TANGENT

MULTI-ACTOR COOPERATION MODELS FOR NTM. FIRST RELEASE

D1.3

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Executive summary

The first release of D1.3 reports on the analysis of multi-actor cooperation models for innovative network traffic management (NTM), considering the system's architecture and operation, to develop optimal cooperation models and provide recommendations towards effective governance structures for network traffic management in the TANGENT case studies cities.

One of the key objectives of the TANGENT project is to propose multi-actor cooperation models for optimizing and controlling the dynamics of traffic and demand and adapting to the evolving complex multimodal transport setting with innovative network traffic management.

Based on the literature review conducted in D5.1 "Analysis of current approaches in optimization of transport network management" related to negotiation and arbitration models for transport network management, this deliverable aims at identifying the case studies current multi-actor cooperation mechanisms in place and the ones that could be tested in TANGENT. It also reflects on data governance aspects of multi-actor cooperation, further developed in D2.2 "Data-sharing governance model".

Keywords

Multi-actor cooperation, arbitration models, data sharing, network traffic management, cooperative decision-making, data governance

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List of abbreviations and acronyms

Acronym	Meaning
ANRC	Autoridade Nacional de Segurança Rodoviária
ASAP	As Soon As Possible
B2B	Business-to-business
B2C	Business-to-Consumer
COP	Common Operational Picture
EC	European Commission
GA	Grant Agreement
KoM	Kick-off Meeting
KPI	Key Performance Indicator
LoS	Level of Service
NTM	Network Traffic Management
SUMP	Sustainable Urban Mobility Planning
WP	Work Package

1 Purpose of the deliverable

1.1 Attainment of the objectives and explanation of deviations

This deliverable aims at providing a first definition of which multi-actor cooperation would take place in TANGENT and highlight the cooperation preferences of each case study city and their stakeholders.

TANGENT implementation requires several shapes and forms of multi-actor cooperation. The development of the TANGENT tool requires stakeholder cooperation to share, harmonise and manage data but also network traffic management (NTM) planning to define common goals, targets and indicators (e.g. Key Performance Indicators) to monitor the success of the tool implementation. Multi-actor cooperation is also essential to the development of response plans and the selection of different scenarios, which would involve the development and selection of an arbitration model for decision-making. The implementation of the selected measures as part of the testing of the TANGENT tool also requires close cooperation among the different local stakeholders. Finally, multi-actor cooperation would ensure the long-term exploitation and use of TANGENT services and findings.

To define the forms of cooperation taking place as part of TANGENT tool development and implementation, a set of workshops with the three case studies cities – Lisbon, Manchester and Rennes – were held with the local stakeholders. This aimed to better understand the local realities – needs and challenges - in terms of cooperation and the stakeholders' preferences to implement cooperation mechanisms and arbitration models. Since Athens is a virtual case study, multi-actor cooperation was not considered for the implementation of the TANGENT tool for this case.

As mentioned in D1.2 "Network Traffic Management needs assessment and system requirement", the stakeholder engagement process has been slightly adapted to incorporate an additional set of workshops to define the system requirements (Stage 2.1 workshops) and therefore delayed the workshops originally planned on multi-actor cooperation by a few months (stage 2.2. workshops). This change in the stakeholder engagement plan is highlighted with the example from Manchester in Figure 1.

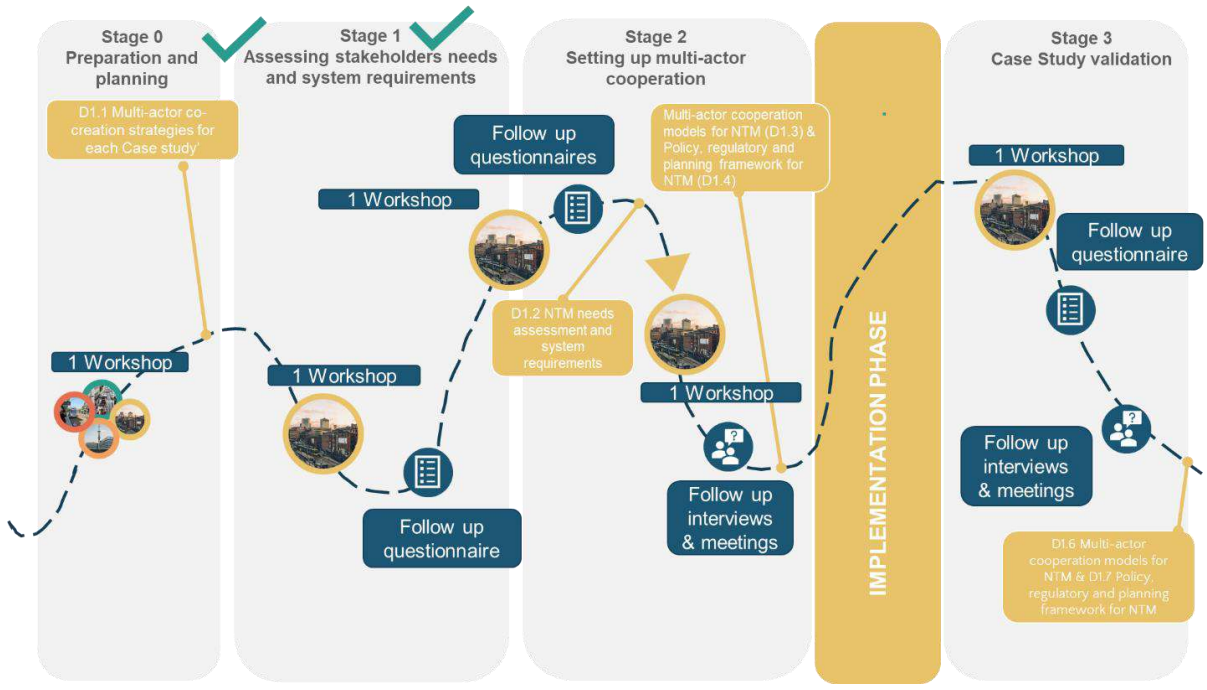


Figure 1: Example of the adapted stakeholder engagement plan for Manchester

1.2 Intended audience

This deliverable is mainly intended for internal tangent partners, case study stakeholders, and cities implementing multi-actor cooperation processes and mechanisms to improve their network traffic management. Researchers in market collaboration studies could also be interested in this deliverable.

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

This deliverable is structured in five chapters. After this introduction in chapter 1, chapter 2 looks into the background for multi-actor cooperation in TANGENT; first through a literature review and identification of key success factors from international experiences, and second, by assessing the cooperation requirements from related tasks in the project. Chapter 3 describes the methodology followed for the discussion and set-up of multi-actor cooperation models in WP1, and chapter 4 presents the results of these analyses with each case study site. Finally, the conclusions and next steps are presented in chapter 5.

This deliverable is directly linked to WP2 in terms of data sharing governance and cooperation, WP5 in terms of optimization of transport network management within a multi-actor setting, and WP7 in terms of the tool implementation in each case study cities and the stakeholders' engagement during that phase.

The literature review carried out in D5.1 *"Analysis of current approaches in optimization of transport network management"* on the negotiation and arbitrations models for transport network management, provides practical guidelines that delineate the development of a consensus-reaching mechanism, discussing its objective, scope, the domain of application, stakeholders, data needs and modelling approach, and how they will be applied in the context of the TANGENT project, will be used in this deliverable D1.3. D5.1, by discussing different consensus definitions, reviewing traditional approaches to selecting optimal solutions and discussing state-of-the-art decision-making approaches, provided the first basis for discussions with local stakeholders in preparation for D1.3. On the other hand, D1.3 aims to identify in detail the means of cooperation based on the research conducted in D5.1.

Workshops held in preparation for D1.3 will contribute some input to provide the governance model for the strategic and operational management of the data layer of the TANGENT solution.

Some of the information gathered in D1.3 should provide some input for WP7 and the elaboration of D7.1 "*Definition of the Case Studies, testing methodology and stakeholders' & users' engagement campaign*", and will also provide some very useful insights on stakeholders' opinions about cooperation the development of arbitration models and the consensus reaching mechanism in Task 5.4 (WP5).

2 Background for multi-actor cooperation

Within this strategic objective, essential elements are (1) the orchestration and coordination of the different transport modes and systems for synchronising and optimizing the overall transport network, (2) and how these efforts can deliver new models and techniques to support efficient traffic operations in the multimodal transport network dynamically and adaptively.

To achieve these goals, the project is conducting a multi-actor co-creation process, bringing together key stakeholders, at each case study site (see D1.1 Multi-actor co-creation strategies for each case study). It is the involvement of local stakeholders that enables the project to find suitable solutions to coordinate transport services and optimise traffic. Moreover, it allows the establishment of cooperation structures and a governance model to support the continued exploitation of TANGENT services and improved Network Traffic Management solutions during the project's implementation and testing phases.

Some of the key challenges in this coordination exercise are the implementation of decision-making mechanisms (arbitration models) and the definition of cooperative actions to optimise traffic conditions, the sharing and management of the required data, according to directives and regulations external to the TANGENT project, and the establishment of effective communication and cooperation structures.

