time (e.g. parking spots availability) and longer-term (e.g. regulations such as restricted areas).

DELPHI will provide a dashboard with visualization tools to facilitate decision-making with a Decision Support System (DSS) based on simulations of scenarios. It will enable to dynamically balance multimodal passenger and freight flows, addressing both anticipated and unexpected scenarios such as traffic disruptions.

Data Spaces

Data spaces provide a decentralised infrastructure where data providers and consumers can share information in a trustful and standardized manner, underpinned by robust governance frameworks and data sovereignty principles. By leveraging technologies such as semantic interoperability, blockchain, and federated data architectures, data spaces ensure that data is shared consistently and securely. These collaborative frameworks support real-time data sharing and analytics, crucial for optimising transport operations, improving passenger experiences, and advancing the development of intelligent transportation systems.

The **PrepDSpace4Mobility** project [38] to develop a comprehensive data space, facilitating interoperability and seamless data exchange among mobility stakeholders at European scale, elaborating the European Mobility Data Space. The project's main achievements include the establishment of data governance frameworks, the publication of inventory of data ecosystems in mobility and logistics as well as development of tools for data integration.

Building on PrepDSpace4Mobility's foundations, the **deployEMDS** project [38] will continue this work by focusing on the large-scale deployment of the European Mobility Data Space, ensuring widespread adoption and further enhancing the impact of data-driven mobility solutions across Europe. For the time being, neither of these two projects address the integration of urban logistics in their urban mobility frameworks.

The **DISCO** project [40] aims at helping cities optimize local Urban Logistics by providing them 23 innovative measures (related to dynamic space planning and management for urban space, buildings/estate, lockers and micro-hubs, multimodal bays, etc.), all supported by the Urban Freight Data Space[7]. The use of data spaces enables quick, secure, sovereign and standardized information exchange, which are the main barriers to data exchange among urban logistics' stakeholders.

[7] As described on the DISCO website, the Urban Freight Data Space "an International Data Spaces Association (IDSA) based ecosystem that enables urban logistics and mobility actors to seamlessly share data with each other on a secure and sovereign manner".

DELPHI aims to build an effective and resilient network-wide data integration platform for multimodal traffic management. To achieve this, DELPHI will develop a methodology framework, in a Data Spaces-driven approach for an integrated, secure and efficient data sharing, storage and process. DELPHI intends to extend data spaces concepts for mobility domain. DELPHI will follow GAIA-X's paradigm as design principle, and will be store at their source, rather than centrally.

Blockchain

The **SENATOR** project aims to enhance efficiency and transparency in urban parcel delivery by integrating blockchain technology into its smart network operator and ICT platform. This integration provides meticulous tracking and immutable traceability of shipments, ensuring data integrity. Blockchain's real-time tracking and comprehensive movement history improve collaboration among logistics operators, enabling efficient coordination of shared resources like fleets and delivery routes. Additionally, blockchain ensures cold chain traceability, with sensors monitoring product temperature from collection to delivery, ensuring compliance with stringent standards.

The **FORFREIGHT** project is relying on blockchain technology for real time information access, such as tracking of shipments and transactions among stakeholders in a secure manner in the context of its Spanish use case.

DISCO project will use Blockchain technology in one of its pilot, in the context of Warehouse as a service platform, to ensure safety of data exchange and smart contracts.

DELPHI's technology-agnostic, multimodal transport architecture will facilitate tracking of data exchange using Blockchain. DELPHI's Blockchain-powered data sharing ensures maximum security, trustworthiness, and data sovereignty for data owners.

Conclusion

This deliverable portrays the current state of the art in passenger and freight transport, governance structures, stakeholder roles, and individual technologies that shape the current landscape of urban mobility. The report has analysed in detail three sections - 1) governance, 2) stakeholder and 3) technology analysis in traffic management, passenger and freight transport related to DELPHI's four use cases.

The report has mapped previous and ongoing research and innovation (R&I) projects from H2020 and HE that can provide inputs to the DELPHI project. Projects that have been mapped by the deliverable include the six other projects of the Multimodal Traffic Management Cluster: FRONTIER, TANGENT, DIT4TRAM, ORCHESTRA, ACUMEN and SYNCHROMODE. Additional projects mapped by the deliverable focus on logistics and urban logistics: ULaaDs, LEAD, DISCO, MOVE21, FORFREIGHT and SENATOR.

Key stakeholders have been identified in the ecosystem in passenger and freight transport by analysing the partners of the project. The technologies implemented by those projects provide a valuable state-of-the-art in urban mobility and urban logistics solutions.

