TANGENT

POLICY, REGULATORY AND PLANNING FRAMEWORK FOR NETWORK TRAFFIC MANAGEMENT. SECOND RELEASE.

D1.7

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Authors	Daniel Franco, Dr. Lakshya Pandit, Morgane Juliat (Rupprecht Consult) Dagmara Wrzesińska, Emiliya Kamenova, Juliette Thijs (POLIS)
Internal reviewers	Mark Meyer (POLIS) Pedram Zand (PANTEIA)
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Executive summary

This deliverable is the second release of policy and regulatory framework on traffic network management, providing an update on the preliminary analysis of the planning and regulatory framework in each TANGENT city, as well as at national and EU levels, towards the effective integration of Network Traffic Management solutions and multi-actor cooperation models in local sustainable urban mobility planning processes.

It will aim at providing preliminary guidance to cities across EU to effectively address the challenges of Network Traffic Management in connected, cooperative and innovative transport systems, by developing pathways of reflection towards developing a Network Traffic Management planning framework.

Progressing from D1.4, the second version of the deliverable i.e. D1.7, aims at strengthening the capacities of local authorities and mobility stakeholders to assess and set up optimal multi-actor cooperation models, building upon the lessons learned and conclusions from TANGENT's case studies' implementation.

Key words

Network traffic management, planning, regulatory framework, sustainable urban mobility planning, sump, transport modelling

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List of Abbreviations and acronyms

Acronym	Meaning
AML	Lisbon Metropolitan Area (Área Metropolitana de Lisboa)
AOM	Autoritée Organisatrice de la Mobilité (Authority Organising Mobility)
ASAP	As Soon As Possible
API	Application Programming Interface
AV	Automated Vehicles
B2B	Business-to-business
B2C	Business-to-Consumer
CAVs	Connected and Automated Vehicles
CCAM	Cooperative Connected and Automated Mobility
CCO-M	Centro de Controlo Oparacional da Mobilidade (Operational Mobility Control Centre)
C-ITS	Collective - Intelligent Transport Systems
COI	Centro Operacional Integrado (Integrated Operational Centre)
CREL	Circular Regional Externa de Lisboa (Lisbon Regional External Circular Road)
CRIL	Circular Regional Interna de Lisboa (Lisbon Regional Internal Circular Road)
DIRO	Direction Interdépartementale des Routes Ouest DIRO (Interdepartmental Directorate of West Roads)
DRT	Demand Responsive Transport
EC	European Commission
EC	European Commission
ECA	European Court of Auditors
EEA	European Environmental Agency
EMEL	Lisbon Mobility and parking company (Empresa de Mobilidad e Estacionamento de Lisboa)
GA	Grant Agreement

HGVs	Heavy Goods Vehicles
IoT	Internet of Things
ITS	Intelligent Transport Systems
KDK	Traffic Management Centre of the Attica Region
KoM	Kick-off Meeting
KPI	Key Performance Indicator
LCVs	Light Commercial Vehicles
LMA	Lisbon Metropolitan Area
MaaS	Mobility as a Service
MMTIS	Multimodal Travel Information Services
MTM	Multimodal Traffic Management
NAPs	National Access Points
NPSE	Transport Project provider companies
NTM	Network Traffic Management
O.SY	Road Communications Services S.A
OASA	Athens Public Transport Authority
PDU	Plan de Déplacement Urbain (Urban Mobility Plan)
PGIL	Plataforma de Gesto Inteligente de Lisboa (Lisbon Intelligent Management Platform)
RTTI	Real-Time Traffic Information
SICI	Smart Infrastructure Classification Index
SDAGT	Schéma Directeur d'agglomération de la gestion du trafic (Agglomeration traffic management master plan).
STA.SY	Central Communications Services S. A
SUMP	Sustainable Urban Mobility Plan
TEN-T	Trans European Transport Network
TfGM	Transport for Greater Manchester

TIGA	Territories of Innovation of Great Ambition
WP	Work Package

1 Introduction

1.1 Attainment of the objectives and explanation of deviations

The deliverable is part of Task 1.4 “Network Traffic Management planning and regulatory framework”, which aims to analyse the planning and regulatory frameworks in each TANGENT city, as well as national and European levels, towards the effective integration of new “Network Traffic Management” solutions and multi-actor cooperation models in local sustainable urban mobility planning processes. Building upon partners’ wide experience with Sustainable Urban Mobility Planning (SUMP) methodology, explained further in Section 4 of this deliverable, TANGENT aims to guide cities across the European Union to effectively address the challenges of Network Traffic Management (NTM) in connected, cooperative and innovative transport systems, by developing a NTM planning framework. This will be done with the D1.4 “Policy, regulatory and planning framework for NTM. First release” and D1.7 “Policy, regulatory and planning framework for NTM. Second release”.

The objectives related to this deliverable have been met in full, with some delay due to the prioritisation of capacities for other deliverables and tasks. This decision was made based on minimal impact that delaying this deliverable would have on other project activities at this stage.

1.2 Intended audience

This deliverable mainly addresses policymakers to provide support in setting up institutional and planning frameworks for the integration of new NTM solutions and multi-actor cooperation models. It also addresses local authorities and planning practitioners to support the setup of local frameworks.

1.3 Structure of the deliverable and links with other work packages & deliverables

This deliverable is structured in six chapters, providing a comprehensive analysis of the policy, regulatory and planning framework for Network and Traffic Management (NTM):

Chapter 1: The introduction outlines the objectives and scope of the deliverable, providing an overview of the structure of the deliverable and its links with other work packages and deliverables.

Chapter 2: This chapter delves into the state of the art of planning and regulatory frameworks for NTM solutions in Europe. It highlighted the major challenges faced by European transport, such as safety, greenhouse gas emissions, and traffic congestion.

Chapter 3: This chapter covers the Sustainable Urban Mobility Planning (SUMP) methodology, essential for effective NTM planning. It outlines the principles and steps of SUMP and its integration with NTM solutions.

Chapter 4: The chapter provides an overview of the planning and regulatory framework in each TANGENT case study, covering city, regional, and national levels. It showcases the diverse approaches taken by different cities and countries to address NTM challenges and implement effective solutions.

Chapter 5: The pathway in this chapter reflects on the performed analysis to identify the main challenges and limitations for NTM planning and implementation. It derived conclusions and recommendations for

developing a complementary approach that integrates Multimodal Traffic Management (MTM) with SUMP.

Chapter 6: This chapter concludes with the insights gained with key points.

The first release of this deliverable aimed at setting a first understanding of the planning and regulatory frameworks in each TANGENT city, on the national level, and at the European level, towards the integration of NTM solutions and multi-actor cooperation in local sustainable urban mobility planning processes. The report aims to identify a set of challenges in the definition of planning and regulatory frameworks that could prevent the effective integration of new NTM solutions and multi-actor cooperation. The second release of the deliverable (D1.7) further develops and confirms or dismisses these first observations.

Deliverables D1.4 and D1.7 are also linked to D8.5 “Policy Recommendations” in WP8, as part of Task 8.5 “creating a project legacy” which will consist of a policy document targeted at public authorities that describes the link between multi-modal network management and policy and makes recommendations on how multimodal network management can be integrated into policy and planning processes.

2 Overview of current policies and regulations relevant to NTM solutions

European transport faces major challenges regarding safety, greenhouse gas emissions, traffic congestion and its negative externalities. In addition, the development of disruptive technologies and the emergence of new mobility solutions generate a revolution in the transport network and traffic management. In this context, TANGENT aims to develop new complementary tools for optimising traffic operations in a coordinated and dynamic way from a multimodal perspective considering automated/non-automated vehicles and passengers.

TANGENT's research domain covers advanced techniques in modelling and simulation, such as prediction and simulation models for future demand & supply of transport; optimisation techniques for balancing the demand flow between the means of transport; and users' travel behaviour modelling.

As a result, a set of applications for decision-making support was developed creating a framework for coordinated traffic and transport management, encompassing an enhanced mobility information service and dashboard with associated Application Programming Interfaces (APIs) and advanced functionalities with a two-fold approach: (1) to provide real-time traffic management recommendations, and (2) to support transport authorities to design network-wide optimal strategies.

The framework also aims to support a multi-actor cooperation approach for transport network management by enabling communication channels. In this way, the services target different actors in traffic management. The results were tested in three case studies: Rennes (FR), Lisbon (PT), Greater Manchester (UK), and a virtual case study in Athens (GR) with real data from various modes of transport, under different traffic events such as bottlenecks, accidents, and pedestrian flow.

Network and Traffic Management, through the lens of multimodality, is a crucial tool for mobility planning in metropolitan regions, allowing cities to collect and process vast amounts of data and apply advanced technologies to improve the movement of people across different modes of transport. The data-driven insights provided by Multimodal Traffic Management (MTM) systems enable urban planners to make informed decisions, prioritize sustainable transport, and adapt to changing mobility needs. As cities continue to grow and evolve, MTM will play an increasingly important role in ensuring efficient, inclusive, and sustainable urban mobility, aligning with broader policy goals and addressing the real needs of users.

Since the publication of the first version of this deliverable i.e. *Policy, Regulatory and Planning Framework for NTM. First Release*, new developments on applicable regulatory and planning frameworks for NTM have been monitored and summarised in this chapter.

2.1 International scale

On the international level, the United Nations Economic Commission for Europe (UNECE) has been a pioneering organisation working on traffic management initiatives since 1950. Through its Global Forum on Road Traffic Safety (UNECE, 2022), UNECE has contributed to the definition of harmonised international agreements and conventions regarding traffic, focusing on improving road safety through standardised regulatory frameworks and conventions. Concerning the regulation of innovative mobility services and technologies, the UNECE's World Forum for the Harmonization of Vehicle Regulations (UNECE, 2018), and its Working Party on Automated/Autonomous and Connected Vehicles, work on the development of technical provisions for automated vehicles.

The Working Party on Road Transport (SC.1 under UNECE) fosters the development and facilitation of international transport by road (involving both goods and passengers) by simplifying and harmonising

rules and requirements at transport. This is done through the management and updates of the international legal instruments. The Working Party meets once a year with support from UNECE's Transport Division.

2.2 Directives and Regulations on NTM at the EU level

In 2023, a new Directive (EU) 2023/2661 amended the previous ITS Directive (2010/40/EU). The aim of the new Directive is '*to adapt to the emergence of new road mobility options, mobility apps and connected and automated mobility'*. The earlier legal framework i.e. Directive 2010/40/EU had traffic and travel information, e-Call emergency system, intelligent truck parking followed by RTTI and multimodal travel information as its first priorities. The new Directive i.e. (EU) 2023/2661 has the objective to foster quick deployment of new intelligent services by proposing travel and traffic data available in digital format (for e.g. speed limits, traffic flow plans or roadworks). It includes specifications and standards for the four priority areas i.e. 1. Information and mobility ITS services for passengers, 2. Travel, transport and traffic management ITS services, 3. Road safety and security ITS services, and 4. ITS services for CCAM. It redefines the term 'ITS service' including 'sustainability' as an added contribution (along with user safety, efficiency, comfort, and/or facilitating transport and travel operations) through its well-defined organisational and operational framework. In this deliverable, sustainability is further addressed through planning and regulatory framework of Sustainable Urban Mobility Planning (SUMP).

Earlier, the ITS Directive (2010/40/EU), known as "*the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport*" provided a basis to support coordinated and coherent deployment and use of Intelligent Transport Systems (ITS), specifically in the international context. Although for the time being, there exists no Europe-wide legislation that requires a specific approach to traffic management systems, Directive 2010/40/EU, mandates the use of DATEX II for most of the outputs (or compatible standard). In the European context, DATEX II is the principal framework for traffic management, which structures the format of data relevant to traffic management "to ensure the accessibility, exchange, re-use and update of road and traffic data by road authorities, road operators and service providers for the provision of EU-wide real-time traffic information services" (Directive 2010/40/EU, 2010).

A directive is a legal instrument that establishes goals or results to be achieved among Member States. The directive itself does not determine how these results should be achieved, and it is up to Member State to decide how to transpose directives into national laws. To supplement existing legislation, delegated regulations are used. Delegated regulations are used typically for the technical aspects of a directive to supplement a legislative act on its non-essential parts or amend non-essential elements. Delegated regulation cannot broaden the scope of the legislative act. A delegated regulation is a legally binding instrument that applies to all member states. It is similar to national law in terms of the impact and direct effect it generates.

Most of the delegated regulations of the ITS Directive specify the data (existing already in electronic formats) that must be made accessible on the National Access Point (NAP). In the context of TANGENT, two of the ITS delegated regulations are especially relevant: Real-time Traffic Information (RTTI) (EU, 2022) and Multimodal Travel Information Services (MMTIS) (EU, 2017).

RTTI:
Delegated regulation (EU) 2015/962 on RTTI was initially adopted in 2014 (to be repealed by the end of 2024), with application limited to Trans European Transport Network (TEN-T) and motorways. The revised version (i.e., (EU) 2022/670) from early 2022 extends it to the entire road network (excluding roads that are not owned by a public road or transport road authority). The revision introduces many new data sets (with updated requirements affecting the entire data chain involving data sourcing, formatting, aggregation, distribution and inclusion in traffic information services) mostly applicable to

data held by public authorities. Considering the private data holders, the regulation does not impose data sharing obligations free of charge but looks towards opportunities for data having potential licence agreements regulating their re-use.

One of the most significant changes in EU 2022/670 is the enhanced focus on improving the accessibility and re-use of data for real-time traffic information. This update emphasizes broader and easier access to both static and dynamic data from various sources, including road authorities, public and private data holders, and service providers. The aim is to ensure that real-time traffic data can be reused effectively by all stakeholders across the EU. The concept of crucial data sets has been introduced in the revision. The crucial types of data on the state of the network include road closures, lane closures, roadworks and temporary traffic management measures. The crucial types of data on regulations and restrictions include: (a) dynamic and static traffic regulations (wherever they are applicable) and (b) traffic circulation plans. Considering the type of data on the real-time use of the network, some of these include traffic volume, traffic speed, location and length of traffic queues, travel times, waiting time at border crossings, availability of recharging and refuelling points and stations for electric vehicles and alternative fuel types respectively.