This chapter takes stock of existing research and good practices to guide multi-actor cooperation in urban mobility and looks in more detail into the project's implementation requirements and conditions for multi-actor cooperation models, highlighting key elements from the assessed transport optimisation and consensus-reaching mechanisms.

2.1 Key success factors

As proposed by the Sustainable Urban Mobility Planning (SUMP)[1] concept and methodology, strong cooperation, coordination, and consultation across different levels of government and between institutions are essential for successful mobility planning, implementation, and operation[2]. Data-based decision support systems can significantly boost agile cooperation by setting a common understanding of the priorities and challenges to be addressed and defining a transparent approach towards action planning and conflict resolution. To this end, transport authorities and stakeholders see big potential in establishing data-sharing strategies across Functional Urban Areas, aiming to reach standardised procedures, integrated analysis of the information, and exploitation of open-data sources. It is also important to develop the necessary capacities and institutional framework to support data collection efforts, including regulations and data management systems (addressing safety and privacy issues).

How can such multi-actor cooperation be achieved? What are the main factors to consider in developing suitable models to support long-term cooperation?

[1] Sustainable Urban Mobility Planning is Europe's de facto urban transport planning concept. The policy that facilitated its establishment has been systematically developed by European policymakers since 2005. Its most important milestone was the publication of the Urban Mobility Package at the end of 2013.

[2] The concept is further defined in D1.1 in relation to the TANGENT project.

Existent research and experiences (Bryson et al., 2009) have identified a few key elements to enable successful multi-actor cooperation, including:

- Ensuring a common understanding of the background and context of the cooperation
- Developing effective processes, organisational structures, and governance models
- Providing a clear definition and understanding of the tasks and roles of each actor
- Considering key competencies and resources needed
- Creating an outcome-oriented monitoring and evaluation system

The following subsections describe each of these success factors and their relevance for TANGENT.

2.1.1 Ensuring a common understanding of the background and context of the cooperation

As described, cooperation among multiple actors involved in Network Traffic Management in TANGENT entails, not only a level of information sharing and regular communication but also the coordinated implementation of traffic management measures and consensus-reaching mechanisms, while addressing conflicting trade-offs and priorities.

Yet, to address these challenges, it is first essential to ensure a common basis of understanding across all involved stakeholders. The background for the cooperative action should be clear, including the current state of mobility conditions in a city, the identification of problems to resolve and constraints of existing mobility services, and the strategic goal of the cooperation. The analysis of the context conditions, assessment of resources available, and definition of a common work plan enable actors to actively engage in the cooperative effort.

2.1.2 Developing effective processes, organisational structures, and governance models

To overcome, among common challenges in multi-stakeholder cooperation are an as large diversity of actors, low levels of integration and communication, and conflicting interests. To overcome these, cross-sector collaboration efforts can be applied. These require powerful sponsors, a variety of linking mechanisms, formal and informal networks, well-structured processes and governance models.

The procedural aspects of collaboration define the channels, timing and format of the communication and cooperation to take place, bringing individuals together in a structured way. Organisational structures establish the conditions for long-term cooperation by defining the interrelations, dependencies, and a basis for the assignment of roles among stakeholders. Furthermore, addressing governance involves both setting up formal and informal mechanisms and influences to manage collaboration activities. In this way, it addresses the ‘governing’ of processes and activities performed by the actors (Bevir, 2013).

Governance is of particular relevance for Network Traffic Management, given the need for data to be shared across institutional and departmental borders, and for cooperative actions to be managed transparently and effectively. There are generally three main governance and coordination mechanisms identified in classic governance theory (Veeneman et al, 2018): hierarchy, market and network models. In practice, governance structures involve different combinations of these three mechanisms.

The hierarchical model focuses on the idea of control and dependency as main instruments. The market network mechanisms emphasise reciprocity among actors, through the creation of added value and enhancement of user experience (market) or by cooperation-driven mutual dependencies (networks) (De Bruijn & Ten Heuvelhof,2010). Each of these mechanisms has specific strengths and challenges, which need to be identified and analysed to enable the design of suitable multi-actor cooperation models for Network Traffic Management in TANGENT.

For instance, hierarchical behaviours can facilitate the implementation of common standards (e.g., data format) or set conditions to promote (or enforce) cooperation among involved actors. Market mechanisms have the risk of resulting in monopolistic behaviour or creating conditions of intense competition, which can restrict cooperation and have other negative consequences. In the field of urban mobility data, such behaviours could prevent sharing and cooperative action, or lead to problematic data usage (e.g., disregarding privacy). On the other hand, in a suitable institutional context, market motivations can support the development of more effective solutions. Then, networks build relations based on mutual benefits, which can help drive cooperation and knowledge exchange.

2.1.3 Providing a clear definition and understanding of the tasks and roles of each actor

Through the involvement of key stakeholders in the decision-making process, cooperation can be exploited to improve urban transport systems and realise TANGENT's strategic objectives. Such participative approaches can also help better address local stakeholders' needs in planning and managing transport network systems and increase their accountability and task ownership. The realisation of these advantages requires the formalisation of the multi-actor participation processes, with clearly identified roles, tasks, and priorities, establishing a baseline for the identification of consensus mechanisms that ensure common responses to arising issues.

2.1.4 Considering key competencies and resources needed

Other crucial elements to conducting successful multi-actor collaboration are the supporting skills and capacities, as well as the resources and technologies. It is important to analyse all available (human, institutional, financial) resources to plan and conduct the cooperation process, and to set up appropriate working and participation structures to make efficient use of such resources.

For instance, digital infrastructure and data management, key elements for the successful implementation of NTM services in TANGENT, are meant to enable better governance of the urban mobility ecosystem, but can also serve as a key tool to support cooperation among actors, enabling real-time communication and information sharing.

2.1.5 Creating an outcome-oriented monitoring and evaluation system

Finally, successful cooperation should have a comprehensive monitoring and accountability system. Such effort build on a thorough assessment of the current and future performance of the transport system. To do this, specific objectives and ambitious but realistic targets should be identified (and agreed upon with all involved actors) and define performance indicators for each of these should be defined. Progress towards the objectives of the plan and meeting the targets are assessed regularly based on the chosen performance indicators, and corrective measures can be taken, if needed.

The validation of all actors concerning the guiding principles and objectives of the process, as well as the indicators which will measure the success of the endeavour, is fundamental for the establishment of consensus-reaching mechanisms or arbitration models.

2.2 Towards multi-actor cooperation in TANGENT

Considering the above-described methodological background for multi-actor cooperation, this section will analyse the specific tasks in the TANGENT project which entail active cooperation among local stakeholders, aiming to identify the project's requirements and needs for multi-actor cooperation models which lie mainly in the services optimizing network traffic management.

2.2.1 Optimisation of network traffic management in TANGENT

It is important to involve stakeholders in the decision-making process instead of following a top-down approach to improve network traffic management. Stakeholder participation and consensus can lead to better prediction of ex-post stakeholder responses, foster trust and cohesion between the involved entities and maximize the quality of decision-making (Knoppen et al., 2021). Cooperation among different stakeholders can, however, be far from seamless as pre-established interests, power imbalances, the conflict between private and public actors, institutional "lock-ins", interest to defend the status quo and different professional backgrounds of stakeholders can render communication and reaching consensus difficult (Hrelja et al., 2020).

To address these issues, *D5.1 "Analysis of current approaches in optimization of transport network management"* provides an overview of numerous decision support systems to help decision-makers deal with circumstances where there are numerous potential solutions to a problem and none of them is objectively better than the others, so decision-makers preferences need to be considered to choose between them. D5.1 highlights that for stakeholder cooperation to be successful in the context of urban traffic management, it must be the result of conscious stakeholder intentions of "goals" and such (higher) goals typically include a combination of increasing travel network (operational and economic) efficiency and safety, protecting the environment etc., and they usually come down to more specific, preferably quantitative, objectives.

The fusion of individual beliefs into a collective, consensus-based group opinion, can lead to the identification of the characteristics of the set of near-optimal solutions and to a selection of alternatives possessing the most fitting attributes for attaining the stakeholder's objectives. In the case of TANGENT, decision-makers could choose the optimal configuration of pricing, operating, regulatory and service policies that will lead to the attainment of their collective objectives.

2.2.2 Guidelines for the development of a consensus-reaching mechanism

This section summarises and further links to the case studies, and the guidelines detailed in D5.1 on how to develop a consensus-reaching mechanism.

2.2.2.1 Objectives

As highlighted in D5.1, within TANGENT, solutions for transport optimization procedures are the result of the different possible configurations of the system services and sub-services, responsible, among others, for congestion pricing, the synchronization of transit and traffic, the synchronization of on-demand and transit modes etc. These services are considered to be separately active within the system and their combination leads to the optimal transport network conditions. Since the possibilities of configuring the decision variables within each service have a wide range, the possible configuration of the multiple decision variables belonging to multiple services gives rise to multiple solutions regarding the parametrization of the overall system. Each combination of system parameters should be evaluated by its ability to respond to several objectives defined by each case study in D1.1 and D1.2. Thereby, the multitude of possible system parametrizations gives rise to a different "cloud" of solutions containing a quantitative depiction of these objectives' performance.