Since urban mobility is a complex issue many European policies and regulations have impacts on urban mobility. Policies and regulations at EU levels that have brought notable hallmarks on today's urban mobility are mapped. Key conflicting issues in governance have been identified, providing a reference to policy recommendations for the DELPHI project. Selected administrative structures of various governments have been analysed to understand who develops and implements policies and regulations on urban mobility.

Stakeholders in urban mobility cover a wide range of types of organisations and entities. All stakeholders have been categories into four high level categories: companies, governments, R&D organisations, and civil societies. By mapping project consortium members, key actors in the four categories have been identified. More detailed analysis of stakeholders under each of the four categories have been carried out.

The analysis of individual technologies provided a precise overview of the front-runner innovations of passenger and freight transport: developments in data-driven solutions, improvement of planning strategies through artificial intelligence and machine learning, improved and more efficient use of resources and assets. The potential benefits of these technologies are vast, offering improvements in efficiency, safety, and environmental sustainability.

This report has provided a detailed landscape of the current governance framework, stakeholders mapping and technology overview for current passengers and freight technologies. These findings contribute as a first foundation for the work carried out in DELPHI's *WP2 - Governance, Regulatory and Stakeholder Analysis* and will also prepare ground for the *WP6 - Dissemination, communication, exploitation and community building*'s missions on standardization and policy recommendations.

Annex A: Consortium List of the projects in the MTM Cluster

The following table lists the consortium members of the 7 projects:

Acronym & Grant Agreement ID	Full name	Project period	Consortium members			
			Research organisation including university	Company	Government (including local authorities)	Associations
FRONTIER Grant agreement ID: 955317	Next generation traffic management for empowering CAVs integration, cross-stakeholders collaboration and proactive multi-modal network optimization	01.05-2021 – 30.04.2024	FUNDACIO EURECAT; EREVNITIKO PANEPISTIMIAKO INSTITOUTO SYSTIMATON EPIKOINONION KAI YPOLOGISTON; UNIVERSITY OF WOLVERHAMPTON; POLYTECHNEIO KRITIS; UNIVERSITEIT ANTWERPEN; UNITED KINGDOM ATOMIC ENERGY AUTHORITY	IBI GROUP ELLAS SYMVOULOI EPIXEIRISEON MONOPROSWPI ANONYMI ETAIREIA; AIMSUN SL; MOBY X SOFTWARE LIMITED; Preston EV Limited; NETCOMPANY-INTRASOFT SA; TAGMASTER AKTIEBOLAG; FRONTIER INNOVATIONS EE; ELLINIKO METRO MONOPROSOPI AE; AE SYN. - LEITOYRG. KAI EKMETALLEYS. ELEYTHERIS LEO. ELEYSINAS - STAYROY - AERODROMIOY SPATON KAI DYTIKIS PERIFER. LEO. YMITOY ATTIKES DIADROMES; ORGANISMOS ASTIKON SYGKOINONION ATHINON AE; DE VLAAMSE WATERWEG	OXFORDSHIRE COUNTY COUNCIL;	INTERNATIONAL ROAD FEDERATION

Funded by the European Union

DELPHI project has received funding under grant agreement No 101104263. It is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

TANGENT Grant agreement ID: 955273	ENHANCED DATA PROCESSING TECHNIQUES FOR DYNAMIC MANAGEMENT OF MULTIMODAL TRAFFIC	01.09.2021 – 30.08.2024	UNIVERSIDAD DE LA IGLESIA DE DEUSTO ENTIDAD RELIGIOSA; ETHNICON METSOVION POLYTECHNION; INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM; CEFRIEL SOCIETA CONSORTILE A RESPONSABILITA LIMITATA SOCIETA' BENEFIT;	AIMSUN SL; RUPPRECHT CONSULT-FORSCHUNG & BERATUNG GMBH; ATOBE - MOBILITY TECHNOLOGY SA; COMPANHIA CARRIS DE FERRO DE LISBOA, E.M., S.A.; PANTEIA BV;	RENNES METROPOLE; TRANSPORT FOR GREATER MANCHESTER;	POLE DE COMPETITIVITE IDFORCAR; POLIS
DIT4TraM Grant agreement ID: 953783	Distributed Intelligence and Technology for Traffic and Mobility Management	01.09.2021 – 30.08.2024	TECHNISCHE UNIVERSITEIT DELFT; UNIVERSITE GUSTAVE EIFFEL; ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE; EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH; ETHNICON METSOVION POLYTECHNION; BAR ILAN UNIVERSITY; STICHTING AMSTERDAM INSTITUTE FORADVANCED METROPOLITAN SOLUTIONS(AMS);	AIMSUN SL; SIEMENS MOBILITY GMBH; TECHNOLUTION BV; ARANE ADVISEURS IN VERKEER EN VERVOER BV; GERTRUDE; NEO GLS; D.E.I.A. DEVELOPMENT ENGINEERING INFRUSTRUCTURE ASSOCIATION LIMITED; OSEVEN SINGLE MEMBER PRIVATE COMPANY	GEMEENTE AMSTERDAM; GEMEENTE UTRECHT; BORDEAUX METROPOLE; GLYFADA MUNICIPALITY	POLIS