Considering the use of National Access Points (NAPs), the revised regulation mentions *public and private data holders* to ensure the provision of metadata allowing data users to find and use data via NAPs. This was earlier more restricted to *road authorities and road operators*, in cooperation with *digital map producers and service providers*. Two new provisions of the revised RTTI are particularly relevant to TANGENT: (1) obligation for traffic regulations/restrictions and traffic management plans to be integrated into the driver information services (e.g., routing information) where accessible (published) on the NAPs; and (2) public authority access to in-vehicle data under FRAND (fair, reasonable and non-discriminatory) conditions for specific public authority transport management tasks.

MMTIS:
MMTIS was adopted in 2017 and provides the requirements to develop EU-wide multimodal travel information services. This delegated regulation was revised in 2024.The creation of NTM requires data to be shared between different stakeholders in a high-quality, interoperable format – hence MMTIS is crucial for TANGENT. The document supplementing Directive 2010/40/EU (which was amended by (EU) 2023/2661) distinguishes two main data categories: 1. Static, historic, and observed travel and traffic data (further classified into four Level of Service), and 2. Dynamic travel and traffic data (further classified into three Level of Service). This data must be made available by the Member States through the National Access Points (NAPs). The act ensures accessibility, exchange, and update of standardised traffic information.

In light of the delegated regulation, the access, exchange and reuse of **static**, historic and observed data for: 1. the road transport should refer to standardised format in RTTI regulation of 2015, 2. other transport modes use the CEN data exchange standard NeTEx CEN/TS 16614 and subsequent versions, technical specifications set in EU 454/2011, technical documents under IATA passenger services conference, and Transmodel EN 12896 where exchange protocol does not exist, 3. spatial network refer to Directive 2007/2/EC.

For the access, exchange and reuse of **dynamic** travel and traffic data for: 1. the road transport, the formats in RTTI regulation of 2015 should be referred, 2. other transport modes the relevant parts of the CEN public transport data exchange standard SIRI CEN/TS 15531 and subsequent upgraded versions and technical specifications set in EU 454/2011 should be used. Alternatively, any machine-readable format fully compatible with the above-mentioned standards by the agreed timeline can be used.

All data standards considered in the MMTIS (Bourée et al.,2019). are summarized in Table 1.

Table 1: Data standards mentioned by the MMTIS

Type of data	Data standard	Description
Road	DATEX II	DATEX II defines a common set of data exchange specifications to support the exchange of traffic and travel information seamlessly interoperable across boundaries, including national, urban, and interurban road administrations, infrastructure providers, and service providers.
Rail	TAP-TSI	The Commission Regulation (EU) 454/2011 addresses the railway undertakings, rail infrastructure managers, and ticket vendors to standardize the data exchange for timetables, fares, reservation messages, and operational messages between railway undertakings and infrastructure managers.
Air	AIDM	IATA, a trade association representing 82% of total air traffic has made the Airline Industry Data Model (AIDM) available for review which aims to become a single point of access to store: industry-agreed vocabulary, data definitions and their relationships, and related business requirements. The objective of AIDM is to allow the generation of interoperable messaging standards related to passenger services.
Spatial	INSPIRE	The INSPIRE directive (2007/2/EC) of the European Parliament and the Council establishes an infrastructure for Spatial Information in the European Community. Several texts have been produced to support the INSPIRE objectives, such as the technical Guidance for the implementation of INSPIRE dataset and service metadata based on ISO/TS 19139:2007 (02/03/2017) and policies or activities which may have an impact on the environment. It addresses 34 spatial data themes, one of them being Transport Networks.
Public Transport	Transmodel	The European Public Transport Reference Data Model provides reference data structures to express the semantics of the public transport domain. It covers 8 parts: common concepts; public transport network; timing information/vehicle scheduling; operations monitoring & control; fare management; passenger information; driver management; management of information & statistics.
	NeTEx	Network and Timetable Exchange (NeTEx) is a data exchange standard (provided using XML) for the public transport network, timetables, and fares. It is divided into 3 parts: network typology, timing information, and description of the tariff offer.
	SIRI	Standard Interface for Real-time Information (SIRI) is an XML protocol allowing to exchange of real-time information about public transport services and vehicles.

3 Sustainable Urban Mobility Planning

3.1 Introduction of the SUMP concept

Sustainable Urban Mobility Planning is Europe's main urban transport planning concept, developed since 2005. The Urban Mobility Package COM (European Parliament, 2013) (913, article 3) defined Sustainable Urban Mobility Plans, and the European Commission provided initial guidelines. The urban Mobility Package aimed to guide urban areas towards sustainability and meet EU transport system goals. The concept has gained popularity across Europe and beyond, with updated SUMP guidelines published in 2019 to aid practitioners in developing their city's SUMP.

Figure 1: SUMP Cycle (SUMP Guidelines, 2019)

A SUMP anticipates common issues in transport master plans, ensuring that planned actions are realistic and implementable. It creates a programme of measures considering urgency, impact, public acceptance, and available resources. Benefits of a SUMP include effective resource use, fulfilling legal obligations, and improving quality of life through better public spaces, road safety, citizens' health, and reduced pollution. A SUMP integrates all transport modes and purposes with other sectoral plans and urban areas. Coordinated development of sectoral plans and measures improves processes. Including policies like urban development, road space design, and family-friendly and barrier-free mobility in the mobility concept is crucial.

The SUMP approach has brought significant changes to the transport planning process. In this approach, instead of determining the future structure using the current structure situation and trends, a participatory approach is developed to formulate a vision for the inhabitants to define the city they want to live in, determine the details, and then determine what steps should be taken from today to reach this

vision. With a SUMP planning process, instead of predicting the future structure based on the existing structure (prediction; fore-casting), first, the outline of the future structure and the steps to be taken from the current structure to get here are predicted (back-casting). As such, the SUMP approach is much more goal-oriented than traditional transport policy planning methods. Moreover, in the SUMP approach, not only the plan as a document or report prepared by experts but also participation, continuity, and keeping the process alive gain priority. A goal-oriented planning process actively designs a sustainable mobility system instead of working purely in a forecast-oriented manner. In contrast to traditional transport planning, the SUMP methodology does not only focus on infrastructural measures but combines them with regulatory measures, incentives and information in cost-effective packages of measures. Essential for the planning process are cross-administrative and cross-political cooperation, meaningful participation of the urban community, and effective monitoring.

Quantifiable objectives and verifiable indicators should be developed that contribute to the setup of an ongoing monitoring system. With effective monitoring and evaluation, the implementation status and the effects of the measures can be continuously checked and, if necessary, readjusted. A performance review can also help to increase the transparency of mobility policies and actions, to make the positive effects of the measures clear to politicians and the public, to de-emotionalise discussion processes, and thus to improve the acceptance of planning. In this way, all aspects and parties involved in the development of a SUMP and/or transport policy will be connected – a process called integrated planning. As such, a SUMP will not focus solely on transport, but also on (its relation and/or contribution to) local and regional economic development, land use, social integration, etc. This highly integrated planning approach fits the requirements of the mobility of the future, in which different modes of transport are optimally linked and sustainable modes and innovations are promoted. Moreover, preparation along the SUMP standard offers advantages in terms of acquiring funding for actions later on in the process. Sustainable Urban Mobility Planning is an essential element of the official European Union climate policy and is advocated by all European and many national institutions and banks. If a city has a SUMP, it already has a competitive advantage for better access to funding (e.g. EU Structural and Investment Funds, Horizon 2020-CIVITAS, Connecting Europe Facility). This mechanism is expected to increase in the coming years.

3.2 SUMP as key planning and regulatory framework in Europe

3.2.1 European scale

The transport sector in Europe significantly impacts social, economic, and environmental aspects, with the EU prioritizing the reduction of global warming. In 2017, 27% of the EU's greenhouse gas emissions came from transport, primarily road transport. Despite goals to cut emissions by 60% by 2050, emissions have risen, with transport emissions increasing by 2.2% in 2017 compared to 2016. Passenger and freight transport are expected to grow significantly by 2050, highlighting the need for bold, cohesive actions to reverse this trend.

The European Green Deal (European Commission, 2019), recently released by the European Commission (EC), aims at making Europe the first climate-neutral continent by 2050. For it to succeed, it must be corroborated by ambitious and concrete action plans with well-defined targets and integrated with other policies at the national and local levels. European cities host 72% of the EU population and generate over 80% of the EU GDP. It is estimated that 84% of people in Europe will live in urban areas by 2050 (European Commission, 2020). In urban areas, about 25% of CO2 emissions produced are attributable to the transport sector, as well as 30-50% of other transport-related pollutants, like particulate matter (PM) and Nitrogen Oxide (NOx) (ALICE/ERTRAC Urban Mobility WG, 2014). The annual economic damage associated with delays in passenger transport and cargo as a result of traffic congestion in Europe is estimated at around €100 billion (UNECE 2020).

European cities face significant challenges in meeting air quality standards. Success in EU-level policies, such as the Green Deal, depends on actions by local authorities. Urban mobility promotes

growth, jobs, and sustainable development. Encouraging low-emission vehicles, active travel, public transport, and sharing schemes is crucial to reducing congestion and pollution. The EU invested €16.5 billion in urban mobility from 2014-2020, focusing on metro, tramways, cycle paths, and intelligent transport systems. However, a report from the European Court of Auditors (2020) indicates no significant reduction in car usage and persistent air pollution. Member States' commitment is key to substantial improvements. The 2011 White Paper on Transport identifies the need to take additional steps to ensure that cities contribute to reducing Europe's dependence on imported oil and cutting carbon emissions in transport by 60% by 2050, achieving essentially CO2-free city logistics in major urban centres by 2030, approaching the target "zero victims" in road transport by 2050. During the last two decades, the European Commission has developed a growing awareness with respect to the challenges of the urban transport sector[1] , and, consequently, has started defining specific policies and developing dedicated tools to tackle them. Transport is a shared responsibility between the EU and the Member States where the subsidiarity principle[2] applies. Urban mobility is essentially a local responsibility. This potentially hinders the elaboration of common solutions between cities, which might conveniently be tailored to different urban contexts, and produces a single market fragmentation risk when it comes to Intelligent Transport Systems (ITS), access regulations, and discriminatory practices. For this reason, European guidance, research, innovation, good practice exchange, and capacity-building activities represent effective means in the hands of the EC and Member States to support the success and coordination of local policies and measures.

To facilitate the adoption of a more shared approach, the EC encourages cities to develop a long-term vision and objectives for urban mobility. In 2013 it released the Urban Mobility Package (UMP), and Together towards competitive and resource-efficient urban mobility (European Commission, 2013), providing an overview of possible actions. These included guidelines on Sustainable Urban Mobility Plans (SUMPs), released for the first time in 2013 and updated in 2019 (Rupprecht Consult, 2019), and working documents on access regulations, urban logistics, urban road safety and urban ITS. The central communication, stressing the importance of the coordination between the public and private sector, claims the coordinated deployment of urban ITS and the importance of urban nodes, considered the "starting point or the final destination (first/last mile) for passengers and freight moving on the trans-European transport (TEN-T) network". The role of urban nodes is defined in the TEN-T guidelines (2013), revised in 2021 (European Commission, 2022). It also defined the future scope of action of the EU-funded CIVITAS initiative, which focuses on "tackling urban road congestion, reducing the use of conventionally-fuelled vehicles in urban areas, reducing transport impacts and costs, and strengthening the capacities of local authorities to develop and implement sustainable urban mobility plans". SUMPs represent an innovative approach to city planning, fostering effective, coordinated and consistent initiatives - local authorities have to define long-term objectives - and ensure their achievement within a sustainable framework - the type of corrective action shall be defined through a long-term planning process that takes into account the principles of participation, evaluation and integration.

The Commission's proposal to revise the current TEN-T Regulation would strengthen infrastructure requirements in view of achieving more efficient and sustainable transport services and shifting passengers and freight towards more sustainable modes of transport. To this end, the revised regulation calls for more transhipment terminals, improved handling capacity at freight terminals, reduced waiting times at rail border crossings, and longer trains to shift more freight onto cleaner transport modes. All 430 major cities along the TEN-T network will have to develop Sustainable Urban Mobility Plans to promote zero-emission mobility and to increase and improve public transport.

[1] The first European policy proposals in the area of urban mobility, the Citizens' Network, date back to 1995 and 1998. In 2001, the 1st White Paper on Transport was released.

[2] Its legal basis is Article 5(3) of the Treaty on European Union (TEU): "Under the principle of subsidiarity, in areas which do not fall within its exclusive competence, the Union shall act only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level".

Provisions to make the TEN-T more resilient to the effects of climate change are also included. The Commission proposal reinforces the governance of TEN-T to assure the timely completion of the network – by 2030 for the core network, 2040 for the extended core network, and 2050 for the wider, comprehensive network. In the context of TANGENT, Lisbon, Rennes, and Athens are part of the urban nodes network that have to develop SUMPs to promote zero-emissions mobility.

3.2.2 National scale

Greece has passed a law (4784/2021) in 2021 to create an institutional framework favouring the development of SUMPs and encourage local communities to use SUMPs as the main lever for upgrading the urban environment**.** The Greek government took a step forward and not only institutionalised SUMPs but also made them mandatory for cities with a population of more than 30,000 inhabitants.

In France, the obligation to draw up a PDU (similar to a SUMP) is defined by law (Article L1214-3 of the transport code) making it mandatory to establish mobility plans in the territorial jurisdictions of the mobility organising authorities included in the agglomerations of more than 100,000 inhabitants. This is also mentioned in Article L.221-2 of the Environmental Code. PDUs were first introduced in 1982 but their compulsory character dates back to 1996 (CEREMA,2020). Since 2021, PDUs have been replaced by the Plan de Mobilité (PdM), implemented by the *Loi d'orientations des mobilités* (LOM) (Law on the orientation of mobilities) n2019-1428.

In Portugal, there is no formal legal obligation for local authorities to implement a SUMP. In 2011 the Institute for Transport and Mobility (IMT), developed a national strategy for the approach of accessibility, transport, and mobility, and their relationship with land use planning, which included:

- National Directives for Mobility – setting the national strategy for mobility and the appropriate instruments to put in place;
- Guide for the development of Mobility and Transport;
- Technical and Thematic brochures on sustainable mobility and SUMP;
- Guidance on accessibility, mobility and transport issues in land use planning instruments at the municipal level.

The National Directives were proposed to be adopted as a Ministers Council Resolution in 2012, making SUMP mandatory for municipalities with over 50,000 inhabitants or for district capitals, and voluntary in others. The Transport Metropolitan Authorities of Lisbon is legally obliged to prepare a SUMP.