Ideally, this cloud of solutions is Pareto-optimal, meaning that it is not possible to increase performance in one objective, without decreasing the performance in a different one. This solution cloud is potentially very large and, therefore, there is a need to select a smaller number of solutions (ideally one) from within it. The chosen solution must lead to optimal performance in the objectives that matter the most to stakeholders. The consensus mechanism that will result from Task 5.4 will aim to find an unbiased consensus among stakeholders regarding the importance of each objective.

2.2.2.2 Levels of decision-making

D5.1 distinguishes between three levels at which the consensus-reaching mechanism could be integrated/activated, corresponding to the major types of decision-making and planning:

- a strategic level
- a tactical level
- an operational level.

Depending on the level of decision-making, the function of the mechanism could be substantially differentiated. Depending on the decision-making level, the granularity of the data/information needed to reach a consensus is significantly different and ranges from information about strategic objectives that are valid for many years to information valid only for the event necessitating the consensus. Information on each case study cooperation preference for each of these levels of decision-making was identified as part of WP1 activities and is defined in the next section.

2.2.2.3 Application Domain

As mentioned in D5.1 the form of the consensus mechanism can vary depending on the application domain, with a potential area of application in TANGENT in the creation of response plans, aiming at optimizing network behaviour by orchestrating the network's recovery process from minor or major network disruptions. Three potential domains were identified as potentially needed stakeholder consensus:

- A consensus related to the triggering mechanism of the response plan
- A consensus related to the content of the response plan
- A consensus related to both network-wide and corridor-specific priorities

2.2.2.4 Stakeholders

Stakeholders in the decision-making process in TANGENT will correspond to operators, transport authorities, representatives of the private sector, public institutions and levels of government, etc. Depending on its institutional role and areas of responsibility, each stakeholder must meet multiple objectives spanning all decision-making levels. Every stakeholder has preferences, representing trade-offs between different objectives and preferred courses of action. An accurate portrayal of these individual preferences is thus crucial when seeking a consensus among stakeholders, which has been part of WP1 activities and developed under D1.1, D1.2 and D1.3.

In D5.1, TANGENT partners have identified critical stakeholders as those who have the responsibility to implement or block decisions regarding the parts of the transport network system that falls under their jurisdictions, and/or stakeholders who possess significant expertise and impact on decisions affecting those parts of the network. These stakeholders have been actively contacted and engaged with as part of WP1 activities and workshops. This distinction between critical and other stakeholders should also be reflected in the evaluation of their preferences, with the key intuition being that more important stakeholders must be more influential in the consensus-reaching process.

2.2.3 Preference data requirements and data governance models

In D5.1, two data sources as the input of the consensus-reaching mechanisms are being defined, one being the aforementioned cloud of solutions, and the other being a quantitative depiction of stakeholders' preferences. The solution's cloud would ideally result from the simultaneous optimization of TANGENT services, which falls under T5.1, T5.2 and T5.3. The consensus-reaching mechanism will provide the framework for collecting, documenting, quantifying and assessing stakeholders'

preferences. The preference data will be represented by utility values, preference relations or rankings or similar structures able to capture stakeholders' priorities in a quantifiable way. This exercise has been started as part of WP1 activities, through workshops and questionnaires.

The data output of the mechanism will have the same ontology as the initial cloud of solutions, but the solution will be drastically reduced, containing only options that are compatible with stakeholders' preferences.

3 Methodology

Following the SUMP planning principles and concept (Rupprecht Consult, 2019), TANGENT has designed a stage-wise approach for its multi-actor co-creation processes. Each stage addresses key aspects of TANGENT's multi-actor cooperation towards optimal Network and Traffic Management, as illustrated in Figure 2.

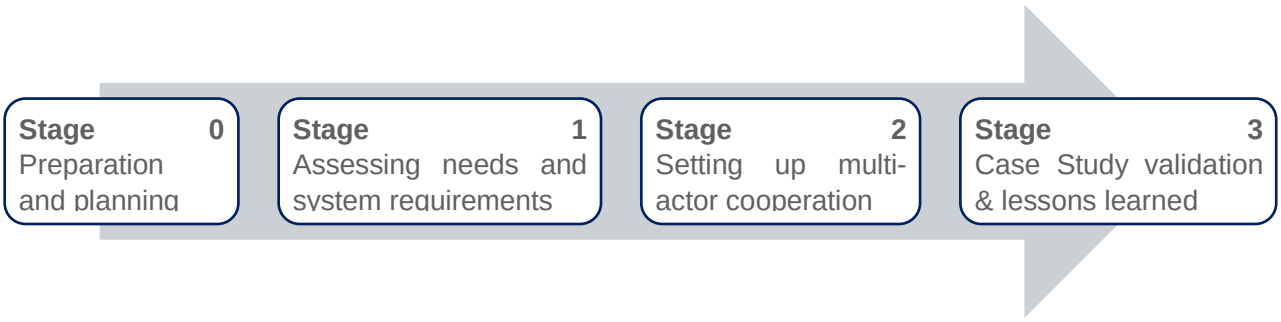


Figure 2: WP1 stakeholder engagement process

All four stages have been detailed in deliverable D1.1. Stage 0 and Stage 1 helped case studies further define their use cases and start the process of stakeholder engagement. Stage 2 of the multi-actor co-creation process focuses on setting up the conditions and structures for efficient multi-actor cooperation, guiding partners to work with local stakeholders and cooperatively analysing the organisational, governance and operational structures of its transport networks. To adapt to the need of the project, 6 workshops were held under stage 2: Stage 2.1 consisted of 3 workshops with Rennes, Manchester and Lisbon to further define the needs and system requirements; Stage 2.2 consisted of 3 workshops with Rennes, Manchester and Lisbon to further discuss multi-actor cooperation in TANGENT.

In this way, the co-creation stage aimed to discuss multi-actor cooperation for innovative Network Traffic Management for each pre-defined scenario (e.g. a flood in a specific city), including a joint analysis of the organisational, governance and operational, structures, as well as the capacities and resources needed for efficient cooperation in the NTM implementation. In addition, the co-creation stage intended to assess the required information sharing and visualisation preferences for solutions, reviewing information flows and data-sharing needs for the described scenarios and NTM models.

And it does so, by building on the results of the system and stakeholder needs assessment. It allowed TANGENT to analyse the service model and multimodal integration to be tested in each case study and assess the functional, operational and technical requirements of the multi-modal network management, including infrastructure (physical and digital), expected impacts on each scenario and potential solutions.

3.1 Approach

To develop this deliverable and these workshops, we have designed and developed a specific methodology, consisting of linking to other activities taking part in the project, namely from WP2 and WP5. The developed approach, built up on consists of the three steps defined below.

The first step of this approach was to follow up on D1.2 "Network Traffic Management needs assessment and system requirement" with a further definition of each use case, their requirements and TANGENT service implementation plans. This aimed at enabling the assessment of roles and tasks for each stakeholder involved in the use cases, for the data requirements to be identified and for the topic of data governance to be addressed. Hence, D1.2 and discussions taking place in Stage 2.2 workshops

also contributed to D2.1 “Data requirements and available data sources” and D2.2 “Data-sharing governance model”.

The second step of this approach was to gather information on multi-actor cooperation which was already discussed with the stakeholders as part of WP1 activities. This has been addressed via WP1 workshops and questionaries already in Stage 1 of WP1 workshops and through the WP1 questionnaire sent in advance of Stage 2.1 workshops to assess system needs and requirements. The questionnaire aimed at identifying multi-actor cooperation needs and preferences for each of the use cases and assessing how each city currently makes decisions on network traffic management and what level of cooperation exists. The questionnaire contained 9 questions about multi-actor cooperation, covering the topics of likeliness and willingness to cooperate, the type of cooperation activities, which stakeholders are most likely to cooperate, how decision-making is taking place, how often information is shared and under which circumstances would stakeholders be willing to cooperate. Additional information on the questionnaire is available as part of section 4.

The third step of this approach was to involve key project tasks in the preparation, elaboration and moderation of the workshops, namely with WP2 and WP5. The workshops allowed us to discuss directly with local actors about the multi-actor cooperation in TANGENT, in close cooperation with WP2 (on data governance) and WP5 (on arbitration model and consensus mechanisms) to ensure a coordinated approach across project activities. Creating the link between the case studies description, WP2 and WP5 ensure the conceptual definition of optimal system architecture and new arbitration models, and the further characterisation of case studies & NTM solutions to be tested (see Figure 3).