ORCHESTRA Grant agreement ID: 953618	Coordinating and synchronising multimodal transport improving road, rail, water and air transport through increased automation and user involvement	01.05-2021 – 30.04.2024	SINTEF AS; TECHNISCHE UNIVERSITEIT DELFT; HAUTE ECOLE SPECIALISEE DE SUISSE OCCIDENTALE; INSTITUT FUR KLIMASCHUTZ ENERGIE UND MOBILITAT-RECHT, OKONOMIE UND POLITIK EV(IKEM); CENTRE D ETUDES ET D EXPERTISE SUR LES RISQUES L ENVIRONNEMENT LA MOBILITE ET L AMENAGEMENT	CERTX AG; IOTA STIFTUNG; SOCIETA' PER AZIONI ESERCIZI AEROPORTUALI SEA; DEEP BLUE SRL; FSTECHNOLOGY SPA; GRUPPO ISC SRL SOCIETA' BENEFIT; APPLIED AUTONOMY AS; HEROYA INDUSTRIPARK AS; ENAV SPA;	STATENS VEGVESEN	ITS NORGE
DELPHI Grant agreement ID: 101104263	FeDerated nEtwork of pLatforms for Passenger and freigHt Intermodality	01.07.2023 – 30.06.2026	EREVNITIKO PANEPISTIMIAKO INSTITOUTO SYSTIMATON EPIKOINONION KAI YPOLOGISTON;	EREVNITIKO PANEPISTIMIAKO INSTITOUTO SYSTIMATON EPIKOINONION KAI YPOLOGISTON; EBOS TECHNOLOGIES LIMITED; INLECOM COMMERCIAL PATHWAYS COMPANYLIMITED BY GUARANTEE; AIRBUS URBAN MOBILITY GMBH; INFINEON TECHNOLOGIES AG; STATHERES SYGKOINONIES MONOPROSOPI ANONYMI ETAIREIA;	MUNICIPIUL CLUJ-NAPOCA;	ALLIANCE FOR LOGISTICS INNOVATION THROUGH COLLABORATION IN EUROPE

				AE SYN. - LEITOYRG. KAI EKMETALLEYS; ELEYTHERIS LEO. ELEYSINAS - STAYROY - AERODROMIOY SPATON KAI DYTIKIS PERIFER. LEO. YMITOY ATTIKES DIADROMES; KOINO TAMEIO EISPRAXEON LEOFOREION K.T.E.L. YPERASTIKON GRAMMON MYKONOY ANONYMOS ETAIRIA; DHL EXEL SUPPLY CHAIN SPAIN SL; METRO DE MADRID SA; KOIKI HOME SOCIEDAD LIMITADA; NTT DATA ROMANIA SA; SIMPILITY NAFTILIAKES METAFORIKES KAI EPIKOINONIAKES EPICHEIRISEIS ETAIRIA PERIORISMENIS EFTHYNIS		
ACUMEN Grant agreement ID: 101103808	Ai-aided deCision tool for seamless mUltiModal nEtwork and traffic managemeNt	01.06.2023 – 31.05.2026	AALTO KORKEAKOULUSAATIO SR; UNIVERSITE GUSTAVE EIFFEL; LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY;	S.L.A. SA; AIMSUN SL; DIMOS ATHINAION EPICHEIRISI MICHANOGRAFISIS; HERE GLOBAL B.V.; LUXMOBILITY S.A.R.L.	FORUM VIRIUM HELSINKI OY	POLIS

			UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II; ETHNICON METSOVION POLYTECHNION; UNIVERSITE DU LUXEMBOURG; TECHNISCHE UNIVERSITEIT DELFT; STICHTING AMSTERDAM INSTITUTE FORADVANCED METROPOLITAN SOLUTIONS(AMS);			
SYNCHROMODE **Grant agreement ID: 101104171**	Advanced traffic management solutions for synchronized and resilient multimodal transport services	01.05.2023 – 30.04.2026	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS; UNIVERSIDAD DE LA IGLESIA DE DEUSTO ENTIDAD RELIGIOSA;	NOMMON SOLUTIONS AND TECHNOLOGIES SL; NOMMON SOLUTIONS AND TECHNOLOGIES SL; MAP TRAFFIC MANAGEMENT BV; AIMSUN SL; BE-MOBILE; VMZ BERLIN BETREIBERGESELLSCHAFT MBH; ARRIVA PERSONENVERVOER NEDERLAND BV; RUPPRECHT CONSULT-FORSCHUNG & BERATUNG GMBH; PNO INNOVATION SL;	REGION OF CENTRAL MACEDONIA; Provincie Zuid-Holland	POLIS