In the United Kingdom, strategic transport authorities are expected to prepare local transport plans since the Transport Act 2000. They can be subject to a strategic environmental assessment that is undertaken following UK regulations that are based on EU regulations. A recent policy paper sets out the government's approach to innovation in urban transport (Future of Mobility: Urban Strategy, 2019).

3.3 Relevance to NTM solutions and multi-actor cooperation models

The SUMP process offers a key framework to develop mobility solutions through integrated planning, which offers certain opportunities for local practitioners and decision-makers to improve the network traffic management solutions and encourage multi-actor cooperation.

3.3.1 SUMP & Intelligent Transport Systems

SUMP can provide a framework to further develop ITS in cities, allowing the development of all transport modes in an integrated manner using smart technologies and ITS as tools and basic infrastructure to achieve integrated development of transport modes with an important role in the management of infrastructure and transport subsystems operations in a city. The key application of ITS on-traffic management is supporting in practice the development of multimodal transportation in an integrated manner.

Integrating SUMP and ITS can also further promote cooperation across institutional boundaries, as many IT, like traffic management, require coordination across institutional boundaries at the city and regional levels but also among local municipalities. At the regional level, the detailed ITS design and operation are made by private and public stakeholders on a transport network that includes multiple municipalities and service providers. At the local level operational requirements for fulfilling users' needs or sustainability objectives are formulated demanding customised operations (i.e. C-ITS services for priority of buses at signal intersections) or radical changes (i.e. reducing traffic in the city centre or supporting Low Traffic Zone implementation). SUMP processes can take advantage of the existence of integrated ITS in urban areas as they often create the basis for multi-stakeholders common understanding and cooperation.

3.3.2 MaaS

Developing a SUMP can help cities further enable the development of Mobility as a Service (MaaS), but the reverse also stands as information from MaaS services can supply key data for urban traffic and travel information, as well as traffic management. MaaS often reaches out beyond a single urban area and therefore collaboration among other institutional bodies at the regional and sometimes national levels is necessary. Early engagement with all relevant administrative departments is particularly relevant when identifying how MaaS data (and often location-specific including information about users' preferences and behaviour) could be used to support traffic management and city planning. Collaboration with other bodies, at regional but also at national and European levels, is also important to establish technical interoperability frameworks.

Adopting MaaS measures as part of the SUMP process will institute a new stage in traffic management within the city, where traffic optimization can come from different sources, one being mobility service providers, and used to enable some advanced services to the end-users. In the case of MaaS, the traffic management operators would have access to dynamic traffic data but also collect essential information, enabling them to provide traffic data services related to forecasting travel time estimation, level of services, etc. However, MaaS is not just an additional information channel for users, and traffic management is not just another source of mobility information. Integration between MaaS and traffic management is essential to increase the efficiency of urban mobility, the overall state of the traffic, and the quality of services delivered to users. An improved service of sustainable modes would further promote the use of these services among citizens.

Policy, regulation, and legislation that enable and support MaaS are key to its successful implementation and to ensure its further integration with traffic management.

4 Planning & Regulatory Framework for MTM

This section builds on the input of the first three rounds of workshops and additional findings resulting from desk research, with the cooperation of TANGENT case studies. The goal of this section is to portray the planning and regulatory framework surrounding network traffic management innovation in place in each TANGENT case study at the city, regional and national levels.

4.1 Rennes

Rennes Métropole is a grouping of 43 municipalities (among which is the city of Rennes, the capital of the Brittany region). Métropoles are public authorities enabled by law as of December 16, 2010, and consolidated by law as of January 27, 2014. Métropoles must gather more than 400 000 inhabitants upon their creation. Rennes Métropole's population was 444,723 in 2014 (of which 219,370 were in the capital city of Rennes). Rennes Métropole is experiencing significant population growth, with a forecast of 100,000 additional inhabitants in 2040.

Rennes Métropole was created in January 2015, replacing the previous *Communauté d'agglomération de Rennes*, which had itself succeeded in 2000 the previous "Rennes district", created in 1970. French Métropoles are in charge of their territory, economic development and territorial planning, waste management and water management, housing policy, culture policy and, finally, mobility, transport, and road infrastructure.

Rennes Métropole, as the Authority Organising Mobility (Autoritée Organisatrice des Mobilité AOM), defines the overall transport strategy in its territory through its Urban Mobility Plan (Plan de Déplacement Urbain PDU) and consequently organises the public transport policy in its 43 municipalities. To promote sustainable mobility throughout the territory, Rennes Métropole is implementing a set of solutions favouring public transport and developing complementarity between the different modes of transport, with a clear choice for innovation and experimentation. Along with a policy of strategic planning, Rennes Metropole developed 2017 to 2021 the InOut initiative around new mobility to support demonstration and experimentation. As an annual event, InOut brought together national professional mobility actors ("in") for networking, conferences, showing and facilitating experimentation as well as the public through a dedicated event ("out"), where citizens could learn and experience new mobility solutions.

The figure below shows the main policy orientations and challenges of the PDU.

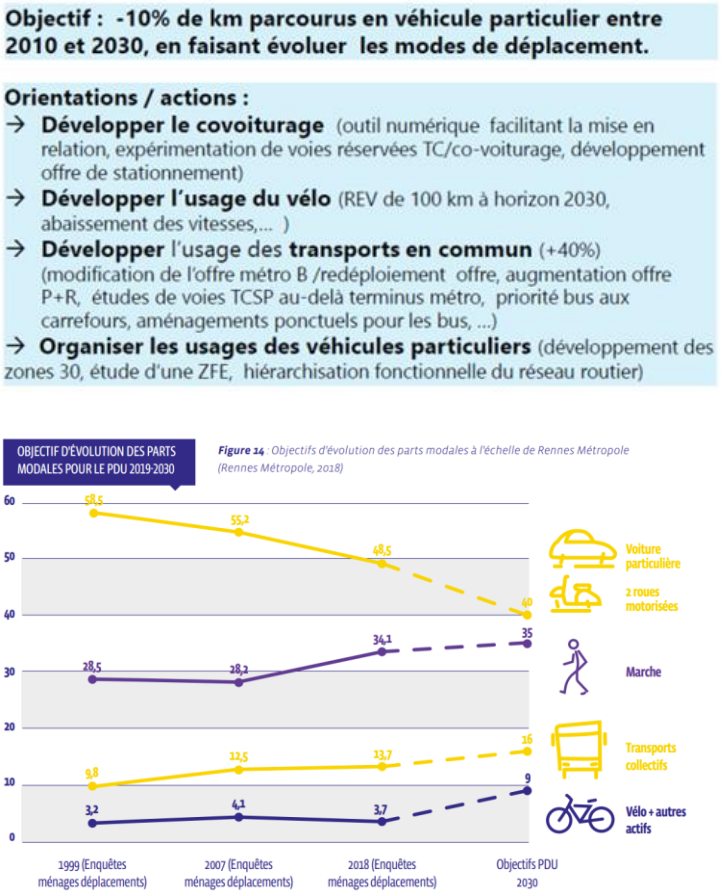

Figure 2. Policy Orientations of Rennes Métropole (Source: PDU 2020)

4.1.1 National planning framework

The foundations for France's traffic management policy result from multiple rounds of discussions that took place across the 2010s which resulted in identifying key challenges such as:

- Difficulties in developing new road use;
- Budgetary constraints for investment and maintenance;
- Recurrent congestion of the main road network.

But it also led to identifying key opportunities in improving network traffic management

- Possible gains by optimising existing infrastructure with incentives for the development of dynamic traffic management measures;
- Improving mobility in large peri-urban areas[3];
- Using dynamic traffic management measures as quicker responses than heavy investments to act on congestion in agglomerations and facilitate the pathway to more sustainable modes (e.g. shared mobility, intermodality, public transport).

The Ministry for the Environment, Energy and Sea has instructed every urban area of more than 250 00 inhabitants with a core road network consisting of sections of the National Road Network (without a concession with motorway characteristics) to develop a "Schéma Directeur d'agglomération de la Gestion du trafic" SDAGT (Agglomeration traffic management master plan). It should integrate the

[3] Spaces between the city and the countryside, in the urban fringe

agglomeration's structuring network and the various transport offers while accounting for projects approved or in progress. The organisation of the SDAGT should be developed under the authority of the prefects coordinating road networks in collaboration with other local authorities.

The objectives of this planning framework are to (Sproni & Mitrano, 2017):

- Develop a common culture of mobility at the level of large conurbations and share coordinated objectives between the different actors (Public Transport Authority, road managers, ...);
- Achieve a coherent set of optimisation projects on the structuring of the road network around large conurbations, taking into account the orientations of planning documents;
- Give priority to traffic management and road sharing measures whose costs and delays make them real short- or medium-term alternatives to new infrastructure projects;
- Have a multi-annual programming tool for traffic management operations for the State (global vision) with the first horizon of 5 years;
- Improve the mobility offer (reliability of the road network, performance of public transport, legibility of the intermodal offer from the road network, etc.) and support the development of new mobilities (carpooling, car sharing).

4.1.2 Regional planning framework

Rennes' SDAGT, for the urban area of Rennes and Nantes, is currently being developed by the Direction Interdépartementale des Routes Ouest DIRO (Interdepartmental Directorate of West Roads) in close collaboration with local metropolitan authorities (Nantes Métropole and Rennes Métropole), the regional authority, Departmental Council and local road authorities.

The working group is currently setting up the scale of the SDAGT, identifying the stakeholders involved, the road network to consider and the existing partnerships. It aims at defining a collaborative tool to improve network traffic management in the urban area and provide a tool for data sharing, collaboration and mutualisation.

4.1.3 Local planning framework

The analysis of Rennes' urban mobility plan (PDU)(Rennes Métropole, 2019), which covers the period of 2019-2030, in terms of the framework provided around network traffic management shows a certain vision to implement definitive and experimental actions in terms of NTM. A congestion observatory in connection with the traffic management and operation system common to the State and Rennes Métropole and the Rennes Métropole traffic management control centre is planned to be modernised. A tool for traffic management and the optimization of the functioning of the structuring road network, the Rennes' Traffic Management Agglomeration Master Plan (SDAGT) - is currently being developed by the State services. It will aim to meet several challenges concerning the functioning of road mobility:

- Seek solutions to limit regular congestion (southern and western ring roads of Rennes);
- Act for more performance of public transport (penetrating in particular);
- Develop intermodality practices;
- Encourage new mobility (development of carpooling);
- Promote a dynamic partnership for road operation and the dissemination of information to users.

4.1.3.1 Connected, Cooperated and Automated Mobility

A particular focus on autonomous vehicle innovation regarding NTM is also noticeable in Rennes' urban mobility plan. This focus appears to be motivated by the understanding that shared autonomous vehicles, combined with better management of traffic and road congestion can provide a coherent and sustainable mobility system. The plan aims at preparing Rennes Metropoles for the arrival of autonomous vehicles and supporting their deployment. Beyond this legal and technical monitoring,

Rennes Métropole intends to participate in these developments and verify their acceptability by the inhabitants and users of the territory.

Beyond these experiments, it is necessary to think about the place that these autonomous vehicles will have in the local mobility system. Rennes Métropole has thus proposed, as part of the call for expressions of interest Territories of Innovation of Great Ambition (TIGA), the establishment of a Living Lab for autonomous mobility.

4.1.3.2 Mobility as a Service

Another particular focus on MaaS is also visible, motivated by the need to facilitate users' practices by offering them access to all the possibilities to move via a single subscription and platform. MaaS is considered one of the major challenges of Rennes' urban mobility plan.

This multimodal mobility concept is already underway in Rennes Métropole, notably through the deployment of the KorriGo Services card. This is the support of travel for metro users, buses, self-service bicycles, carsharing, etc. It is also the map of travel on the BreizhGo network (TER, interurban lines) and on several other Britain urban networks.

This approach is also part of a sustainable development objective by offering a single support to access different transport networks and services, thus avoiding the multiplication of cards, tickets or other media, while respecting the privacy of residents (Citizen Multiservice Application standard validated by the CNIL).

4.1.3.3 Multi-actor cooperation

In terms of multi-actor cooperation, Rennes' urban mobility plan mostly focuses on stakeholder engagement and participation in the evaluation of actions because it makes it possible to integrate fundamental dimensions such as pluralism (by integrating the diversity of legitimate points of view), participation (by associating recipients and stakeholders), and to build projects in a co-construction approach that federates the actors.

4.2 Greater Manchester

Greater Manchester, with 2,7M inhabitants, and an area of 1,276 sq. km, has more than 5,6 million journeys across Greater Manchester's transport network each day. Transport for Greater Manchester (TfGM) aims to keep the city region moving and growing, working hard to make travel easier through a better-connected Greater Manchester. 8 million vehicles enter and leave the central part of Manchester city annually, being 8,2M light goods vehicles, 1,2 M heavy goods vehicles, 3,8M buses and coaches and 54,4M cars creating over 2.1 billion journeys, of which 268 million are made by public transport modes.

Increasing the use of sustainable transport to reduce the negative impacts of car use, and thus reducing transport emissions is a particular challenge, given that economic and population growth will increase the travel demand. Making the best use of existing infrastructure will help to reduce environmental impacts. Road and rail networks must be used as efficiently as possible – reducing congestion and improving connectivity between modes. TfGM aims to reduce urban emissions, being aligned with the Low Emissions Strategy and meeting Greater Manchester's decarbonisation agenda.

The challenges faced by the city of Manchester that would be addressed through this project are mainly managing congestion, integrating the different modes of transport like bus, tram, train, and active travel, and encouraging a modal shift to sustainable modes. One of the other main challenges for the city is to integrate traffic management systems and data to ensure that the transport network could be overall managed. Also, a concern for the city is understanding how future mobility can shape the transport

systems. The city plans to test the services from this project within the inner ring road. The city will also look to include travel corridors to/from Old Trafford and the Etihad football stadiums.

Mobility services, that would interest Manchester to address the above-mentioned challenges, are to include first and last-mile services alongside the existing public transport network and the inclusion of Demand Responsive Transport (DRT). Other alternatives for Manchester would include the CAV shuttles and encouraging parking outside of the regional centres and at rail and Metrolink stations.