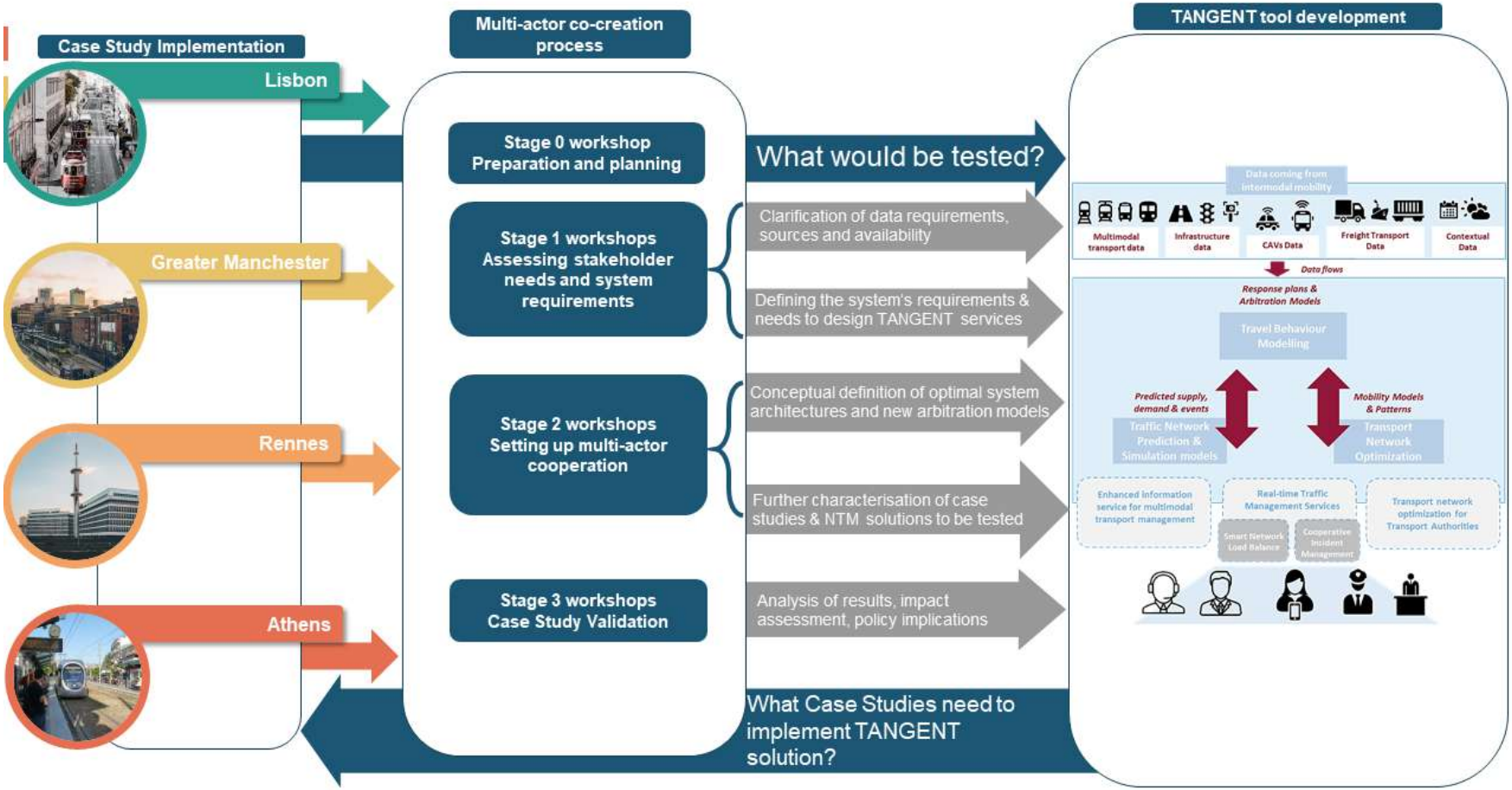


Figure 3: Visual representation of the link between WP1, WP1 and the tool development (WP2,3,4,5,6)

3.2 Workshops

As part of the WP1 Stage 2.2 process, Rupprecht Consult prepared and moderated a total of three workshops with each case study city: Lisbon (on 30.09.2022), Rennes (on 06.10.2022) and Manchester (on 10.10.2022).

Each workshop lasted two hours and was a result of a close collaboration with DEUSTO, CEFRIEL and NTUA. The workshops were developed along the following agenda:

14:00 - 14:10	Introduction:	agenda, objectives and format	Rupprecht
14:10 - 14:20	Case study:	description, functionalities, NTM	Case study leader
14:20 - 14:30	Interactive session 1:	mapping stakeholder roles	Rupprecht
14:30 - 14:40	Multi-actor cooperation	data governance, sharing	Cefriel
14:40 - 15:20	Interactive session 2	data governance, sharing	Cefriel
15:20 – 15:30	Multi-actor cooperation	coop. traffic management	NTUA, Deusto
15:30 – 15:50	Interactive session 3	NTM decision-making, cooperation principles	Rupprecht, NTUA, Deusto
15:50 – 16:00	Conclusion & next steps		Rupprecht

Table 1: Stage 2.2 workshops Agenda

Three interactive sessions were prepared, using online tools such as Miro (https://miro.com/) and Mentimeter (https://www.mentimeter.com/).

- The first session animated and coordinated by Rupprecht Consult was developed around a Miro board, presenting to the participants the stakeholders' roles identified by case study leaders in D1.2. Participants were allowed to approve, deny or suggest new stakeholders or roles required for the implementation of the TANGENT tool.
- The second session animated and coordinated by CEFRIEL was developed around a Miro board, presenting four data processes that are considered in data sharing. The objective aim of this exercise was to collect information, through Miro boards, that will support them in defining the TANGENT data sharing governance model definition, the objective of the D2.2, and guidelines through the Miro board. The discussion took place around the following topics:
    - The rules that TANGENT is going to apply to regulate the governance of each specific data process
    - The external rules that TANGENT needs to be aware of in each of the three case study cities
    - The identification of stakeholders involved in each data process
- The third session animated and coordinated by Rupprecht Consult was developed around a Mentimeter exercise that comprised five questions developed by DEUSTO and NTUA and three questions developed by Rupprecht Consult. This session took place after a presentation from DEUSTO on TANGENT Service 3 functionalities on transport network optimization for Transport Authorities and a presentation from NTUA on arbitration models and consensus-reaching mechanisms.

Some of the information on multi-actor cooperation for network traffic management was also gathered during the first part of Stage 2 through the pre-workshop questionnaire (see D1.2).

4 Multi-actor cooperation for NTM in TANGENT's case studies

4.1 Stakeholder mapping & roles

This section portrays stakeholders involved in each case study, which role they will play in the development and implementation of TANGENT and how they currently cooperate for network traffic management. For a more detailed description of each stakeholder mentioned below per case study, see Annex I.

4.1.1 Rennes

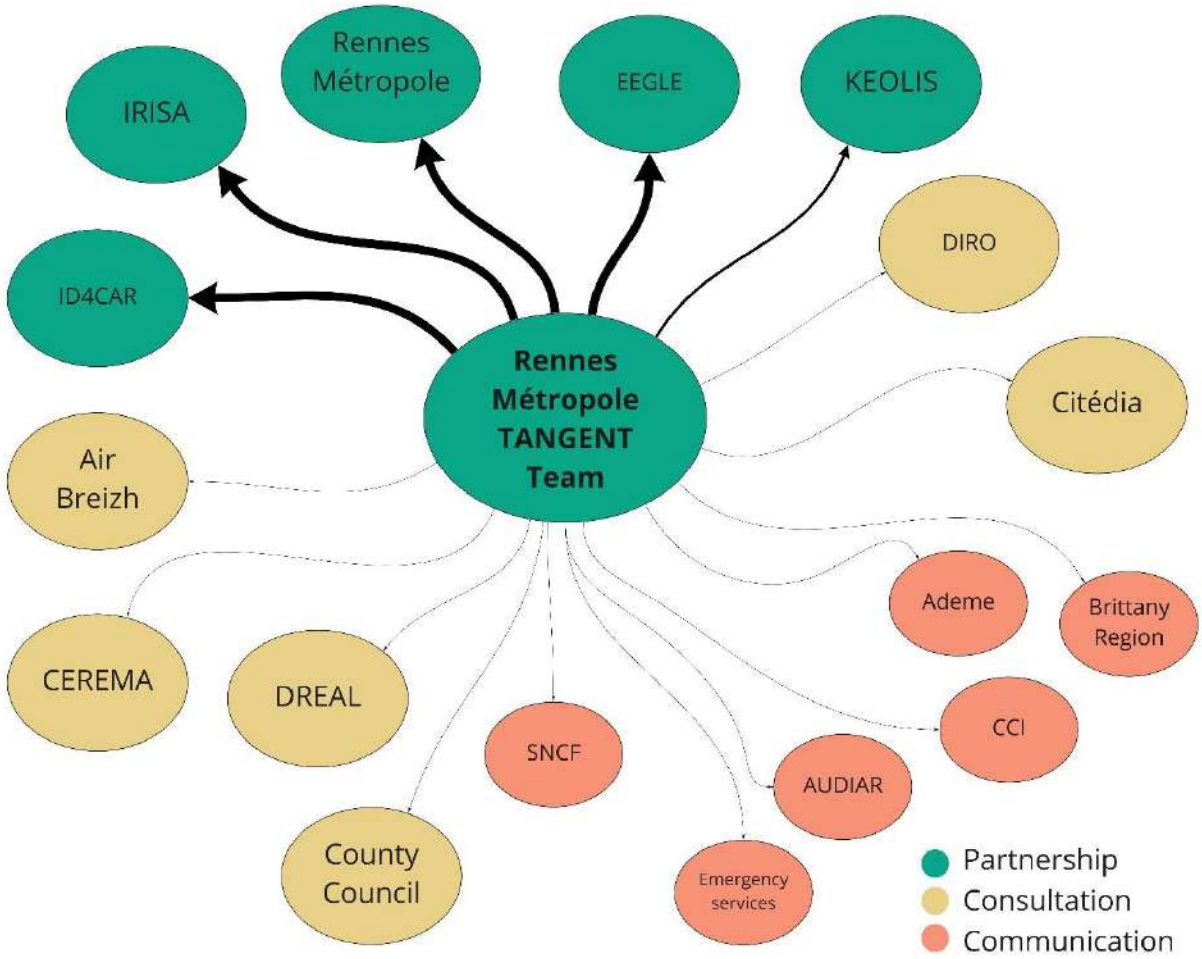


Figure 4: Rennes' stakeholder mapping

Rennes Métropole is the Métropole, a metropolitan intercommunal structure, centred around the city of Rennes. It is located in the *Ille-et-Vilaine* department, in the Brittany region, western France. It was created in January 2015, replacing the previous *Communauté d'agglomération de Rennes*, which had itself succeeded in 2000 to the previous district created in 1970 with fewer powers than the current metropolis. Rennes Métropole, the mobility organising authority, defines the overall transport strategy

in its territory through its Urban Transport Plan (PDU[3]) and, in this context, organises the public transport policy in its 43 municipalities. To promote sustainable mobility throughout the territory, the metropolis 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.