				CITYLOGIN IBERICA SL;		

Annex B: Description of projects presented in the deliverable

Short introduction of the projects except DELPHI (direct copy from the CORDIS portal):

Project information	Project description (CORDIS)
FRONTIER Horizon 2020 ID 955317 Duration: 01.05.21 – 30.04.24	FRONTIER will develop, apply and test the network and integrated traffic management strategies of the future, taking into account new types and modes of transport and connected automated vehicles (CAVs). Researchers will use data generated from real-time monitoring of the transportation system, knowledge generated by operators and decision-makers as well as simulation models to provide solutions for new mobility services and technologies. These systems will support proactive decision making to ensure a seamless transition to autonomous and integrated transport management for future mobility services. The three pilots will focus on: smart infrastructures and connected autonomous CAVs integration; multimodal mobility for passengers and freight cross-stakeholders collaboration; and network performance analysis for planning and policy making.
TANGENT Horizon 2020 ID 955273 Duration: 01.09.2021 – 31.08.2024	Transport is at a crossroad. The sector is paved with disruptive technologies and mobility solutions designed to revolutionise transport networks and traffic management. The EU-funded TANGENT project will develop new tools to improve traffic operations in a coordinated way, considering automated and non-automated vehicles, passengers, and freight transport. TANGENT will research advanced techniques on modelling and simulation, such as simulation models for future demand and supply of transport; optimisation techniques for balancing demand flows; and modelling users' travel behaviour. A set of applications for decision-making support will be delivered to provide traffic management recommendations and to support transport authorities in their design of network-wide optimal strategies. Case studies will be conducted in France, Portugal, the UK and Greece.
DIT4TRAM Horizon 2020 ID 953783 01.09.21 – 01.09.24	The way people and products move has changed dramatically over the past decades and will continue to evolve for many more. The mobility ecosystem is undergoing a remarkable transformational shift on all fronts: technological, social and economic. In this context, the EU funded DIT4TraM project will explore smart ways to manage traffic which is driven more and more by user-centred mobility services and integrated and intelligent transport networks. It will develop and test a holistic approach to decentralisation, distribution and mechanism design for traffic and mobility management. The project's goal is to accelerate the transition to seamless and sustainable connected and autonomous mobility. The findings will lay the foundation for a 180 degree paradigm shift in traffic and mobility management.

Funded by the European Union

DELPHI project has received funding under grant agreement No 101104263. It is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

ORCHESTRA Horizon 2020 ID 953618 Duration: 01.05.2021 – 30.04.2024	ORCHESTRA - Technological and organisational innovations pave the way to an integrated transport system that coordinates and synchronises traffic flows along and across all modes – road, rail, water, and air. The EU-funded ORCHESTRA project will bridge the current silos within traffic management by defining a multimodal traffic management ecosystem (MTME) where different traffic management measures are coordinated and synchronised. This will ensure efficiency and resilience of the transport system and leverage integration of connected and automated vehicles and vessels. To facilitate large-scale deployment of a novel MTME, ORCHESTRA will provide a polycentric multimodal architecture (PMA) defining the roles, responsibilities, information models and governance structures required.
ACUMEN Horizon Europe ID 101103808 Duration: 01.06.2023 – 31.05.2026	ACUMEN - In today's increasingly congested urban landscapes, efficient transportation has become a pressing challenge. Traffic gridlock, safety concerns, and environmental issues all demand innovative solutions. In this context, the ACUMEN project proposes a cutting-edge, privacy-preserving, data-driven digital paradigm aimed at streamlining network management. Its goal? To enable seamless door-to-door journeys, enhance network-level safety and resilience, and contribute significantly to the transport objectives outlined in the Green Deal. At the heart of ACUMEN lies the concept of a modular, multi-layered digital twin. This high-fidelity representation of complex real-world systems creates a digitised version of sustainable, connected urban mobility. Complemented by plug-in modules or digital tools, ACUMEN harnesses the power of AI to support mobility management and decision-making.
SYNCHROMODE Horizon Europe ID 101104171 Duration: 01.05.2023 – 30.05.2026	The EU-funded SYNCHROMODE project will address major challenges faced by European transport systems, including traffic congestion, road safety, energy consumption, and emissions. The project aims to transform traffic management by incorporating a multimodal network-wide perspective. To that end, it will equip traffic managers with the SYNCHROMODE Toolbox, providing predictive and optimisation capabilities to balance network supply and demand and manage the impacts of events. Furthermore, it will execute research activities beyond the current state of the art in transport modelling, traffic prediction, optimisation of multimodal traffic operations, enhanced data quality, use of new multimodal traffic data sources, and new KPIs for improved monitoring and assessment. Project results will be tested and validated in three real-world case studies: Thessaloniki (Greece), the Netherlands, and Madrid (Spain).
URBANE Horizon Europe ID 101069782 Duration:	Advancing the transition path towards safe, efficient and sustainable last mile transport, the last leg of a journey for the movement of goods, is a priority for the EU-funded URBANE project. It will combine green automated vehicles with shared space usage models to uncover last mile delivery solutions. URBANE will focus on four Lighthouse Living Labs in Bologna, Helsinki, Thessaloniki and Valladolid. The project will leverage digital