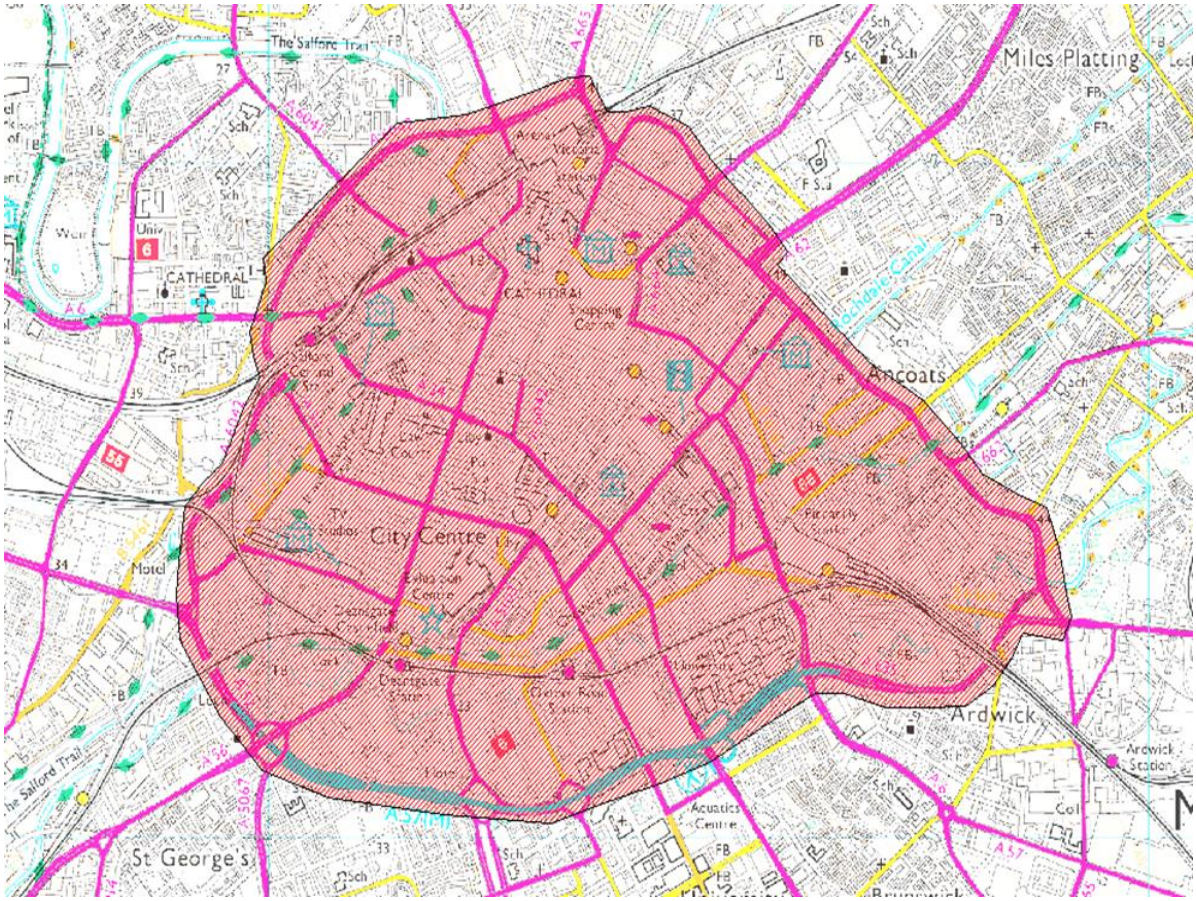

Figure 3: Area within and including Manchester Inner Ring Road.

4.2.1 Transport Planning framework

The perception of Greater Manchester as a good place to live, work, invest and visit is vital to the economy. The city aims to deliver efficient, seamless, intelligent, and easy-to-use public transport compared to other world cities and create public spaces that offer a safe, attractive, and clean environment for walking and cycling. The development of connected infrastructure shared services and placemaking has been at the forefront of the transport innovation agenda for the area of Greater Manchester. Innovation projects are being undertaken to better understand the impact of these services and new mobility solutions and overcome any technical, regulatory, and commercial barriers. Projects such as eHUBS are creating community hubs with access to shared, electric, sustainable mobility solutions, while the legacy of the ground-breaking CityVerve project is the foundation of the city's ambition to be a world-leading smart city.

TfGM and local planning authorities will continue to work with developers to better integrate transport and new development following the principles of: Reducing the need to travel; reducing the need to

travel by car, and the distance travelled; maximizing accessibility by sustainable modes; making the best use of existing infrastructure, particularly through increasing the density of development close to public transport nodes; Maximising opportunities to provide additional public transport.

- Designing to encourage active travel.

Figure 4: Reinforcing principles from Greater Manchester's transport system (Greater Manchester Transport Strategy 2040, TfGM, 2017)

The goal is to provide sustainable travel options that offer an attractive alternative to the private car and minimize the negative impacts of freight traffic. Tackling these issues will enable Greater Manchester to deliver its economic growth, and environmental and quality of life goals without traffic congestion and pollution undermining its long-term success. Greater Manchester has adopted an adaptive, vision-led approach to transport planning. This means that the steps needed to achieve the Right Mix Vision will be continually monitored and adjusted to achieve the goals. By 2040 the vision aims to have 50% of all journeys in Greater Manchester to be made by walking, cycling and public transport.

4.2.1.1 Manchester Transport Strategy

This Transport Strategy 2040 (Greater Manchester, 2017) focuses on the critical long-term challenges faced by Greater Manchester, such as global warming, a rapidly growing and ageing population, low productivity, and the need to reduce poverty and social inequality. This is supported by a more holistic approach to the needs of passengers and freight, with a strong focus on integration across different modes of transport, and with wider policy areas, such as spatial planning and health. Technology and innovation also have a key role to play. Through the 2040 Transport Strategy, Greater Manchester will develop a network approach that would enable them to meet a wider variety of travel demands, facilitating easier interchange at key nodes on our transport network and, along with improved services, enabling people to make orbital, as well as radial, journeys much more easily. The aim is to stop viewing different modes of transport as separate networks, with individual asset management, service planning, and fares and ticketing regimes, and instead plan a single, highly connected transport system that customers can move through seamlessly. This will result in prioritizing transport improvements more effectively, based on the needs of different travel markets and saving resources by minimizing duplication of expenditure and activity.

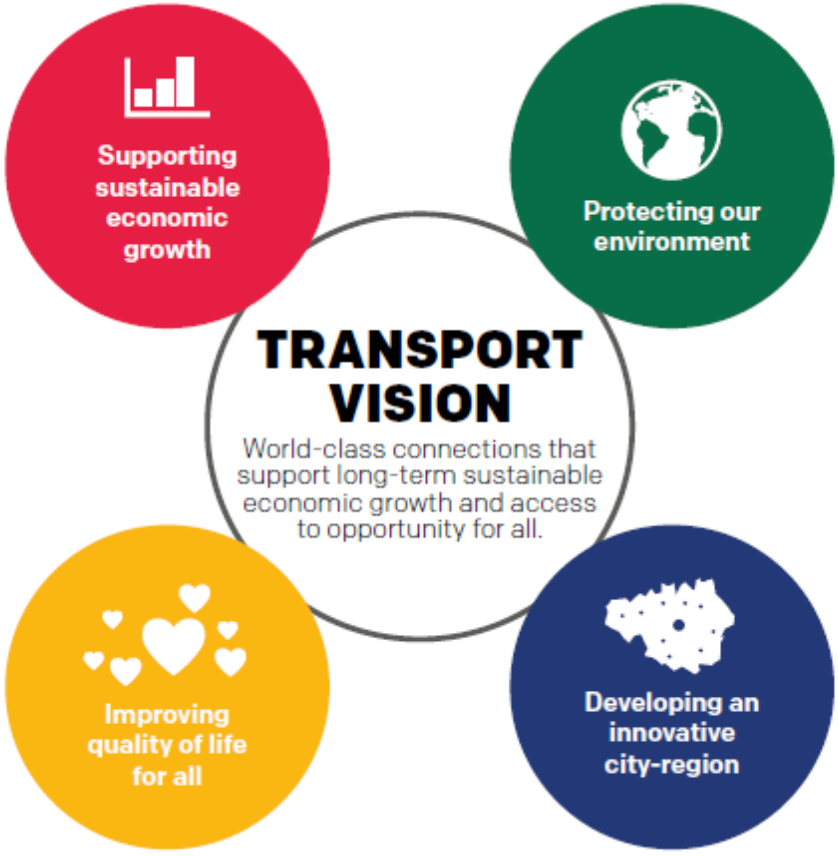

Figure 5: Transport vision of Greater Manchester (Greater Manchester Transport Strategy 2040, TfGM, 2017)

Greater Manchester aims to maintain investment in the bus network and improve public transport connectivity to employment and essential services, as well as improve the customer experience. The demand for public transport, including buses, must grow, facilitating the modal shift from car to public transport, and reducing congestion and harmful emissions. To fully achieve these outcomes, evidence from other cities suggests that improved integration and investment can increase the use of public transport and bring the public transport user benefits. Improved public transport will need to play a major

role in delivering Greater Manchester's sustainable growth agenda up to 2040. An attractive, efficient, and well-integrated public transport network is an essential element within the city region's infrastructure and at the heart of the *Our Network* vision. Together with active travel, it can provide the significantly enhanced connectivity that Greater Manchester's city region requires for success. It can encourage growing numbers of people out of their cars for more of their journeys (helping to reduce emissions and congestion), and it can provide access to employment, education, and opportunities for the third of households without access to a car. Modern, high-quality interchanges have been built or are under construction in the main town centres, with provisions for extensive bus priority, through a network of Quality Bus Corridors and the Bus Priority Package.

The Transport Strategy 2040 (TfGM, 2017) has been developed in line with current Local Transport Plan guidance and European best practice in creating Sustainable Urban Mobility Plans. Alongside this strategy, *Our Network* from Greater Manchester is a passenger-focused way of showing how different modes of public transport – bus, tram, rail, tram-train - and cycling and walking - could form a modern, integrated transport network with seamless connections, simplified ticketing, and aspiration for capped fares.

Transport is already contributing to regeneration, including through the expansion of Metrolink, which is stimulating investment in surrounding areas, and through transforming Greater Manchester's rapid transit stops into Mobility Hubs, including better pick up and drop off provision, cycle facilities and electric vehicle charging points. Reducing the impact of traffic by increasing the use of public transport and through effective traffic management, will be essential. It will improve quality of life by reducing noise and pollution. Locating new development where there is good access to public transport and services will reduce car travel and therefore emissions. Damage to, or loss of, habitats as a result of construction, disturbance from traffic noise or street lighting, and pollution due to run-off from highways should be minimised. 'Green infrastructure' such as parks and roadside trees not only helps to create much more pleasant places to live, but brings important environmental benefits through reducing temperatures, noise, and pollution as well as absorbing run-off. Blue infrastructure also contributes to the quality of life by providing attractive, traffic-free routes for walking and cycling.

Traffic speed is a major factor in whether people feel safe to walk or cycle and lower speeds reduce the severity of casualties. There is evidence that where 30km/h zones have been introduced there can be an increase in walking and cycling. On many roads in Greater Manchester, 30km/h speed limits have been implemented and are legally enforceable by Greater Manchester Police. We will continue to implement speed reduction measures where these are supported by residents, prioritising: residential areas, areas around schools, areas adjacent to the local or strategic cycle network, where this will help to create a wider network of safer routes; and areas identified as having a high collision risk for vulnerable road users.

The goal for TfGM is to achieve walkable centres, with pedestrian-friendly spaces, which accommodate access by bike and by public transport but are still accessible by car and are viable for business. Reduced traffic volumes and speeds can greatly add to the vitality of centres, encouraging people to walk for leisure or stop at pavement cafes. The benefits of traffic-free streets must account for the need to maintain access to cars, buses, and services. Many local centres are bisected by major roads, which create noise, pollution and severance as well as presenting a danger for cyclists and pedestrians, particularly children, disabled and older people. While the movement of traffic needs to be accommodated, greater emphasis must be given to the needs of the area or the locality, prioritising pedestrians, cyclists and bus passengers through crossing facilities, improved links and signage from interchanges and car parks, and improved parking for cycles and motorcycles. A noteworthy mention, in this case, could be made of the daily school journeys, which can have a significant impact on local traffic and transporting children to school by car also contributes to reduced levels of fitness and increasing obesity. For journeys to primary school, a switch to more walking or cycling would both reduce traffic in residential areas and improve the health of our young people. Journeys to secondary school are generally longer, but many could still be made on foot or by bike if safer routes and cycle

parking were provided. To encourage more school pupils to walk or cycle to school, work with the health sector to promote active travel to schools, including the development of school travel plans, should be prioritised. Shaping those habits in children is a longer-term investment in the future of mobility, creating change in behaviour from an early age.

The quality and safety of the route and the waiting environment also affect people's willingness to use the services on offer. Park-and-ride facilities will be located carefully as they can lead to people driving further before they start their public transport journey. To improve access in rural areas, TfGM aims to improve the interchanging between rail and bus at rural stations maintaining proper rights of way and bridleways as funding allows. This will be combined with supporting proposals for speed reduction, including 'quiet lanes' which will provide safer walking and cycling links to local facilities such as schools and stations; and infill gaps in long-distance walking and cycling routes that improve access to the countryside. The policies for achieving better-connected neighbourhoods will make it easier for people to travel by sustainable modes, particularly walking and cycling. However, improvements in infrastructure and services need to be complemented by behaviour change measures that encourage people to choose active travel for short journeys, including journeys to school, encouraging the use of local stations, promoting sustainable travel in new developments, and promoting the use of new transport infrastructure.

TfGM will adopt a digital-first approach, with technology increasingly enabling these apps and web-based tools to be tailored to the needs of individual customers making data available as Open Data to allow third parties to develop apps which will benefit the customers. A more consistent approach to transport information and payment to allow customers to search and pay for different travel services, such as public transport, car clubs, cycle hire, and parking is to be undertaken. This approach could involve the development of a multi-modal, account-based travel platform, sometimes referred to as Mobility as a Service (MaaS). MaaS could be delivered through a smart card, credit/debit card, mobile phone, or other cashless technology. This approach could also support a more sophisticated and responsive methodology to manage demand on the transport networks through nudging travel behaviour.