As identified in D1.1 “Multi-actor co-creation strategies for each Case study”, during TANGENT services implementation, close cooperation is required between Rennes Métropole, IRISA, EEGLE, ID4CAR and Keolis Rennes, the stakeholders with partnership roles for this pilot city, as illustrated in Figure 4. See Annex I for further information on the stakeholders.

Across the range of workshops conducted under WP1 activities, we have learned that communication channels exist between Rennes Metropole, Keolis Rennes and local authorities within the Metropolis to plan for road work and specific events. A meeting is taking place every Thursday to plan deviation routes impacted by road works, which is attended by operational and strategic services of Rennes Metropole, traffic operators, Keolis Rennes, road work planning services, waste management services and communication services. Keolis Rennes also has a specific person dedicated to planned events.

A pre-established management plan is set up for events and crises between the DDTM, DIR Ouest, and Rennes Metropole. There is a Steering Committee in place for the local mobility plan which includes multiple local stakeholders. Another regular coordination meeting might be scheduled in line with the new Agglomeration Masterplan for Traffic Management (SDAGT) with the DIR Ouest and CD35 (Departmental Council of Ile et Vilaine).

According to stakeholders, a discussion is ongoing between different actors in the region to improve cooperation among them by creating a common data-sharing tool to list the current and needed exchanges and to outline the partnership exchange of the tool. This discussion is led by the DIR Ouest (Interdepartmental Direction of Roads) within the framework of the SDAGT 2020-2024 (Agglomeration Masterplan of traffic management).

Overall, different forms of cooperation channels exist in Rennes between the different stakeholders, with some taking place formally while others do not.

[3] Plan de déplacement urbain

TANGENT Sub-service	Functionality	Stakeholder type	Role	Name of the local stakeholder
TANGENT Service 1: Enhanced information service for multimodal transport management				
Real-time information	Visualise the current status of the network	Infrastructure provider - Traffic managers and public transport operators	To monitor the transport network. To monitor mode-specific operation for bus	**Rennes Métropole Control Center = (PC Arthur)** ✓ **KEOLIS Rennes** ✓ **Brittany Region (BREIZHGO coaches)** ? **DIRO** ✓
Predictive Information	Visualise the future status of the network	Infrastructure provider - Traffic managers and public transport operators	Visualize and assess the new interface and its effects Encourage users to choose their modes as per the situation,	**Rennes Métropole Control Center = (PC Arthur)** ✓ **KEOLIS Rennes** ✓ **Brittany Region (BREIZHGO coaches)** ? **DIRO** ✓
TANGENT Service 2: Real-time Traffic Management Services				
Smart Network Load Balance:	Informing the transport passengers	Infrastructure provider - Traffic managers and PT operators	To monitor the transport network across all modes. utilise social media and journey planning apps of incidents	**Rennes Métropole Control Center = (PC Arthur)** ✓ **KEOLIS Rennes** ✓ **Brittany Region (BREIZHGO coaches)** ? **DIRO** ✓
Cooperative Incident Management:	Synchronisation of transit and traffic	PT operator Local Authorities Urban services operator	Monitor and manage the transport network across modes, communicate info between stakeholders	**Rennes Métropole Control Center = (PC Arthur)** ✓ **KEOLIS Rennes** ✓ **Brittany Region (BREIZHGO coaches)** ? **DIRO** ✓
TANGENT Service 3: Transport network optimization for Transport Authorities				
Simulation of scenarios suggested by the decision maker		Public Transport Operator, Local Authorities Urban services operator	user of service 3, definition of scenarios, data provider	**Rennes Métropole Control Center = (PC Arthur)** ✓ **KEOLIS Rennes** ✓ **Brittany Region (BREIZHGO coaches)** ? **DIRO** ✓
Generation of Response Plans		Public Transport Operator, Local Authorities. Urban services operator	user of service 3, definition of response plans, cooperation with other stakeholders to define a response strategy, implementing a response plan	**Rennes Métropole Control Center = (PC Arthur)** ✓ **KEOLIS Rennes** ✓ **Brittany Region (BREIZHGO coaches)** ? **DIRO** ✓

Figure 5: Rennes' stakeholder role in the implementation, and results of the Miro exercise

4.1.1.1 Observations

As a result of this exercise, stakeholders were identified, and their roles were confirmed for the implementation of the TANGENT tool based on the information provided in D1.2. The involvement and role of the Brittany region, especially concerning BreizhGo coaches still need to be confirmed and refined at this stage for all services, as referred to in Figure 5.

4.1.2 Manchester

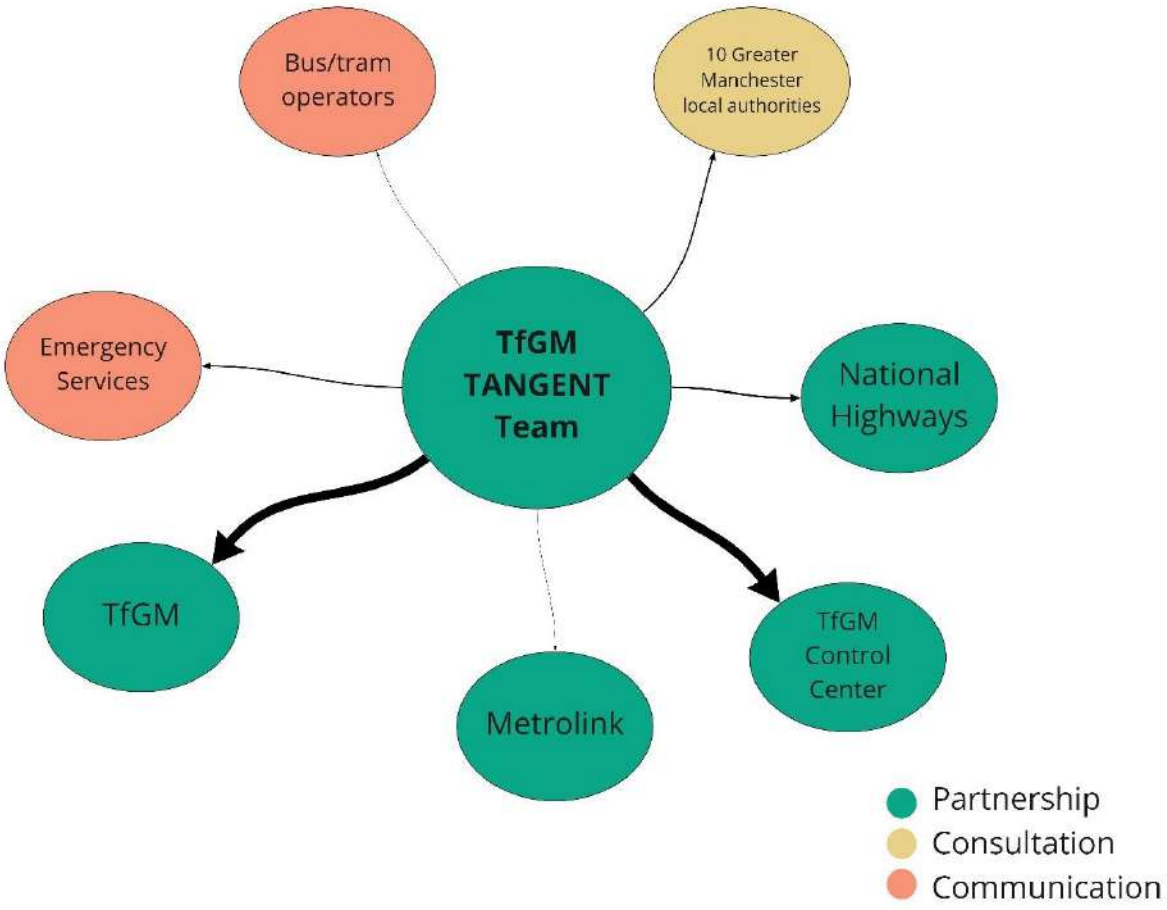


Figure 6: Manchester's stakeholder mapping

Greater Manchester (GM) is a large polycentric city region of 2.73 million residents across 1,276 square kilometres in the Northwest of England. GM is the UK's first combined authority (GMCA), representing 10 local authorities and their leaders, working together to address strategic challenges, chaired by a directly elected mayor. Over 2.1 billion journeys are generated every year, 268 million of which are made by public transport modes. The high use and dependency on private motorised vehicles for journeys as short as 1km results in congested urban centres and key route networks.