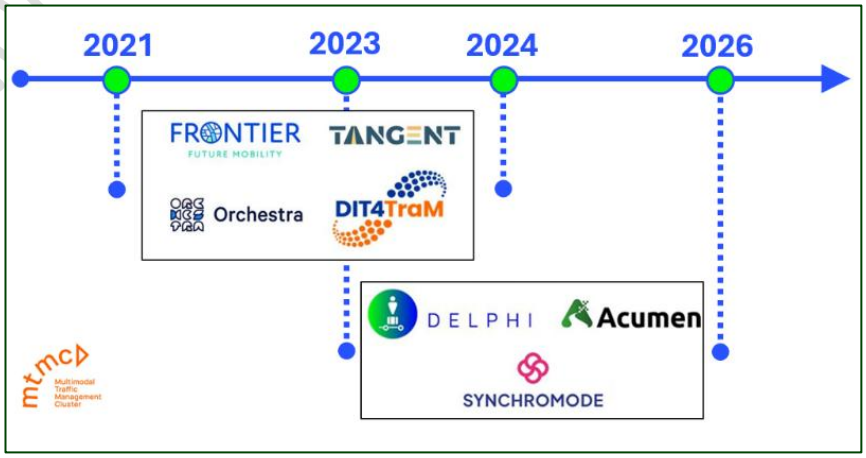
01.09.2022 – 28.02.2026	twinning tools, a data-driven impact assessment radar, and Blockchain technology-led smart contracts to get results, which will enable it to verify the 'physical internet' (i.e. transport network) for urban deliveries.
DISCO Horizon Europe ID 101103954 Duration: 01.05.2023 – 31.10.2026	The daily transport of goods in and around urban areas is essential to support the needs of domestic and international commerce as well as local businesses and consumers. However, it contributes to the disruption of citizens' life quality by increasing traffic congestion, noise, road hazards, air pollution and land use conflicts. As urban freight distribution continues to grow, it is vital to mitigate its side effects. To address this, the EU-funded DISCO project aims to develop and demonstrate a centralised European metamodel that integrates urban freight logistics and optimised city land use. The open data-sharing space will provide city planners with tools that can help them optimally manage, monitor and dynamically predict city freight flows.
FOR FREIGHT Horizon Europe ID 101069731 01.09.2022 – 31.12.2025	Freight transport is a driver of competitiveness and an essential part of supply-chain and logistics systems. Freight transport is also on a green path, which means stakeholders need to adapt. The EU-funded FOR-FREIGHT project aims to help realise this green transition by utilising multimodal freight transport that integrates legacy logistics systems with new technologies. This novel solution will allow better monitoring of goods and emissions throughout the transport process, improved logistics that make freight transport more cost-efficient and sustainable, and decision support for better resource efficiency and adaptability in the changing market.
SENATOR Horizon 2020 ID 861540 Duration: 01.09.2020 – 31.08.2024	In order to manage urban planning policies in an optimal way, the EU-funded SENATOR project aims to produce governance schemes on user demand planning, transport planning, freight and logistics planning and city infrastructure. Within this scope, the project will create a multi-collaborative framework that will bring together stakeholders in urban freight logistics. A 'control tower' will help plan the operations and ease the relationships between urban planners and urban freight logistics players. Eventually, the project will create a new urban logistic model focussed on the four urban layers (end-receiver, transport, logistics and infrastructure) and enhance citizen engagement in urban planning policies.
MOVE21 Horizon 2020 ID 953939 Duration: 01.05 2021 – 30.04.2024	The rapid transition to zero emissions and climate resilient transport systems requires an integrated approach to passenger and freight transport. The EU-funded MOVE21 project will tackle six urban nodes, from policy definition to planning and implementation in the participating cities. The integrated and holistic approach of MOVE21 ensures that potential negative effects from zero emission solutions in one field are not transferred to other domains, ultimately boosting the resilience of the European transport systems. MOVE21 will work through the Living Labs of Gothenburg, Hamburg and Oslo and the three replicator cities Bologna, Munich and Rome. It will test