4.3 Lisbon

The Lisbon Metropolitan Area (Área Metropolitana de Lisboa AML) has 3 million inhabitants with 5 million person-trips each day. Of these, the majority are estimated to be made by car (56%) and public transport modal share only amounts for a quarter of the trips. There is a significant movement of commuters towards the city of Lisbon, which lies at the geographical centre of the metropolitan area and is its main commercial, business, and administrative hub. 370.000 cars are estimated to enter the city on a typical day (for reference, the city has approximately 500.000 inhabitants). This creates significant pressure on the road network, leading to congestion, and impacts the city, notably in terms of urban space management (e.g., parking capacity is scarce), environmental aspects (e.g., noise, air pollution), and other social aspects (e.g., road safety).

Accordingly, the city of Lisbon is committed to rebalancing its modal split. Whilst passenger cars account for 46% of trips per day (a share that is already lower than the average for the wider metropolitan area), the objective is to reduce this number to 34% by 2030, which would imply shifting approximately 150.000 people per day from their cars into sustainable modes (i.e., cycling, walking and other micromobility modes, public transport). To achieve this goal, Lisbon is foreseeing an investment in more attractive public transport, (e.g., through the renewal of bus fleets or the expansion of metro and tram networks), and more accessible public transport offers (e.g., offering free access to people older than 65 y/o and students up until the age of 23 y/o, increasing the offer of cycling infrastructure, etc.)

However, it is also clear that addressing the challenges posed by traffic and mobility in the city of Lisbon implies a wider perspective that considers the whole of AML. This is where the TANGENT project can

contribute to the achievement of these objectives. The metropolis of Lisbon has a large deployment of big network devices and Connected Intelligent Transport Systems (C-ITS) infrastructure on the main motorways accessing Lisbon city namely CRIL (also denominated IC17 or A36), IC19 (also denominated A37), N6 (also denominated Marginal), A1, A2, A5, CREL (also denominated IC18 or A9), and A12. There are also traffic counters and classifiers, variable message panels, speed, and lane control sign information, for exchanging data with the transport network. This information is of paramount importance to optimize the functioning of the mobility system and provide incentives to shift to more sustainable modes of transport.

4.3.1 National planning framework

The Portugal Strategy 2030 (Government of Portugal, 2021) establishes a medium-term path for the economic, social, and environmental development of the country within a decade, advocating options to overcome the set of structural blockages that have faced the country and that, in many cases, were deepened by the pandemic crisis. For the transport sector, the goals considered are as follows:

- To optimise the management and networked provision of existing collective services in the areas of education, sport, health, culture, social and economic and associative nature, ensuring adequate levels of provision of public goods and services and access to digital networks, enhancing rural-urban links.
- Strengthen the role of the social economy in managing the network of collective services.

Regarding the promotion of sustainable mobility, the interventions aim to accelerate the paradigm shift in this sector, towards its decarbonisation, with traditional fossil fuels being progressively replaced by electricity, advanced biofuels, or other energy carriers of renewable origin, such as hydrogen, and the continued commitment to public transport, changing the mobility patterns of the Portuguese. They involve the reinforcement of the mobility system in public transport in the national territory, with the guarantee of more efficient, attractive, and environmentally sustainable collective public transport offers, with special incidence in urban areas of greater population density, without neglecting flexible functions and adapting to low densified interior territories, besides also having to respond to new demands in terms of public health, as became evident during the pandemic. The promotion of the decarbonisation of the transport sector should be boosted by procuring a fleet and encouraging the introduction of clean energy along with the promotion of multimodal, active, and sustainable mobility by taking advantage of innovative and intelligent transport solutions and fostering efficient shared, flexible, connected mobility patterns, and improving the mobility planning to contribute to low-carbon strategies and spatial planning and the development of monitoring tools.

4.3.2 Local planning framework

The Municipality of Lisbon is striving for a city with a people-centred mobility ecosystem that is accessible, useful, reliable, and safe, based on an integrated public transport network complemented by innovative solutions that allow conscious and sustainable choices. *MOVE Lisbon*, the strategic vision for mobility for 2030 (Cámara Municipal de Lisboa, 2020), aims to provide coherence, by defining a clear plan for the desired future and pointing out the guidelines for the use of operational instruments that will take us to a new level in terms of mobility and urban accessibility. This vision proposes a transport system which is more integrated, reliable, connected, accessible, and open to new solutions, reclaiming space for people, increasing the community's sense of belonging, maximising the quality of life of the city and Lisbon Metropolitan Area (AML) residents, and improving the experience of those who use and live Lisbon.

On one hand, the municipality is leading the movement of assumption of the new paradigm of mobility in its territory, on the other, it seeks to influence several partners and integrate them into its action plan. Acting directly with the Government of the Republic of Portugal, the Lisbon Metropolitan Area, other Municipalities, transport operators and mobility services companies, the Lisbon City Council works to

promote solutions that allow for reducing dependence on private cars, creating alternatives that help to foster a rational modal shift, to improve mobility and to increase accessibility.

The *MOVE LISBON* Strategic Vision for Mobility 2030 presents a proposal for future mobility in the city, pointing out guidelines for operational success, namely the reinforcement and/or evolution of 5 transport networks - Pedestrian, Public transport, Road, Cycle, and Interfaces alongside 5 services - like Parking, Shared services, Urban logistics, Additional mobility, and Tourist transport.

The city of Lisbon aims to plan and implement the following as a part of its mobility strategy:

- Increases the attractiveness of public transport (PT);
- Integrates new mobility services into the transport system;
- Restricts private car access to downtown and surrounding hills and implements measures to promote safety in the mobility system, structured through the municipal road safety plan;
- Implements a strategy to accelerate the adoption of electric mobility;
- Requalifies public space and pedestrian network;
- Improves mobility to and from school;
- Expands the cycle lanes network, making it more comprehensive;
- Increases the resident population;
- Promotes the use of the Tagus River as an infrastructure for waterway mobility;
- Continuing the development of Park & Ride infrastructures near peripheral PT interfaces, with tariff integration;
- Finding new employment poles in the PT interfaces surroundings;
- Taking on new forms of work;
- Defends the urgency of metropolitan investment in heavy mobility;
- Strengthens coordination at the metropolitan level of mobility systems.

The successful implementation of the Lisbon mobility strategic vision also depends on the development of legal, institutional, and regulatory mechanisms to ensure the effective implementation of measures defined to improve the transport system. MOVE Lisbon proposes to create or revise regulations that promote the sustainability and effectiveness of the transport system in terms of:

- Parking and circulation on public roads;
- Tourist transport services;
- Taxi services;
- Shared mobility services;
- Whenever safeguarding the public space and security of vulnerable users is justified;
- Electric mobility.

4.3.3 Network Traffic Management

Mobility management presents a particularly interesting potential for a city such as Lisbon, which offers a comprehensive public transport network, and is in the process of investing in infrastructures for active modes and launching high-impact shared services. The definition of assertive management measures can make a decisive contribution to the success of these new investments, enhancing the use of infrastructures and maximising the chances of their successful integration into city life with low cost/benefit ratios. An integrated operational centre will contribute to traffic management, parking, traffic lights, radars, public transport, interfaces, logistics, and shared services, among others, connecting equipment and vehicles, and providing real-time information. Anyone will be able to know the options that the mobility ecosystem offers at any given time, and they will be able to plan, book, purchase, and access their services in an integrated manner. Those who come from the outside will be able to know where the different parking lots are located, their availability, and the possible connections to the multimodal network, boosting their daily use.

To achieve effective management of mobility and the mobility system, which leads to increased efficiency, safety, and comfort of travel in various modes, Lisbon is establishing itself as a smart city, with a Lisbon Intelligent Management Platform (PGIL), an integrative structure that collects and processes data, based on the latest technologies and the best analysis, management, and control algorithms. Lisbon also assumes itself as a dynamic innovation ecosystem, packed with entrepreneurs, start-ups, and investors, capable of attracting "lighthouses" projects like Sharing Cities and global events like the Web Summit. Lisbon proposes that the analysis, control, and optimisation of mobility system resources take place in an Integrated Operational Centre (COI) incorporated in PGIL, which concentrates all relevant information for mobility management in Lisbon and, whenever possible, in the Metropolitan Area. The COI will be able to cluster the Operational Mobility Control Centre (CCO-M), where all the city's mobility ecosystem data are concentrated, transforming data into information that enables the management, control, and monitoring of the mobility system, as follows:

- Integrating processes of all municipal actors, such as the City Council services, the Municipal Police, Carris, and Empresa de Mobilidad e Estacionamento de Lisboa (Lisbon Mobility and parking company EMEL);
- Incorporating data from the mobility system and the respective constraints stemming from municipal services or partner entities management systems, the public transport network, the city's traffic model, the city's traffic lights management system, the speed control radars, the traffic monitoring camera system, the traffic counters, the parking lots, the parking meter network, the limited access areas, the environmental monitoring stations, the urban logistics management systems, the matrix signs, the connected vehicles, the electric vehicle charging stations, among others;
- Analysing the data and generating information that allows optimising the control of mobility in the city continuously, automatically, or manually, managing the traffic constraints, accidents, and incidents, as well as special events;
- Linking with other intelligent control, management, and information systems;
- Ensuring effective real-time operation by managers and decision-makers, and rapid response to events that condition the normal functioning of the mobility system;
- Informing citizens, suggesting the best alternatives, and allowing them to define their mobility options and preferences, enhancing the use of social networks;
- Strongly promoting the City Council's open data policy;
- Encouraging innovation, providing access to university academia, start-ups, and third parties, tools, and data from municipal services;
- Boosting innovation from projects funded by European and other co-financing funds.

4.3.4 Mobility planning

The whole city will be connected through a network of multimodal axes, where an excellent network of public transport and new mobility services will circulate, using roads and train infrastructures efficiently, and innovatively explore the Tagus River waterway, allowing anyone to have access to urban scale functions (hospitals, universities, service centres, stadiums, among others) with flexibility and freedom of choice. From the coherent definition of the networks and services mentioned above, and from the transversal axes, an accessible Lisbon will emerge, where people, regardless of their physical or economic condition, will be able to move freely and access the goods and services they need. MOVE Lisbon also proposes a set of guidelines to achieve a significant reduction in the use of the private car and, consequently, greater use of public transport and active modes.

The vision for the city of Lisbon for the transport networks and their services includes building up a comprehensive, robust and coherent public transport network in the city integrating new modes and their easy and complete accessibility to the network. It should simultaneously guarantee frequency and fluidity, benefiting from its space channel and traffic light priority at the intersections, guaranteeing quality in the mobility of its residents and visitors, as well as students and workers who enter the city every day. The pedestrian network of Lisbon should be universally accessed by foot both within the

neighbourhoods and in the main axes of access to the central areas and infrastructures, in particular, the interfaces and the school network. MOVE Lisbon proposes a road network that increases the importance and fluidity of the circular axes of the city and reduces the importance of the radial axes, protecting the centre through increasingly restrictive crown areas. The network of interfaces allows the connection in PT of any two points of the city with maximum speed and the minimum of transfers, integrating whenever possible other networks and transport services. It is proposed that by 2030 the city's territory will be covered by a public bike-sharing system to be developed in several stages and with a density of stations and bicycles that will maximise the potential for use of this mode. Lisbon also proposed to be a cycling city with an urban network that allows the daily use of the bicycle in the home to work/school trips and leisure travel. Some other functionalities of mobility planning proposed and to be implemented by Lisbon are as follows:

- **C-ITS**: MOVE Lisboa proposes a parking policy fully articulated with the city's mobility policies, adjusting the supply for residents, visitors, and operators of urban logistics in every part of the city. This policy must be supported by an intelligent information system, which guarantees a high quality of service to the users, as well as a better operational management capacity.
- **MaaS**: Integration of new mobility services into the transport system by creating conditions for the existence of integrated platforms of mobility services, in a logic of mobility as a service, ensuring information to the public, simplicity in the acquisition of services and improving its quality and efficiency. It will increase multimodality by adding flexibility and coverage to the transport system.
- **Innovative mobility services**: To make Lisbon a pioneering and testing city for innovative mobility solutions in real but controlled environments, generating a positive impact both on the economy and users. Encouraging the adoption of new mobility models and concepts that promote resource sharing, including innovative solutions regarding shared vehicles, travel, parking spaces, etc., supported by new information and communication technologies, allowing for flexibility in regulation for greater consolidation of innovative solutions.
- **Key Performance Indicators**: Public management processes with direct implications on people's daily lives should include monitoring mechanisms that aggregate and process data and information, producing a set of key indicators to support decision-making. Monitoring can be used to evaluate processes and define changes that allow for the continuous improvement of the mobility system, better mobility efficiency and increased user satisfaction. To accomplish the strategy, a third-generation Sustainable Urban Mobility Plan (PMUS – Portuguese acronym) will be implemented in the city of Lisbon. Monitoring, assessment, and review of the mobility system will be carried out based on the management and control systems as well as on participated mobility observatory platforms, with a set of indicators of public access. These processes will allow:
  - To define indicators that might not only inform the population about the system's performance, but also evaluate and, if necessary, correct the actions developed.
  - To continuously monitor the mobility system, detecting and correcting problems and failures in real-time.
  - To assess the measures and actions implemented as well as the new systems and services, reviewing the options taken, making adjustments, eliminating inconsistencies, and continuously improving the entire mobility system.

The following figures (6 & 7) give an illustration of the goals for Lisbon in their National Programme of Investments 2030 associated with their mobility strategy.

Figure 6: Management and control centres for Intelligent transport system (National Programme of Investments, 2030, Lisbon, 2021).

Figure 7: Steps for multimodal use and fostering decarbonization of cities (National Programme of Investments, 2030, Lisbon, 2021).

4.4 Athens

Athens, Greece, is one of the largest economic hubs in Southern Europe, with more than 3 million residents across ~39 sq.km. Athens faces severe congestion problems due to the rising demand for car trips and the lack of coordination between modes. Recently, the “Grand Walk” project was implemented to relieve the city centre from increased levels of car traffic and make room for alternative and more sustainable means of transport. The “Grand Walk” will free up 50,000 sq.m. of space for pedestrians and soft modes, create 2,000 motorcycle parking spots and 12 taxi stands, and facilitate bus services. The transport network of Athens is characterised by 170 public transport lines, 95 bus lines, 14 trolley lines, 4 metro lines, 2 tram lines, 5 suburban lines, 50 intercity bus lines, 1.030 public transport stations, as well as cars, motorcycles, and freight vehicles.