In addition, TfGM is a transport operator, it owns Greater Manchester's tram system (Metro-link) which entails over 57 miles of track (with new lines being added and further extensions in development) and 92 stops. TfGM also provides Metro Shuttle services (a free bus service operating in 4 districts). TfGM subsidises local rail services and helps funds station improvements across Greater Manchester. For Bus TfGM maintains bus shelters, subsidised fares on certain services and implements the System One

travelcards with plans for smart ticketing apps in development. For Highways, TfGM has been responsible for the maintenance of traffic signals, road management and safety since 2009.

As identified in D1.1 “Multi-actor co-creation strategies for each Case study”, during TANGENT services implementation (and in Figure 6), close cooperation is required between TfGM and National Highways, as well as consultation with the 10 local authorities part of the Greater Manchester. See Annex I for further information on the stakeholders.

During WP1 activities, the discussions with the different stakeholders present have revealed the existence of cooperation processes (communication channels or meetings) when it comes to planned events and certain forms of cooperation when it comes to unplanned events (mostly for highly disruptive ones like public transport shut down or extreme weather). When implemented, these cooperation processes seem to be quite efficient as decisions are reached cooperatively.

Cooperation among stakeholders for smaller incidents varies depending on informal relationships and communication channels existing, as well as capacities available in each stakeholder’s organisation.

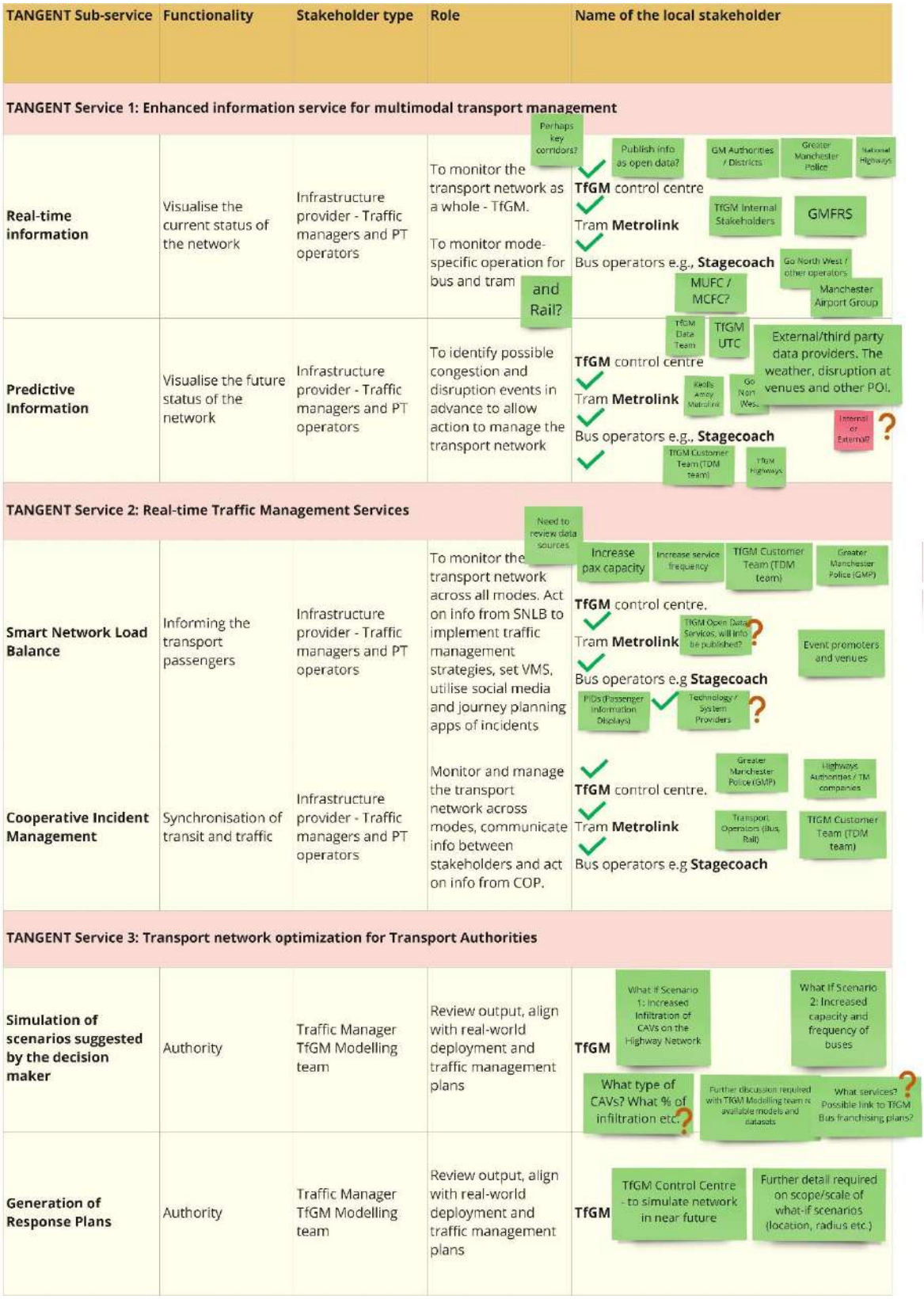


Figure 7: Manchester's stakeholder role in the implementation, and results of the Miro exercise

4.1.2.1 Observations

As a result of this exercise, referring to Figure 7, stakeholders were identified, and their roles were confirmed for the implementation of the TANGENT tool based on the information provided in D1.2. Additional stakeholders were identified for service 1 such as Greater Manchester Authorities and districts, Greater Manchester Police, National highways, Go NorthWest, Manchester Airport Group, Manchester United and Manchester City football clubs, etc. Some interrogations were raised regarding service 3, What-If Scenario 1 "Increased infiltration of CAVs on the Highway network" by mentioning that CAV services should be further defined. The question marks left in Figure 7 highlight the need to further clarify specific aspects of stakeholders' roles with further discussions between these stakeholders and the case study leader.