	different mobility hubs and innovations and develop means for clean and smart mobility and logistics.
ULAADS Horizon 2020 ID 861833 Duration: 01.09.2020 – 28.04.2024	The EU-funded ULaaDS project sets out to offer a new approach to system innovation in urban logistics. Its vision is to develop sustainable and liveable cities through re-localisation of logistics activities and re-configuration of freight flows at different scales. Specifically, ULaaDS will use a combination of innovative technology solutions (vehicles, equipment and infrastructure), new schemes for horizontal collaboration (driven by the sharing economy) and policy measures and interventions as catalysers of a systemic change in urban and peri-urban service infrastructure. This aims to support cities in the path of integrating sustainable and cooperative logistics systems into their sustainable urban mobility plans (SUMPs). ULaaDS will deliver a novel framework to support urban logistics planning aligning industry, market and government needs, following an intensive multi-stakeholder collaboration process. This will create favourable conditions for the private sector to adopt sustainable principles for urban logistics, while enhancing cities' adaptive capacity to respond to rapidly changing needs. The project findings will be translated into open decision support tools and guidelines.
LEAD Horizon 2020 ID 861598 Duration: 01.06.2020 – 30.09.2023	Sprawling cities need smart urban logistics to become more environmentally, socially and economically sustainable. It is important for today's tech-savvy city planners to generate simulations that can help guide their future plans. This is why it is necessary for them to make maximum use of the latest computer-aided design (CAD) technology. The EU-funded LEAD project is designing digital twins of urban logistics to support experimentation and decision making in public–private urban settings. Specifically, the project's long-term goal is to develop an open physical internet-inspired framework for smart city logistics. Headed by a large consortium, the project will test its solutions in six cities: Madrid, The Hague, Budapest, Lyon, Oslo and Porto.
PrepDS4Mobility ID 101083655 Duration: 10.2022 – 09.2023 https://mobilitydataspace-csa.eu/	PrepDSpace4Mobility lays the foundation for a secured and controlled way of pooling and sharing mobility data across Europe. The 12-month Coordination and Support Action (CSA) contributes to the development of the common European mobility data space by mapping existing data ecosystems, identifying gaps and overlaps within, and proposing common building blocks and governance frameworks found in existing data space architectures. The actions are carried out by a project team comprised of leading experts from the private and public mobility sectors, with key competencies in mobility, economics, and digital technologies. Jointly, they are supporting a new European era of mobility data sharing, centred around the principles of trust, interoperability, and sovereignty, where data can be made available, accessed, and securely exchanged across Europe. PrepDSpace4Mobility represents a vital pillar for the future deployment of a single market for mobility data.

deployEMDS ID 101123520 Duration: 11.2023-10.2026 https://deployemds.eu/	The common European mobility data space (EMDS) aims to facilitate data access, pooling and sharing for more efficient, safe, sustainable and resilient transport. It builds on initiatives and applications related to transport data and will be supported by initiatives to boost interoperability, security, and the availability and provision of data and services. Aligned with the European data strategy and the Sustainable and Smart Mobility Strategy, deployEMDS, a project co-funded under the EU Digital Europe Programme, will support policymaking by enabling data sharing and reuse for efficient multimodal mobility and traffic management, as well as for measuring progress of sustainable urban mobility across Europe.
URANUS European Research Council (ERC) ID 101088124 Duration: 01.07.2023 – 30.06.2028	The inefficient management of urban mobility, which leads to traffic congestion, is further complicated by the scarcity and poor quality of traffic data. Unmanned aerial vehicles (UAVs) offer a potential solution, providing an advanced traffic sensing technology capable of swiftly and precisely covering dispersed locations to capture road traffic data. The ERC-funded URANUS project proposes employing UAVs to intelligently gather vehicular and pedestrian information. The goal is to coordinate the management of urban mobility and UAV networks, ultimately improving urban mobility performance. The project aims to develop a robust real-time urban mobility management framework using distinctive sensing capabilities. The success of this project could potentially revolutionise our understanding of optimising joint operations among sensing and control technologies.

Annex C: Short introduction on the Multimodal Traffic Management Cluster (MTMC)

The MTMC is a collaborative initiative led by the seven Horizon Europe research projects focused on Multimodal Traffic Management. This follows the initial cluster called 4FRONT, of the four first projects (H2020 projects issued from the same call):



MTMC projects

DiT4TRAM, FRONTIER, ORCHESTRA, TANGENT. The Multimodal Traffic Management Cluster now integrates DELPHI and its sister projects SYNCHROMODE and ACUMEN.

The goal of the MTMC is to leverage the combined knowledge and expertise of these projects to "drive a transformative shift towards advanced multimodal traffic management".