Problems that Athens faces include severe congestion, lack of coordination between different modes, pollution, accidents, and an overrepresentation of private vehicles in commuting patterns. The key mobility priorities for the city of Athens are the improvement of network connectivity and operation, reduction in emissions, accidents, and congestion, and prioritisation of public transport and soft modes.

Mobility services that will be of interest to Athens include first and last-mile services operating alongside the existing public transport network, on-demand vehicles serving less dense areas within the Athens Metropolitan Area and CAVs operating on dedicated lanes or alongside traffic, as they mature technologically.

The significant changes to the Athens’ Road infrastructure due to the interventions of the “Grand Walk” form a new traffic “reality” for the citizens, with a strong multimodal character, which in turn requires more advanced management strategies for the demand to be served efficiently. TANGENT will provide strategies to improve network connectivity and operation through a better information system that connects all modes.

4.4.1 Planning framework

Athens is served by several different public transport modes: buses and trolley buses, metro, tram, and suburban rail, which are run by different operators. An extensive bus and trolley bus network, consisting of about 260 bus routes and 19 trolley bus routes, operates in the city of Athens covering most of the Athens metropolitan area. Buses and trolleybuses in Athens are mainly operated by OSY, a subsidiary of the state-owned Athens Mass Transit System (OASA S.A.). The latter also acts as the Transport Authority for the city of Athens, being responsible for the strategic and operational planning, coordination and control of the public transport carried out by public transport means in the Attica Region.

In the action plan of OASA S.A. (Athens Public Transport Authority, 2020), special emphasis is placed on the need to create a meeting between Local Authorities and Urban Transport operators, with the main issue being the integration of Municipal Transport into the unified Public Transport System of the Prefecture of Attica and the achievement of interoperability between them. During the year 2020, requests for the Municipal Transport operation and modification of municipal lines operation were submitted to OASA, which were approved by the Board of Directors of OASA by the Municipalities of Ag.Anargyron-Kamaterou, Maroussi, Nikaia-A.I.Renti, Piraeus, Haidario.

The main activities included in the management of the Athens Mass Transit System (OASA) that are worth mentioning and relatable to this deliverable are as follows:

- Transport Planning & Development
- Operational Planning & Development
- Monitoring & Control of Urban Transport System
- Construction & Project Maintenance

- Supervision of the operation of the N.P.S.E.

OASA currently collaborates with more than 25 municipalities of Attica to develop a Sustainable Urban Mobility Plan. The action continues with the formulation of measures and proposals that will promote sustainable modes of transport (walking, cycling) and their combination with urban transport, discouraging the use of private means, so that the State can be led cooperatively to reduce air pollutant emissions and limit the greenhouse effect. The OASA participated in the planning and approved a total of 60 traffic studies and traffic regulations from 25 municipalities. The regulations concern geometric configurations and traffic modifications in the context of studies aimed at improving urban mobility and upgrading the urban environment by creating safe pedestrian corridors, and cycle paths and organising traffic and parking.

4.4.2 Traffic management

The Traffic Management Centre (KDK) of the Attica Region began its operation in July 2004 and since then its operation has been continuous (24 hours a day, 365 days a year). The main objectives of the Centre's operation are:

- The optimisation of traffic conditions and the safety of the main road network through a quick response to incidents, informing drivers of the prevailing traffic conditions and intervening in light signalling,
- The reception – processing – study and utilization of traffic data received along the main road network, as well as the cooperation with university bodies (Universities, TEI, etc.) for the realization of relevant research,
- The provision of traffic data in "real-time" to third parties to support telematics applications,
- The cooperation with other traffic control centres (Traffic Police, Traffic Control Centre of Attiki Odos, Fire Brigade, EKAB, TRAM, etc.).

Continuous monitoring is used, among other things, in the management of telematics information (Smart Stops, Passenger Screens, mobile app, site) in real-time for extraordinary events (extraordinary modifications, traffic measures affecting the transport work) and for planned events (network changes, planned strikes, stops, etc.) concerning the Road Communications Services (O.SY) and the Central Communications Services (STA.SY) and general transport issues (fares, etc.). The main objective for 2021 is to provide passengers with accurate information at an even higher level with continuity and consistency, on the one hand, passengers are provided with information under the given reference framework of the telematics system in operation and, on the other hand, that all the requirements for monitoring and supervision of the transport work carried out are met. In addition, new reports will be designed to analyse the traffic data of the leased vehicles in the context of the monitoring of the relevant service contracts.

OASA continuously collects and processes the production and service usage data of the Urban Transport System, to optimize the transport planning and coordination of the transport work performed by the ground and underground public transport in Athens, always in relation to the objectives set in the N.P.S.E.

4.4.3 Mobility planning

The New Strategic Transport Plan of Attica was launched in 2021 (Athens Public Transport Authority, 2020) which comprises their goals of immediate needs for fleet reinforcement to optimize the level of service and redesign the transport system. As a part of their measures and framework, specific actions and interventions were planned by OASA to reach their goals by reorganizing their bus fleet and trolleybuses together with extending their metro line. OASA leased buses to be put into circulation in the region of Attica for the purpose of increasing the frequency of their buses to compensate for the daily trips created in the transport system.

OASA participated in the Electrification Committee, which was established on the initiative of the Ministry of Energy and Environment, to investigate the parameters of the penetration of electrification in the field of transport. The competent Ministries of Infrastructure and Transport and Energy & Environment were requested to assist and temporarily grant to the OASA Group electric buses, to investigate their operation and to properly plan their integration into the existing fleet and facilities of the OASA Group.

Athens aims to improve its traffic management strategies and make its transport infrastructure more holistic. To have more insights on electrification, micromobility and autonomous vehicles, Athens opted to provide for pilot application in the European project HARMONY, which was executed to support metropolitan authorities, transport operators, and mobility service providers with cutting-edge technology to provide multidimensional impacts to the existing transport policies. Intending to develop, implement and test autonomous traffic management systems with real-time transport system monitoring and simulation models, Athens participated with their pilot in the FRONTIER project to develop a strategic control system for communication between different traffic management centres, promote interoperability across business structures and models and encourage the increase in the share of public transport, improve sustainable mobility and increase network capacity.

Furthermore, further refinement and the synthesis of a model for the regular extraction of Performance Indicators of the Transport Project of OASA and the Passenger Service Level of Athens Urban Transport using Advanced Analytical Data Processing Techniques is under consideration.

4.5 Findings from TANGENT's workshops on Policy and regulatory planning framework

Developing a Policy and Regulatory Planning Framework for Network and Traffic Management (NTM) that incorporates the insights from the workshops (Stage 3 within T1.1 and Policy recommendations workshop in T1.3) and the planning approaches from the cities of Rennes, Manchester, Lisbon, and Athens, this framework focuses on addressing data governance, multi-actor coordination, regulatory gaps, and city-specific planning integration within NTM.

4.5.1 Data Governance and interoperability standards

A robust data governance structure is essential for seamless NTM operations across urban areas. Key recommendations include:

- **Unified Data Standards and Interoperability:** Establishing standardized data protocols (includes adopting standards such as DATEX II (for road traffic data) and NeTEx (for public transport)) that support interoperability across city, regional, and national platforms. The workshops underscored the need for cities to adopt consistent data formats to enhance data integration, which would reduce system incompatibilities across different transport services and allow real-time data sharing supporting a scalable traffic management network.

- **National Access Points (NAPs) Strengthening:** Following examples from the workshops, cities should invest in mature NAPs to facilitate data exchange between stakeholders. This also aligns with the EU's directive for real-time traffic information, ensuring that both public and private entities can contribute data to a central access point.

- **Privacy and Security Protocols:** With an increase in data sharing between public and private entities, privacy and security considerations must be integrated into data governance. Adherence to GDPR, encryption standards, and data anonymization practices will ensure that sensitive data remains protected. To address the security and privacy concerns raised by both private and public stakeholders, data governance should mandate encryption, real-time

monitoring, and compliance with privacy regulations such as GDPR. This framework should include tiered access based on role, ensuring that sensitive data remains protected yet accessible to authorized personnel for critical decision-making.

4.5.2 Multi-Actor Collaboration and Governance

Effective NTM implementation depends heavily on coordinated governance and collaboration between stakeholders. Suggested steps include:

- **Central Coordinating Entity:** Inspired by Greater Manchester's centralized traffic management efforts, cities should consider establishing a dedicated governance entity. This entity would oversee data governance, dispute resolution (provide decision-making support during incidents), and enforce compliance with NTM policies. Creating a centralized structure helps to facilitate cooperation between various stakeholders including transport operators, city authorities, and private stakeholders.

- **Clear Role Definition and Responsibility Allocation:** The framework should define clear roles and responsibilities among stakeholders, especially during incidents and long-term planning. By establishing who manages data, who has decision-making power during disruptions, and who takes the lead in specific scenarios, cities can mitigate operational conflicts and establish accountability during critical incidents.

- **Regular Stakeholder Engagement:** Following the model of the co-creation workshops in the TANGENT project, cities should establish regular feedback loops between stakeholders to keep policies and operations aligned. Stakeholders involving transport authorities, private mobility providers, data providers, urban planners via municipal agencies should have scheduled meetings to align objectives, address ongoing issues and update protocols to adapt to the evolving NTM requirements. For instance, in Lisbon due to the complexity and diversity of stakeholders, there was gap in communication observed due to which TANGENT's service functionality of *cooperative incident management – synchronised traffic control and public transport* was prioritised (via Stage 3 Workshop insights) showcasing the requirement of further improvement in stakeholder engagement and cooperation in decision-making.

4.5.3 Regulatory Framework Adaptations for Flexibility and Growth

The policy framework should include regulatory provisions that allow for adaptive and flexible NTM systems:

- **Scenario Planning and Incident Management:** As seen in the Lisbon and Rennes workshops, cities should implement scenario-based planning tools within the regulatory framework to allow for rapid adaptation during traffic disruptions (including weather disruptions) or large events. This planning capability should include predefined response plans and adaptive incident management strategies that incorporate predictive modelling. This approach helps stakeholders to implement and adjust strategies based on predictions and traffic models that dynamically update in response to real-time data.

- **Pilot Testing and Phased Implementation:** Particularly for cities at the early stages of NTM adoption, the framework should allow phased implementation of tools through pilot programs. Pilot projects can assess effectiveness and scalability of NTM solutions, allowing stakeholders to identify operational challenges before the large-scale deployment. This risk-mitigating approach reduces financial and operational risk and ensures that solutions are feasible and adaptable.

- **Investment in Digital Infrastructure:** Cities need regulatory support to prioritize funding for digital infrastructure critical to NTM, such as intelligent traffic signals, CCTV integration, and IoT devices. Encouraging public-private partnerships (PPPs) can further incentivize the development of necessary infrastructure.

4.5.4 Local Policy Alignment and Urban Mobility Integration

Aligning NTM solutions with local Sustainable Urban Mobility Plans (SUMPs) will enhance the value of these tools within broader urban mobility strategies.

- **Integration of NTM with SUMP Objectives:** Following best practices from Lisbon's MOVE framework as an example, cities should ensure that NTM aligns with broader SUMP goals, such as promoting sustainable transport modes and reducing vehicle emissions. This alignment ensures that NTM solutions contribute toward citywide sustainability goals, supporting policies that shift reliance from private vehicles to public and active transport modes.

- **Performance-Based Indicators and Impact Assessments:** The NTM framework should incorporate KPIs that directly align with city-specific goals, such as reducing congestion, improving air quality, travel time reduction and enhancing public transport efficiency. Regular impact assessments using these KPIs will measure the success of NTM initiatives and provide transparency to the public. Public transparency will build trust and reinforce NTM's role in achieving local policy goals.

- **Incorporating Real-Time Feedback and Public Engagement:** Following best practices from Rennes and Manchester, NTM should actively engage the public through real-time data dashboards, accessible transport options, and open data portals. Public feedback channels should be established to allow citizens to stay informed and contribute towards the continuous improvement of NTM initiatives and strategies.

4.5.5 Adoption of Advanced Technologies and Capacity Building

NTM requires both technological readiness and skill development among city authorities and transport operators:

- **Adoption of AI and Machine Learning for Traffic Prediction**: Cities are exploring AI-driven predictive models to optimize traffic flow and enhance incident management. Regulatory support for AI implementation should include guidelines on algorithm transparency and data accuracy to ensure fair and reliable outputs. This should follow a human-centric approach addressing AI in Traffic Management. Recent developments from the EU HORIZON project AITHENA can provide insights on the transparency and associated aspects related to AI involving human-centric methodology.

- **Training Programs for Operators and Stakeholders**: Capacity building should be a core part of the policy framework, with structured training programs for city staff and transport operators. Training should cover the use of real-time data dashboards, cybersecurity measures, and AI-driven decision support systems to maximize the efficacy of NTM solutions. This requires pilot testing with the local authorities as one of the important steps during the development of tools such as dashboards.

- **Encouraging Technological Innovation through Flexible Regulation**: Regulations should allow room for testing emerging technologies, such as digital twins and autonomous vehicles, within the NTM framework. By providing legal pathways for innovation, allowing controlled testing of these technologies, cities can incorporate new technologies that enhance traffic management while ensuring compliance with safety standards.

4.6 Approach towards smart infrastructure classification

TANGENT's Smart Infrastructure Classification Index (SICI) is a comprehensive tool designed to support various stakeholders, including end-users, operators, authorities, and policymakers, in advancing cooperative, connected, and automated mobility. SICI classifies infrastructure into six categories. The first category addresses physical infrastructure elements such as road markings and signs, essential for both human drivers and autonomous vehicles. The second category encompasses various sensor types that facilitate infrastructure characterization and monitoring. The third category pertains to the availability of reference information provided by road and transport operators. The fourth category focuses on near real-time information regarding the state of the transport network. The fifth category assesses the communication of information to vehicles and users. The sixth category evaluates the presence of traditional and cooperative active traffic management functions.

Based on the insights from the SICI as presented in D6.6 of the TANGENT project, the following points focus on addressing the gaps identified and enhancing the capabilities of local authorities and mobility stakeholders for effective Network Traffic Management. Incorporating these strategies would significantly enhance the robustness and comprehensiveness of the SICI evaluations, enabling more informed decision-making and planning.