4.1.3 Lisbon

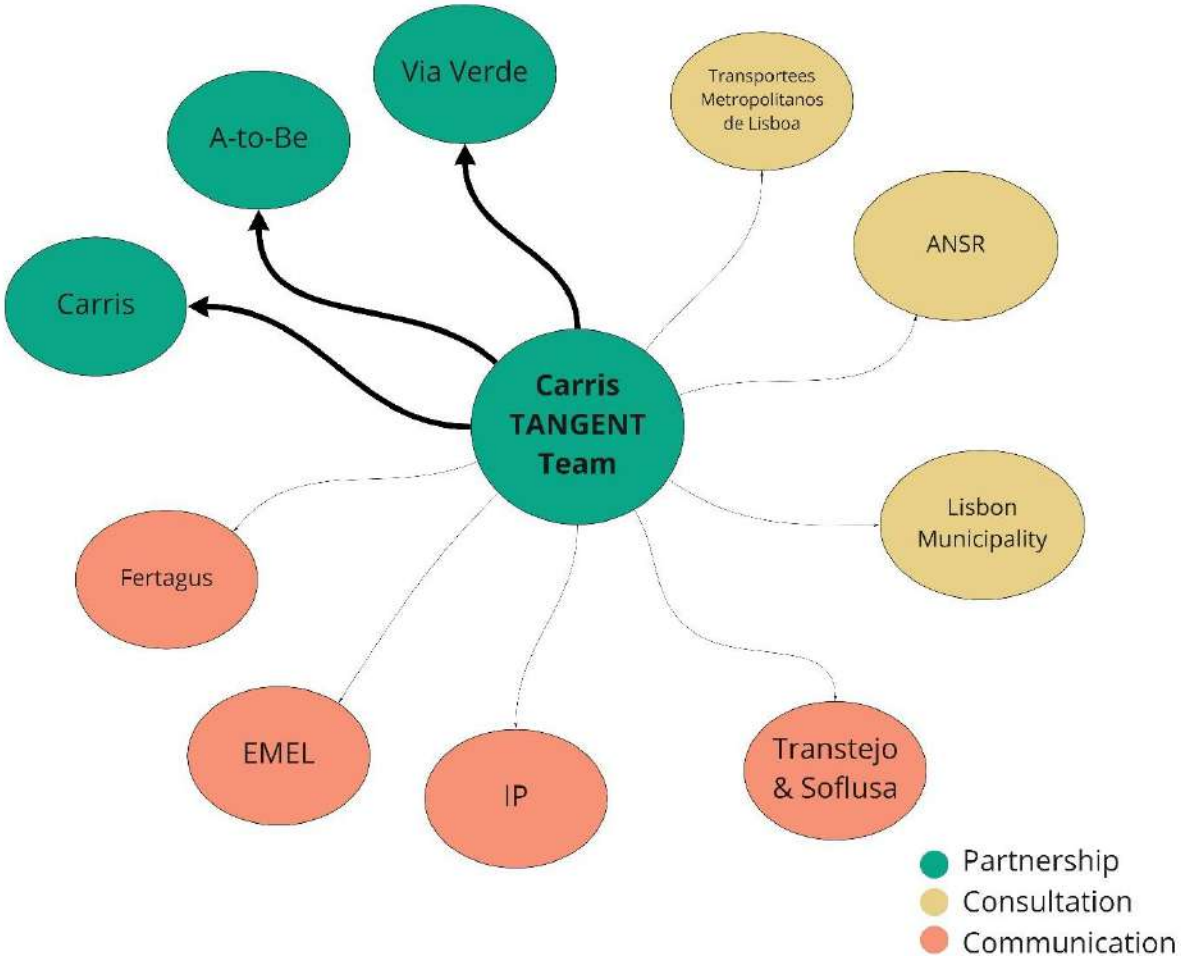


Figure 8: Lisbon's stakeholder mapping

Lisbon Metropolitan Area covers 18 municipalities in Great Lisbon and Setúbal Peninsula, with a total population of 2.8 M in a total area of ~3,000 km². CARRIS is the main surface transport operator of the city of Lisbon, moving more than 140 million passengers per year in its bus and tram network. It has a network with more than 2000 stops and operates roughly 700 buses and 50 trams. CARRIS has a team devoted to analysing data about its passengers' movements which supports the activities associated with network management and development. CARRIS is involved in planning the deployment of new

bus and tram routes, studying passenger flows and estimating demand. In addition, has developed numerous activities of planning special services, devoted to providing extra offers to events in its operating area, and has a team that addresses changes in the network due to foreseen (e.g. works) and unforeseen events (e.g. flooding, accidents).

As identified in D1.1 (and in Figure 8), “Multi-actor co-creation strategies for each Case study”, during TANGENT services implementation, close cooperation is required between CARRIS, A-to-Be, Via Verde, but also consult with the Lisbon Municipality, Transportes Metroplitanos de Lisboa and ANSR (Autoridade Nacional de Segurança Rodoviária). See Annex I for further information on the stakeholders.

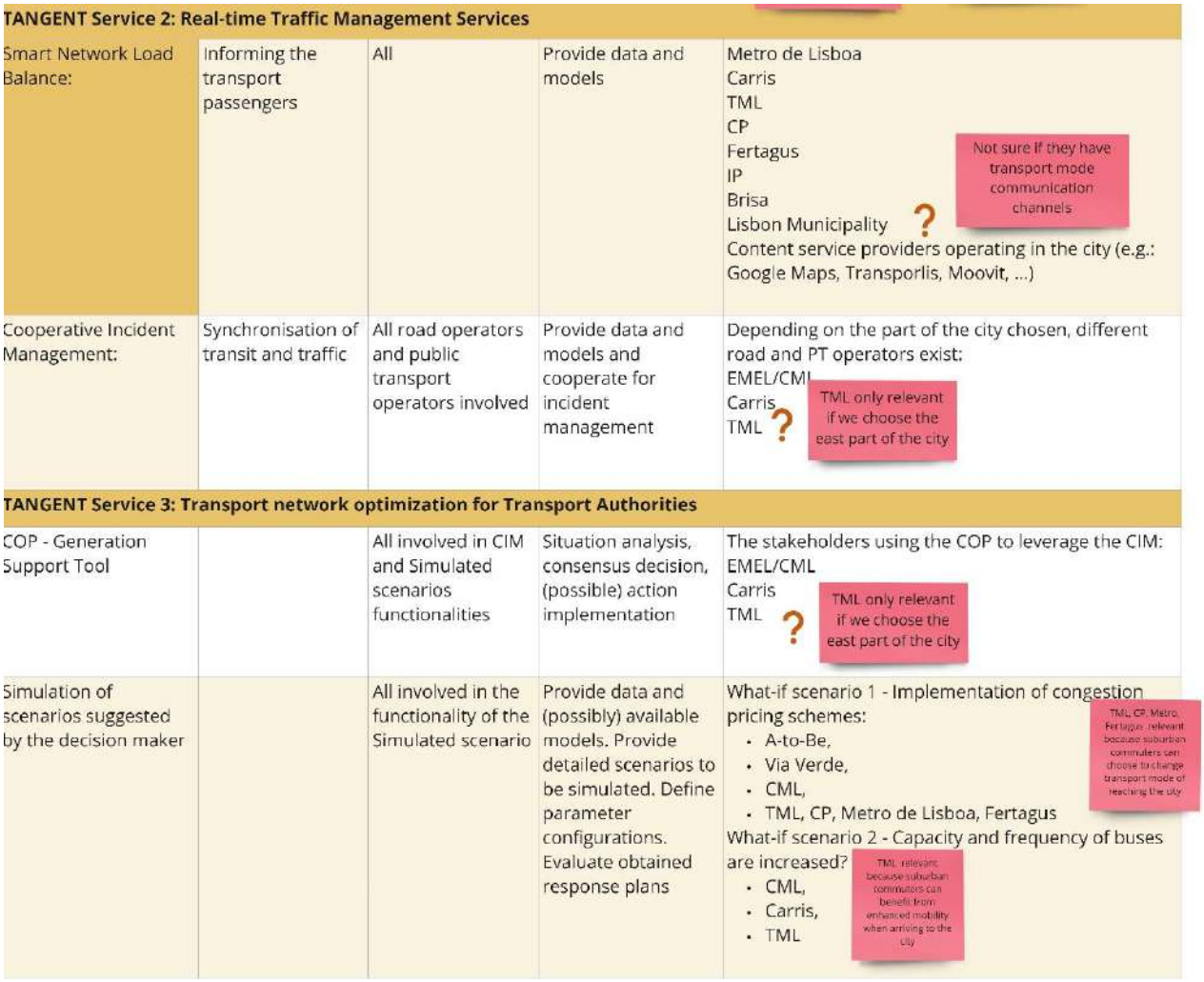
During WP1 activities, the discussions with the different stakeholders present have revealed certain aspects of the network traffic management in Lisbon, mainly that due to the multiple transport operators and the irregular cooperation patterns, multi-actor cooperation remains difficult. Few communication channels exist for stakeholders to communicate regarding road closures or redirection roads. There used to be a monthly meeting between stakeholders to better cooperate but stopped taking place sometime before March 2020.

TANGENT Sub-service	Functionality	Stakeholder type	Role	Name of the local stakeholder
TANGENT Service 1: Enhanced information service for multimodal transport management				
Real-time information	Visualise the current status of the network	Public Transport Operators	Provide supply (and desirably) demand information	**CARRIS** - Bus and TRAM Operator **METRO LISBOA** - Metropolitan operator **CP** - Train Operator **FERTAGUS** - Trans- River urban train operator **TML** - Interurban bus Authority Data sets formats standards to be used No real-time information for public transport demand Some challenges on data sharing: owership; monetization models
		Road Operators	Provide traffic network conditions and the current state	**IP** - National infrastructure for interurban roads, non-tolled motorways, and rail networks ? **Brisa** - Tolled motorways infrastructure around Lisbon **Lusoponte** - Tagus Bridges infrastructure **NAP** - National Access Point No real time data available for tolling Does any of the stakeholders have direct protocols?
		Content service providers	Provide traffic network conditions and the current state	Waze, TomTom, Google Maps, Bing Maps - Traffic, INRIX, Moovit (PT modes) (S. Meza - Cefriel) May be a media content provider (Radio, TV, Web News, ...) possibly interested in publishing traffic conditions ? ?
		Public micro-mobility operator	Provide bike sharing supply and demand	**EMEL** - Municipal mobility and parking company Not able to share information concerning users which is not agregated
		Parking Operators	Provide parking supply and demand	Municipal parking systems: **Lisbon - EMEL Cascais - CascaisPróxima SABA, Empark** and other private parking systems Not able to share information concerning real-time occupation of parking lots (off street)
Predictive Information	Visualise the future status of the network	Public Transport authorities	Provide mobility calibrated models	**CML/EMEL & Carris**? In mobility calibrated models with consider both traffic and public transport? Lack of information concerning land use to improve the model