This multi-project and lasting collaboration is taking shape through several forms including the update of the STRIA Roadmap on Network and Traffic Management Systems[8] and the publication of three key documents:

- Navigating Data in the Field of Traffic Management (Policy brief)
- Multimodal Traffic Management: Roadmap for 2030 and beyond
- Multimodal traffic management technology roadmap

These documents aim at elaborating a shared vision and strategic framework towards the implementation of integrated multimodal traffic management systems across Europe, including both passenger and freight transport.

[8] https://trimis.ec.europa.eu/system/files/2021-04/stria_roadmap_-_network_and_traffic_management_systems_0.pdf

References

[1] Publications Office of the European Union. (2022). *EU missions : 100 climate-neutral and smart cities.* Publications Office of the EU. https://op.europa.eu/en/publication-detail/-/publication/822ee360-c9bf-11ec-b6f4-01aa75ed71a1/language-en/format-PDF/source-256649647

[2] Publications Office of the European Union. (2009). *Action Plan on Urban Mobility*. Publications Office of the EU. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52009DC0490

[3] Publications Office of the European Union. (2010). *ITS Directive*. Publications Office of the EU. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32010L0040

[4] Publications Office of the European Union. (2022). *ITS Directive*. Publications Office of the EU. https://eur-lex.europa.eu/eli/dir/2023/2661

[5] *White paper: European transport policy for 2010 | EUR-Lex*. (n.d.). https://eur-lex.europa.eu/EN/legal-content/summary/white-paper-european-transport-policy-for-2010.html

[6] Publications Office of the European Union. (2013). *Mobility Package Directive*. Publications Office of the EU. https://transport.ec.europa.eu/transport-modes/road/mobility-package-i_en

[7] Publications Office of the European Union. (2020). *Sustainable and Smart Mobility Strategy*. Publications Office of the EU. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12438-Sustainable-and-Smart-Mobility-Strategy_en

[8] Publications Office of the European Union. (2021). *Urban Mobility Framework.* Publications Office of the EU. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12916-Sustainable-transport-new-urban-mobility-framework_en

[9] Publications Office of the European Union. (2021). *Trans-European Transport Network Regulation*. Publications Office of the EU. https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

[10] Publications Office of the European Union. (2024). Revised Driving Licences Directive. Publications Office of the EU. https://www.europarl.europa.eu/legislative-train/theme-a-new-push-for-european-democracy/file-revision-of-the-directive-on-driving-licences

[11]Publications Office of the European Union. (2024). *European Declaration on Cycling*. Publications Office of the EU. https://transport.ec.europa.eu/system/files/2023-11/European_Declaration_on_Cycling_en_0.pdf

[12]*Lead project – Lead project*. (n.d.). https://www.leadproject.eu/

[13]*Ulaads project – Ulaads project.* (n.d.) *https://ulaads.eu/*

[14]Bosmans, W. (2021). *Bpost krijgt depot in centrum Mechelen*. Made In. https://www.made-in.be/mechelen/bpost-krijgt-depot-in-centrum-mechelen/

[15]BPOST, *Successful Mechelen Ecozone pilot project - bpost delivers letters and parcels emission-free*. (n.d.). https://press.bpost.be/successful-mechelen-ecozone-pilot-project-bpost-delivers-letters-and-parcels-emission-free

[16]Boztas, S. (2024). *Dark stores banned from residential areas in Amsterdam - DutchNews.nl*. DutchNews.nl. https://www.dutchnews.nl/2023/05/dark-stores-banned-from-residential-areas-in-amsterdam/

[17]Van Rooijen, T., & Quak, H. (2010). *Local impacts of a new urban consolidation centre – the case of Binnen stad. Procedia - Social and Behavioral Sciences*, *2*(3), 5967–5979. https://doi.org/10.1016/j.sbspro.2010.04.011

[18]Trentini, A., Feliu, J. S. and Malhéné N (2015). *Developing urban logistics spaces: UCC and PLS in South-Western Europe*. HAL Id: halshs-01214749

[19]Carotenuto, P., Ceccato, R., Gastaldi, M., Giordani, S., Rossi, R., & Salvatore, A. (2022). Comparing home and parcel lockers' delivery systems: a math-heuristic approach. *Transportation Research Procedia*, *62*, 91–98. https://doi.org/10.1016/j.trpro.2022.02.012

[20]New York City Government Publication Office (2023)*, DOT Commissioner Rodriguez launch LockerNYC to combat package theft*. The Official Website of the City of New York. https://www.nyc.gov/office-of-the-mayor/news/266-24/mayor-adams-dot-commissioner-rodriguez-launch-lockernyc-combat-package-theft-reduce#/0