4.6.1 Improving real-time traffic and data management

Although the current datasets used in SICI implementation (in D6.6) include reference and dynamic data from roads and public transport networks collected for operational purposes, they do not offer a comprehensive evaluation due to the omission of several key elements. The available data predominantly addresses traffic and public transport incidents, variable message signs, and V2I roadside units. However, other essential infrastructure factors, such as physical infrastructure and active traffic management approaches, are insufficiently represented.

To address these gaps in future iterations, partnerships with local governments, transport authorities, and private sector stakeholders are recommended to access a wider range of data sources. Machine learning and big data analytics can be used to integrate disparate data sources effectively. This approach would involve applying data fusion techniques to merge GIS data, transport models, and socio-economic datasets into a comprehensive analytical framework. Additionally, it is advisable to create extensive data catalogues that include traffic and public transport data as well as infrastructural datasets. These catalogues should be updated and maintained regularly to ensure the accuracy and relevance of data.

Engaging with the community through participatory data collection initiatives, such as crowd-sourced data and citizen science projects, is an option to consider. Vehicle-mounted camera data can be processed with AI to evaluate physical road parameters, while mobile phone apps and in-car integrated apps can provide data about the existence and quality of, for instance, SICI's Category 5 Information Channels. This method would supplement traditional data sources and offer more detailed insights into local infrastructure needs and issues, although it may not be applicable for all SICI's categories.

4.6.2 Infrastructure readiness assessment

SICI application identifies the lack of comprehensive digital infrastructure coverage in urban and peri-urban environments. Municipalities should prioritise the expansion of digital infrastructure, particularly in underserved areas. Ensuring full coverage of advanced sensor systems, communication networks (V2X), and real-time data sharing platforms will help bridge the gap in infrastructure readiness for connected and automated mobility (CCAM). The SICI framework revealed that data integration from different transport models and geographic systems could be improved.

Cities often struggle with developing infrastructure that can evolve with future advancements in automation and connectivity. Policymakers should focus on designing scalable infrastructure that can grow in sophistication as new CCAM technologies emerge. This includes deploying adaptable traffic management systems that can handle both human-driven and automated vehicles seamlessly. Following this, policymakers should advocate for better integration of digital systems across public transport, road authorities, and private mobility service providers. To overcome gaps in infrastructure readiness and to validate new technologies, local authorities should initiate pilot projects where SICI plays a major role in the assessment.

4.6.3 Continuous monitoring and evaluation of infrastructure readiness

Given the evolving nature of connected and automated mobility, local authorities should regularly monitor infrastructure readiness using the SICI framework. By establishing periodic evaluations, cities can identify any shortcomings in infrastructure and make data-driven decisions on how to prioritise upgrades. SICI could serve as a tool for setting benchmarks, monitoring progress, and refining infrastructure strategies over time. Cities should focus on both short-term and long-term planning by incorporating SICI assessments into the broader strategic transport planning process. This includes not only the immediate need for infrastructure upgrades but also the long-term vision of transitioning to fully automated transportation systems.

4.6.4 Aligning regulations with smart infrastructure goals

As SICI identifies varying levels of infrastructure readiness, policymakers should ensure that regulations are aligned with the progressive nature of smart infrastructures. Legal frameworks should facilitate the adoption of new technologies while ensuring data privacy, public safety, and the security of digital infrastructure. This might include updating traffic laws, vehicle certification requirements, and insurance policies to account for automated vehicles and smart road infrastructures. Given that infrastructure readiness is highly tied to the legal environment, cities should develop clear guidelines for how different levels of infrastructure readiness (as indicated by SICI) relate to legal requirements. These guidelines can guide infrastructure investments and ensure compliance with national and EU-level transport policies.

4.7 Validation from impact assessment

Introducing TANGENT tools within the transport models of TANGENT case studies, different key performance indexes were reviewed to support and validate the use of new technologies and policy framework supporting it. Considering the identified KPIs, there are 6 in TANGENT: reduction in congestion, reduction in pollution, reduction in accidents, behaviour change, cooperation with all actors, and information for decision making (for more information on the insights provided below in this subchapter, please refer to TANGENT deliverable D7.7).

In relation to the KPI on reducing congestion after the introduction of TANGENT tools in the transport model of Rennes, the indicator showed increase in number of cars along with increase in the average car speed (+28%). While for the average travel time, a reduction of 32% was observed. This shows how TANGENT tools supported in improving the overall traffic flow (though better signal and routing), which allowed more cars to be mobile during the peak hours, facilitating quick journeys through better coordination and optimised infrastructure. For Greater Manchester (GM), the impact of TANGENT Tools showed 5% decrease in travel time on regular days and 6% decrease on days with events. While the values were below 10%, they still showed the positive influence of TANGENT contributing towards better traffic flow. GM also had new factors of speed variability and junction performance within congestion reduction KPI. The utility of tools showed improvement in speed variability (9.15% for event days, and 5.6% for regular days), which shows how travel speeds will become more predictable when

implementing TANGENT solutions. On key traffic junctions in GM, 13.5% improvement in waiting times on normal days and 16% improvement on event days reflect the successful implementation of TANGENT handling busy intersections. Overall, these indicators reflect, successful reduction in congestion in GM, which can be further enhanced while implementing Dynamic Congestion Pricing (DCP). For Lisbon, there was no direct data on person-hours lost while Waze data (crowd-sourced) showed a reduction in delays and improved speeds suggesting progress towards congestion reduction. In Athens (which is a virtual case study), the travel times reduced by 14% overall (14% for cars and 35% for buses) exceeding the KPI target of 10, while harmonic speeds for all vehicles increased by 8% (below KPI target).

In addition, focusing on the KPI on congestion, variability in data sources (e.g., crowd-sourced Waze data vs. fixed sensors) may introduce inconsistencies. Noting these differences and their potential impact on accuracy is crucial prior to reaching any conclusion or providing recommendations.

Considering the KPI on reducing pollution after the introduction of TANGENT tools in Rennes, the CO2 emissions decreased by 6% during the peak hours. The reduced travel times and improved traffic flow support the overall reduction in the emissions. For Greater Manchester, TANGENT provides significant contribution in its yearly pollution reduction targets. On regular days, CO2 emissions were expected to drop by 4%, while a drop of 2% was observed for event days. For Lisbon, while there were no emissions data available, the traffic improvements suggest benefits while high vehicle count indicates that more measures are needed. For Athens, the CO2 emissions reduced by 23% (double the KPI target). Based on the KPI focusing on reducing accidents, the TANGENT tool had minimal effect on the road safety in Rennes. In contrast, for Greater Manchester, improvement in road safety was observed. The modelling in GM's traffic model showcased decrease of 6 traffic deaths on normal days and 4 for event days, which was supported by improvement in traffic flows. This reflects an approximate 10% reduction of all traffic deaths in a calendar year in Greater Manchester. In Lisbon, improvements in traffic flow and reduced delays suggest safer conditions, potentially leading to fewer accidents.

For the behavioural change KPI, while the results showed more car usage (+10%), they also reflected increase in public transport users (+17%). The models used for Rennes to assess the behavioural change didn't provide meaningful results on the background of new users. On the other hand, in Greater Manchester the optimisation of public transport results showed 3.4% increase in bus-kilometres made by people in the case study where 1/3rd of the new bus users were former car users. Hypothetically, this reflects how TANGENT can reduce the modal share of private vehicles by 1% and increase the modal share of public transport by 10%, contributing to GM's aim of increasing use of public transport by 10%. This suggests how diverse transport models are crucial for the validation of certain results (although at times they may present unclear results, as was the case in Rennes), and how cities should allow room for testing these technologies. In Lisbon, 49.2% of new bus users were observed which were former car users showing increased public transport use. In the virtual case study of Athens, car use decreased by 32%. For the KPI on cooperation with all actors, it was concluded that multi-actor cooperation remains a challenge in Rennes and Lisbon. Especially with Lisbon case study, the prioritised TANGENT functionality (insights from Stage 3 workshops) of *cooperative incident management – synchronised traffic control and public transport* confirms the added need to have a better cooperation between the diverse actors involved (For Manchester and Rennes case studies, the prioritised TANGENT functionality was *current state of traffic network*).

Considering the information for decision-making as a KPI, the city of Lisbon targeted informing public and decision-makers on at least 2 transport investments and developing tool to support planning for specific events (including simulations of 5 planned events). The TANGENT tools have not been used in decision-making process, due to lack of direct investment during the implementation phase of the project.

4.8 Insights from the Multimodal Traffic Management Roadmap on policy integration

The Multimodal Traffic Management (MTM) Roadmap outlines a comprehensive strategic vision aimed at transforming Europe's transport networks into multimodal, sustainable, and resilient systems. This aligns with the EU's goals for climate neutrality and resilience, while also preparing the transport sector for future challenges and opportunities. The Multimodal Traffic Management Cluster (MTMC), responsible for the development of the roadmap, is a collaborative initiative that brings together seven EU-funded Horizon Europe research projects focused on Multimodal Traffic Management (MTM): DiT4TRAM, FRONTIER, ORCHESTRA, TANGENT, SYNCHROMODE, DELPHI, and ACUMEN. MTMC aims to leverage the collective experience and expertise of these projects to address emerging challenges and seize opportunities in MTM through a collaborative approach.

The MTMC Roadmap outlines the critical role of policy integration in achieving effective multimodal traffic management (MTM). The focused approach on policy integration for traffic management in cities, incorporating insights from the roadmap includes developing cohesive EU-Wide standards and regulations, establishing an EU-Level Level of Service (LOS) framework for MTM, and training and skills development for Multimodal Traffic Management Centre (TMC) operators.

Developing cohesive EU-Wide standards and regulations:

Establishing cohesive regulatory frameworks across EU cities and regions is essential for MTM. This requires a baseline regulatory standard that harmonises traffic management and multimodal policies, enabling compatibility between local, regional, and EU directives. For instance, integrating standards such as DATEX II (for traffic data) and NeTEx (for public transit) can facilitate interoperability across city boundaries. The development of consistent Key Performance Indicators (KPIs) across the EU for traffic and transport efficiency, sustainability, and user satisfaction ensures that cities align on benchmarks for MTM success. These indicators can include measuring congestion levels, air quality impacts, and user satisfaction, promoting a performance-based policy framework. Furthermore, extending Sustainable Urban Mobility Plans (SUMPs) to include specific requirements for MTM integration is important. SUMPs should guide cities in implementing MTM strategies that reduce congestion and promote low-emission transport modes while ensuring that all urban nodes, especially those in the Trans-European Transport Network (TEN-T), align with EU climate neutrality and mobility goals.

Establishing an EU-Level Level of Service (LOS) framework for MTM:

Developing a unified Level of Service (LOS) framework that reflects different operational realities across EU cities is essential. This standard should adapt to local contexts—such as varying infrastructure capacities and transport mode availability—while maintaining core service quality benchmarks that promote multimodal traffic flow and safety. These LOS standards should include criteria that allow cities to tailor MTM solutions to meet local needs, addressing variations in traffic demand, infrastructure conditions, and multimodal requirements. Flexibility ensures that cities can implement MTM strategies effectively without compromising the overall EU objectives.

Training and skills development for Multimodal Traffic Management Centre (TMC) operators:

Common skills and competency standards for TMC operators across the EU will enable consistent and effective MTM operations. This includes expertise in real-time data analytics, multimodal coordination, and advanced traffic prediction techniques. Creating certification and training programs that validate core competencies will ensure that TMC operators meet a high standard of operational readiness. These programs should focus on using ITS, connected and automated vehicle management, and AI-driven predictive tools, which are essential for efficient MTM.

This policy integration framework, backed by targeted research, will help align city-level traffic management with broader EU goals for sustainability, interoperability, and resilience, as outlined in the MTMC roadmap.

5 Pathway through integrated MTM and SUMP approach

5.1 Analysis of key factors, challenges and requirements identified

The analysis of regulatory and planning frameworks across governance levels, as applied to TANGENT's case studies and supported by the reviewed research and literature, underscores the critical role that clear and comprehensive frameworks play in the successful implementation of Network Traffic Management (NTM) solutions taking a multimodal route. This analysis also highlights key challenges and gaps in current regulations, which need to be addressed to enable the effective deployment of NTM services.

Common Strategic Framework:
At local and regional levels, efforts to enhance the sustainability and multimodality of transport systems—by strengthening public transport and fostering complementarity and integration among different transport modes—require a high level of cooperation among involved actors. This is especially true for deploying cooperative traffic management through real-time decision-making and network optimization. Policies and strategies related to mobility planning can be instrumental in facilitating this multi-actor cooperation by setting common objectives and principles to guide decision-making and resolve conflicts. Additionally, governance structures, along with communication and engagement channels for cross-sectoral cooperation, form the foundation for the implementation of NTM services.

Stakeholders Landscape:
As noted, the implementation of NTM involves numerous actors, making close collaboration among them essential. The range of stakeholders is complex, including authorities responsible for traffic control operations, procurement, service maintenance, external advisors, infrastructure managers, vehicle manufacturers, national and European legislators, and even financial services (for tolling). Each service area imposes specific interconnection requirements, impacting collaboration needs. Additionally, the need to cover functional urban areas, often crossing administrative boundaries, and to enable cooperation among neighbouring municipalities and regions, underscores the importance of a broad planning framework that includes all relevant actors, both within and beyond these boundaries. While cities include initiatives to include multiple stakeholders, a framework including structured engagement and collaboration via co-creation and adaptations to new technologies and solutions is crucial.

Interoperability:
NTM involves integrating services across the entire transport ecosystem. For each subsystem, it is crucial to specify essential requirements and ensure technical compatibility. Interoperability is key to ensuring the effectiveness of NTM, particularly given the increasing interactions among different technologies and transport modes. While some cross-modal challenges have been addressed, others still pose significant obstacles to large-scale NTM implementation, challenges that could be overcome with clear and comprehensive regulatory and planning frameworks.

Human factor and travel behaviour:
Humans remain the most variable and unpredictable element in transport-related challenges. Disparities in needs, preferences, and constraints can lead to conflicts within the transportation system. Humans are also the most mistake-prone component of the network, making behaviour difficult to predict with certainty. In addition, accessibility concerns for people with physical impairments must be addressed. There are significant differences in cognitive capacity, decision-making abilities, attention levels, risk perception, and other psychological factors (Millonig & Haustein, 2020), which must be considered in NTM regulation and action planning.

Based on the learnings from WP3, the insights derived from (D3.4) indicate several factors that influence the selection of transport modes for users in TANGENT cities. The primary determinants across all studied cities were identified as the travel cost and the total duration associated with each mode of transportation. Additional significant factors included age, income, and satisfaction levels with public transport services. Specifically, in Athens, it was noted that whether the user travels during peak hours is a crucial parameter affecting their choice of transport mode.

Accurate predictions of modal split hold substantial potential to support policymakers and transportation planners in advocating sustainable transportation alternatives. By evaluating the impact of new services and traffic management strategies on travel demand for various transportation modes, these predictions can aid in identifying the factors influencing commuter behaviour and designing effective strategies accordingly.

Smart infrastructure classifications
To facilitate the transition to cooperative, connected, and automated mobility (CCAM), it is essential to establish standardized procedures for assessing infrastructure capabilities. One such procedure involves defining classification schemes to evaluate the maturity, readiness, or support that infrastructures can provide for CCAM. These classifications serve multiple purposes: they inform end-users, assist operators, and help authorities and policymakers in planning the development of CCAM. Additionally, as smart infrastructures become more widespread, these standardized approaches are critical for infrastructure management by guiding future infrastructure improvements and investments to support higher levels of automation and advanced use cases.

TANGENT's SICI provides an innovative pathway via classification of infrastructure through six categories which helps in assessing the infrastructure for accommodating CCAM for an area's mobility environment.

Harmonised regulatory and legal frameworks:
Research and past experiences (GECKO, 2019) demonstrate the need for a European framework for regulating disruptive mobility innovations. Such a framework would guide national governments and local authorities in developing their regulatory systems and harmonizing standards for testing new mobility services, technologies, platforms, and infrastructure. A unified policy agenda and relevant regulatory directives are critical for assessing the impacts of mobility innovations at economic, environmental, social, and organizational levels, as well as for facilitating the exchange and transfer of findings and lessons learned. Current efforts on the national level to test services such as AV services and their integration with public transport require harmonised regulations at the international level for a standardised rollout of the technology, complying, for example, with road safety and signalisation standards across countries.

At national and international levels, harmonized and holistic legal frameworks are crucial for the successful implementation of NTM in urban and regional environments. Data management norms, for instance, define clear regulations at the local level and provide conditions for testing innovative technologies and services (through pilots and living labs). A legal framework is also essential for addressing liability issues related to cooperative traffic management services, including data ownership and reliability.

Data governance:
As the analysis has shown, addressing the lack of data interoperability and governance will be crucial to fully exploiting the benefits of NTM. Harmonized frameworks at both national and European levels can ensure that stakeholders safely exchange data while respecting security and privacy requirements. Firstly, in order to create NTM, data must be shared between different stakeholders, which currently is still a difficult element of discussion between stakeholders. The interoperability of data, especially between different transport modes, creates another challenge. Currently, there exists high granularity

in terms of data formats and content which might require a change in practices among some of the key players. A key data-related issue remains data processing in the light of GDPR. The lack of data interoperability issue must be addressed to exploit properly the data and exchange them with the stakeholders (service providers, traffic management centres and end-users). As identified by GECKO, "this governance of data is of key importance and rather urgent to avoid self-governance. Moreover, data sharing and access to data are big questions, treated differently across EU Member States. These raise significant sensitivities amongst transport operators, both in terms of impact on their business of opening such data and in terms of costs associated with the data gathering and compatible data formats". The discussions with local actors at each TANGENT site on data governance constitute a valuable experience towards this goal.

Furthermore, support from national and international levels also has vital importance in relation to the allocation of resources and guidance towards the harmonisation of research efforts. Funding service testing and implementation, through a clear planning and policy framework at the EU/national level, is a key factor for the further development of NTM solutions, as well as expert guidance and capacity-building activities for local planners and operators.

Transition to Multimodal Traffic Management:
As the regulatory frameworks, data governance standards, and collaborative approaches evolve, NTM will naturally transition into Multimodal Traffic Management (MTM). This shift reflects the growing complexity of transport systems and the need to integrate multiple transport modes—public transit, private vehicles, cycling, walking, and emerging modes like electric scooters—into a cohesive management strategy. MTM builds on the foundations of NTM but expands to ensure seamless coordination across all transport modes, promoting sustainability, efficiency, and multimodality in urban and regional traffic systems. This transition highlights the future focus of traffic management, where managing multiple interconnected transport modes is key to achieving long-term urban mobility goals.

5.2 Integration of MTM and SUMP processes

Multimodal Traffic Management (MTM) and Sustainable Urban Mobility Planning (SUMP) are both key approaches to improving urban mobility, and they can complement and support each other in various ways. The table below shows how they relate and support each other:

Table 2: Integrating MTM and SUMP perspectives

Approach	MTM perspective	SUMP perspective	Integration / Support
Holistic and Integrated Approach	MTM focuses on the coordination and management of multiple modes of transport (e.g., walking, cycling, public transport, cars) in real-time to ensure smoother flows, safety, and efficiency.	SUMP is a strategic approach to planning urban mobility that focuses on long-term sustainability, increasing the share of greener transport modes.	MTM can provide the real-time operational backbone that complements the strategic goals of SUMP. While SUMP provides the framework for shifting to sustainable transport, MTM ensures the day-to-day functionality and smooth operation of the multimodal transport system.
Encouraging Multimodal Choices	MTM facilitates this shift by providing integrated traffic management solutions that coordinate different transport modes, including real-time information about route choices, service	It emphasizes building infrastructure and policies that make multimodal travel accessible and attractive.	MTM helps achieve SUMP goals by making multimodal transport systems more reliable, efficient, and user-friendly, thus encouraging more people to adopt sustainable travel options.

Approach	MTM perspective	SUMP perspective	Integration / Support
	availability, and disruptions.		
Real-time Data for Planning	MTM relies heavily on data collection and analysis in real-time to optimize transport flows across different modes. This data includes traffic conditions, public transport schedules, micromobility flow, and environmental conditions.	SUMP benefits from these data by using it for evidence-based decision-making. Planners can use traffic and mobility data from MTM to identify patterns, bottlenecks, and areas where new interventions are needed (e.g., creating bike lanes or expanding public transport services).	By feeding real-time data from MTM into SUMP processes, planners can better monitor, evaluate, and adapt their strategies to achieve more sustainable outcomes. This ensures that planning decisions are responsive to actual traffic and mobility conditions.
Promoting Accessibility and Equity	MTM can enhance this by integrating services in a way that improves accessibility, for example, by ensuring that traffic management systems are designed to accommodate the needs of vulnerable road users, providing real-time travel information in accessible formats, or ensuring that public transport is given priority in heavily congested areas.	SUMP is often concerned with ensuring equitable access to transport across all demographics, ensuring that different groups (e.g., elderly, disabled, low-income residents) have access to affordable, safe, and efficient transport options.	MTM can be designed to ensure that the SUMP's equity and accessibility goals are met, by making sure transport management systems cater to all users, particularly those relying on public or active transport.
Resilience and Adaptability	MTM helps by providing the flexibility and adaptability needed in real-time to respond to such challenges. It can reroute traffic, adjust public transport schedules, or promote certain modes to maintain mobility in changing conditions.	SUMP incorporates long-term plans for urban mobility, but it also needs to be flexible and resilient to changes such as new technologies, population growth, or unexpected events (e.g., pandemics, natural disasters).	By providing adaptive traffic management systems, MTM ensures that urban mobility systems can remain functional and resilient, aligning with SUMP's long-term flexibility and resilience objectives.
Reducing Congestion and Emissions	MTM plays a direct role in reducing congestion by optimizing traffic flows, reducing delays, and balancing demand between different transport modes. It can also prioritize sustainable modes, such as giving public transport priority at intersections.	SUMP typically includes goals for reducing traffic congestion, improving air quality, and lowering greenhouse gas emissions by promoting sustainable transport modes and reducing private car use.	By improving the flow and coordination of public and active transport, MTM helps reduce the need for car travel, supporting SUMP objectives to reduce emissions and congestion.
Public Engagement and User-Centered Mobility	MTM enhances this by providing real-time information and feedback systems that make travel easier and more predictable for users. Apps, displays, and notifications can inform	SUMP involves public participation in its planning processes to ensure that the mobility needs of citizens are considered. It also focuses on improving the	By providing user-friendly interfaces and real-time updates, MTM can improve public satisfaction and engagement, supporting the SUMP process in creating a mobility system that people want to use.

Approach	MTM perspective	SUMP perspective	Integration / Support
	users about the best transport options based on current conditions.	user experience of the transport system.	

Multimodal Traffic Management and SUMP processes are highly complementary. While SUMP offers a strategic, long-term vision for sustainable mobility, MTM ensures that this vision is practically realized in the day-to-day operation of urban transport systems. By supporting one another, they can work together to create an efficient, sustainable, and user-friendly mobility system.

5.3 Next steps

The large-scale deployment of intelligent and interoperable traffic management solutions like NTM has been acknowledged as the key to maximizing the infrastructure capacity and reducing negative externalities of road transportation. TRIMIS indicated 6 European Technology Platforms that can enable further opportunities and are specifically applicable to NTS: The Single European Sky Air Traffic Management Research (SESAR); The advanced signalling and Rail Traffic Management System (ERTMS); The Safe and Secure Maritime Traffic Monitoring and Information System (SafeSeaNet); The Real-Time River Traffic Information System (RIS); The Cooperative Intelligent Transport Systems (C-ITS); Galileo (The European Global Navigation Satellite System).

The analysis of applicable planning and regulatory frameworks in TANGENT's case study sites sets a baseline for the strategic discussions and actions in the preparation and implementation of each case study (WP7), as well as the assessment of its results and subsequent identification of lessons learned and policy recommendations (WP8).

The challenges and requirements identified in this document for planning and regulatory frameworks for NTM services, together with the assessment of applicable context at each site, served as guiding elements for the case studies preparation and deployment as a follow-up during and after the project. The policy goals and strategic objectives for future mobility at each case study site, as well as the limitations and conditions set by applicable regulations, provide the framework for the further definition of TANGENT's case studies (e.g. scope, KPIs).

6 Conclusions

This deliverable, being the second release, provides analysis of the planning and regulatory framework in each TANGENT city, as well as at national and EU levels, towards the effective integration of Network Traffic Management solutions and multi-actor cooperation models in local sustainable urban mobility planning processes.

It presented an overview of the SUMP concept as a planning tool and how it can enable an integrated approach towards the implementation of innovative NTM solutions. It revealed several pivotal insights that highlight both the opportunities and challenges of implementing Network and Traffic Management. Primarily, the successful deployment of NTM depends on adaptable, scalable policy frameworks that address the evolving dynamics of urban mobility. By integrating MTM approaches, cities can better coordinate among diverse transport modes, ultimately supporting reduced congestion, lower emissions, and enhanced user experiences. Key enablers identified include robust data governance, cross-sector cooperation, and flexible regulatory structures that allow for agile response to technological advancements and evolving urban challenges.

Data governance is recognized as a cornerstone for effective NTM systems. The need for interoperable data, managed through robust governance frameworks, was emphasized throughout the report. Data-sharing protocols that protect user privacy and ensure data quality are essential for real-time decision-making and effective forecasting. Investments in digital infrastructure, such as IoT and AI capabilities, can significantly amplify the value of NTM by enabling predictive analytics and seamless multimodal coordination.

The importance of a multimodal approach that aligns with Sustainable Urban Mobility Plans (SUMPs) is a recurrent theme. MTM systems provide cities with the flexibility to balance and optimise different transport modes, supporting broader SUMP objectives. Real-time information platforms, integrated with MTM, can facilitate user engagement, providing citizens with up-to-date travel options and enhancing public satisfaction. Public involvement in the planning process is critical to tailor MTM strategies to community needs and foster acceptance of new policies and technologies.

For NTM systems to be viable long-term solutions, adaptive policy frameworks are crucial. The integration of adaptive scenario planning, as observed in cities such as Rennes and Manchester, allows urban areas to prepare for unforeseen events while maintaining service continuity. Regulatory flexibility also encourages cities to experiment with pilot programs, thereby reducing risk and allowing for scalable solutions that can evolve as new mobility needs arise.

Considering these findings, several strategic recommendations are suggested (including but not limited to):

Establish Robust Data Governance: Developing comprehensive data governance frameworks that address privacy, interoperability, and real-time data integration is essential. Ensuring adherence to GDPR and similar standards can foster trust among users and stakeholders.

Classification of infrastructure through standardised approach*:* Classification approaches for smart infrastructure, such as TANGENT's SICI, can assist in infrastructure management by providing guidance for planning future infrastructure improvements and investments to accommodate higher levels of automation and advanced use cases.

Promote Interagency and Public-Private Collaboration: Effective MTM requires coordinated efforts among public agencies, private sector partners, and the community. Establishing a central governance body for NTM can facilitate efficient decision-making and help resolve cross-sectoral challenges. In addition, the transition to smart infrastructure requires significant investment and expertise from both

the public and private sectors. Leveraging public-private partnerships (PPP) to fund and implement SICI-based infrastructure projects could help local authorities accelerate infrastructure upgrades while ensuring they remain flexible and future-proof.

Align MTM with SUMP Objectives: Integrating MTM solutions with SUMP goals ensures that traffic management strategies contribute to broader urban sustainability objectives, such as reducing car dependence, improving public transit, and minimizing environmental impact.

Enhance Public Engagement through Real-Time Information: Providing accessible, real-time information platforms empowers citizens to make informed travel choices, encouraging greater use of public and active transport options.

Assessing crucial factors influencing travel behaviour: In TANGENT cities, travel cost and total duration are the main determinants of transport mode choice. Other significant factors include age, income, and satisfaction with public transport. In Athens, peak hour travel is a key factor. Precise modal split predictions can help policymakers and transportation planners promote sustainable alternatives. Evaluating new services and traffic management strategies helps identify commuter behaviour drivers and design effective strategies.

Foster Policy Flexibility for Innovation: Adaptive regulatory frameworks enable cities to accommodate new technologies, such as autonomous vehicles and AI-driven traffic management, while minimizing disruption to established systems.

This deliverable provides framework for cities aiming to establish or enhance their NTM capabilities, emphasizing that successful implementation hinges on collaboration, robust data frameworks, and policies adaptable to future technological advancements.

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