[21]De Cani, R. (2023). *Two decades in, what can other cities learn from the London congestion charge?* Arup. https://www.arup.com/perspectives/two-decades-in-what-can-other-cities-learn-from-the-london-congestion-charge

[22]KVK (2024) *Zero-emission zones: what do they mean for your deliveries?* (2024). KVK. https://www.kvk.nl/en/sustainability/zero-emission-zones-what-do-they-mean-for-your-deliveries/

[23]Durlin, T., Aljaž Plevnik, Mojca Balant, & Luka Mladenovič. (2018). THE STATUS OF SUMPS IN EU MEMBER STATES. In Elma Meskovic & Richard Adams (Eds.), *THE STATUS OF SUMPS IN EU MEMBER STATES*. ICLEI - Local Governments for Sustainability, European Secretariat, Freiburg, Germany. https://www.rupprecht-consult.eu/fileadmin/migratedRupprechtAssets/Documents/SUMPs-Up PROSPERITY-SUMP-Status-in-EU-Report.pdf

[24]Vergnani, R., etc (2021). *Cities-Regions and Companies working together: Guide for advancing towards zero-emission urban logistics by 2030*. ALICE-ETP & POLIS. https://www.etp-logistics.eu/wp-content/uploads/2021/12/POLIS_ALICE_Guide-Zero-Emission-Urban-Logistics_Dec2021-low.pdf

[25]French Road Safety Observatory. (2024), French Government Publication Office. https://www.onisr.securite-routiere.gouv.fr/en/about-onisr/local-partners

[26] ORCHESTRA project consortium (2022) *Intermediate PMA for multimodal traffic management* (D3.2). ORCHESTRA Project, funded by European Union's Horizon 2020 research and innovation programme (Grant Agreement No. 953618). https://orchestra2020.eu/wp-content/uploads/2021/07/D3.2-Intermediate-PMA-for-multimodal-traffic-management.pdf

[27] FRONTIER project consortium (2022). *Network and traffic visualisation dashboards – Initial Version* (D5.2). FRONTIER project, funded by European Union's Horizon 2020 research and innovation programme (Grant agreement N°955317). https://www.frontier-project.eu/sites/default/files/2023-08/FRONTIER_D5.2%20%E2%80%93%20Network%20and%20traffic%20visualisation%20dashboards%20-%20Initial%20Version.pdf

[28] TANGENT project (2021-2024), funded by European Union's Horizon 2020 research and innovation programme (Grant agreement N°955273). https://tangent-h2020.eu/

[29] SENATOR project consortium (2021). *SENATOR architecture and detailed design* (D3.1). SENATOR project, funded by European Union's Horizon 2020 research and innovation programme (Grant agreement N°861540). https://www.senatorproject.eu/wp-content/uploads/2023/01/D3.1-SENATOR-architecture-and-detailed-design_vFinal.pdf

[30] R. C. Bello *et al*., "Designing a dynamic platform for the next generation of multi-modal logistics," *2024 Joint European Conference on Networks and*

Communications & 6G Summit (EuCNC/6G Summit), Antwerp, Belgium, 2024, pp. 1102-1108, doi: 10.1109/EuCNC/6GSummit60053.2024.10597059.

[31] DIT4TRAM project (2021-2024), funded by European Union's Horizon 2020 research and innovation programme (Grant agreement N° 953783). https://dit4tram.eu/

[32] ACUMEN project (2023-2026), funded by European Union's Horizon Europe research and innovation programme (Grant agreement N° 101103808). https://acumen-project.eu/

[33] SYNCHROMODE project (2023-2026), funded by European Union's Horizon Europe research and innovation programme (Grant agreement N° 101104171). https://synchromode.eu/

[34] URANUS project (2023-2028), funded by European Research Council (ERC) (Grant Agreement N° 101088124) https://cordis.europa.eu/project/id/101088124

[35] MOVE21 project (2021-2024), funded by European Union's Horizon 2020 research and innovation programme (Grant agreement N°953939). https://move21.eu/

[36] FORFREIGHT project (2022-2025), funded by European Union's Horizon Europe research and innovation programme (Grant agreement N° 101069731). https://www.for-freight.eu/

[37] FRONTIER project (2021-2024), funded by European Union's Horizon 2020 research and innovation programme (Grant agreement N° 955317), https://www.frontier-project.eu/its-innovations

[38] PrepDSpace4Mobility co-funded by European Union (Grant agreement N° 101083655). https://mobilitydataspace-csa.eu/

[39] deployEMDS project, co-funded by European Union (Grant agreement N° 101123520). https://deployemds.eu/

[40] DISCO project (2023-2026), funded by European Union's Horizon Europe research and innovation programme (Grant agreement N° 101103954). https://discoprojecteu.com/