Sharing information/data between public transport operators

Integration between public transport operators

New table



TANGENT Service 2: Real-time Traffic Management Services				
Smart Network Load Balance:	Informing the transport passengers	All	Provide data and models	Metro de Lisboa Carris TML CP Fertagus IP Brisa Lisbon Municipality ? Content service providers operating in the city (e.g.: Google Maps, Transporlis, Moovit, ...) Not sure if they have transport mode communication channels
Cooperative Incident Management:	Synchronisation of transit and traffic	All road operators and public transport operators involved	Provide data and models and cooperate for incident management	Depending on the part of the city chosen, different road and PT operators exist: EMEL/CML Carris TML ? TML only relevant if we choose the east part of the city
TANGENT Service 3: Transport network optimization for Transport Authorities				
COP - Generation Support Tool		All involved in CIM and Simulated scenarios functionalities	Situation analysis, consensus decision, (possible) action implementation	The stakeholders using the COP to leverage the CIM: EMEL/CML Carris TML ? TML only relevant if we choose the east part of the city
Simulation of scenarios suggested by the decision maker		All involved in the functionality of the Simulated scenario	Provide data and (possibly) available models. Provide detailed scenarios to be simulated. Define parameter configurations. Evaluate obtained response plans	What-if scenario 1 - Implementation of congestion pricing schemes: • A-to-Be, • Via Verde, • CML, • TML, CP, Metro de Lisboa, Fertagus TML, CP, Metro, Fertagus: relevant because suburban commuters can choose to change transport mode of reaching the city What-if scenario 2 - Capacity and frequency of buses are increased? • CML, • Carris, • TML TML: relevant because suburban commuters can benefit from enhanced mobility when arriving to the city

Figure 9: Lisbon's stakeholder role in the implementation, and results of the Miro exercise

4.1.3.1 Observations

As a result of this exercise (see Figure 9), some stakeholders were identified and their roles were confirmed for the implementation of the TANGENT tool based on the information provided in D1.2. Additional roles were identified for service “enhanced information service for multimodal transport management, real-time information” such as sharing information/data between public transport operators and integration between public transport operators. EMEL mentioned they were not able to share information concerning users which are not aggregated. The role of TML in the implementation of parts of Services 2 and 3 will depend on the final choice for the testing area in the city. It has been noted that TML can be relevant to running simulation scenarios because suburban commuters can benefit from enhanced mobility when arriving in the city and can change transport modes to reach the city.

4.2 Data governance

Data governance is one of the essential multi-actor cooperation processes to be developed in TANGENT to ensure consistent and efficient data sharing, harmonization and management. This section contains brief information on the key goals and necessities for cooperative data governance in TANGENT. Further and more detailed information will be available in D2.2 on data sharing governance.

TANGENT will define the data-sharing governance model to regulate the following processes:

- Dataset identification and description: Identification of high-quality datasets to fulfil TANGENT data requirements. Description of the datasets in the TANGENT data catalogue. Sharing of the catalogue within the TANGENT consortium
- Data access: Access to the dataset. Visualization of the content (without manipulation)
- Harmonization: Data conversion and fusion to support TANGENT service functionalities
- Data usage: Data usage to feed the TANGENT services

CEFRIEL developed, as part of the development of D2.2, a collaborating activity for the workshops with the scope to collect information about directives, regulations, and data-sharing governance aspects considered and applied to the three real case studies. The objective was to extract useful knowledge for defining the TANGENT data governance guidelines for gathering and sharing data processes.

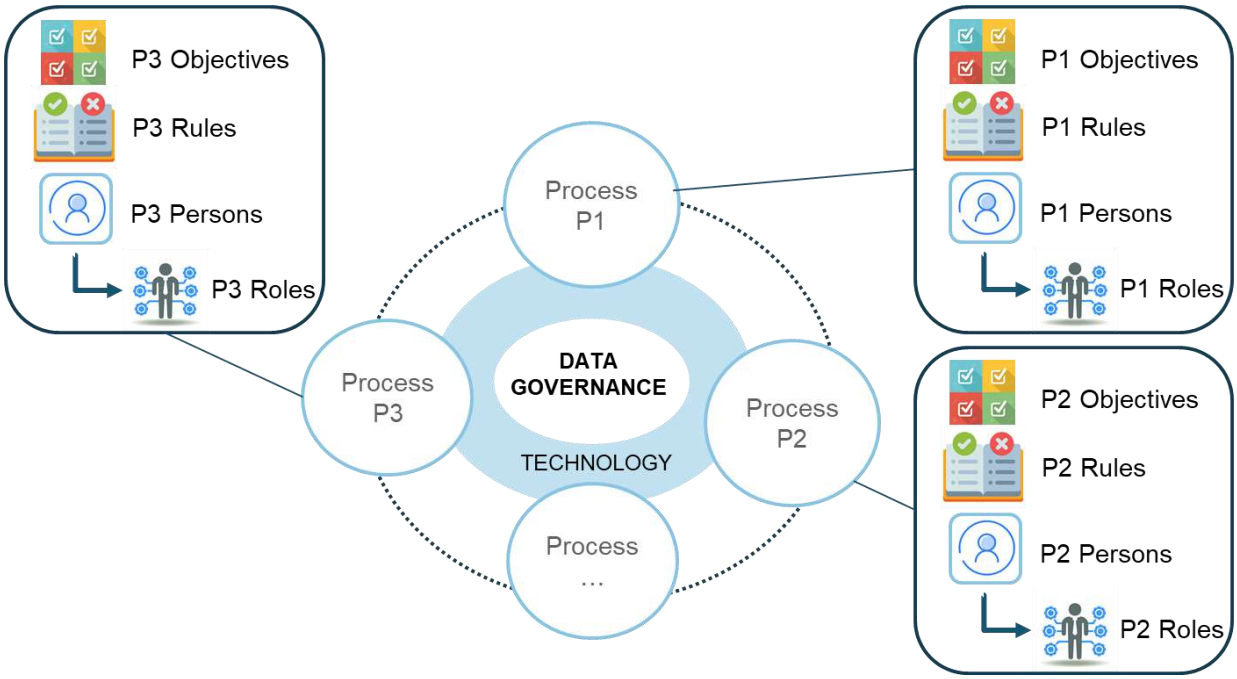


Figure 10: Data Governance General Structure & processes

Figure 10 illustrates the main concepts of a general data governance structure introduced by CEFRIEL during the workshops as a starting point for the data sharing governance model definition. Four processes for the TANGENT data-sharing governance model were presented to the participants, as a representative set of activities that will be regulated within the Project (Figure 10). Then, the available data sources for each case study were reported (extract from D2.1 “Data Requirements and Available Data Sources”.), together with indications about the corresponding transport mode, provider, dataset accessibility and temporal granularity.

Then the participants, both case study leader and stakeholders, were invited to actively join a working session, by contributing to the compilation of a Miro Board focused on the main aspects of data governance regarding the four selected processes. For each of the three case studies, a different Miro Board was developed and shared with all the participants.

Each Miro Board is defined by four frames, one for each of the considered processes. Figure 11 shows the structure of one of the four frames of the Miro Board.

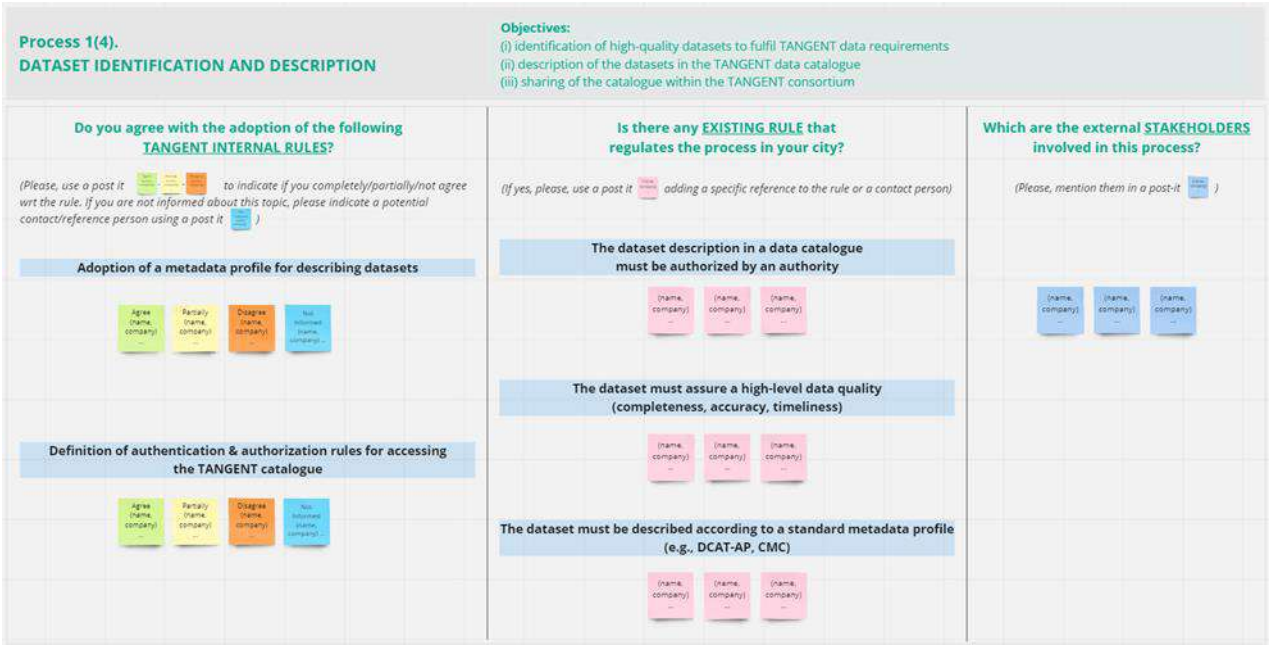


Figure 11: Example of Miro Board frame for Dataset Identification and Description Process (Source: CEFRIEL)

The header of the frame summarizes the title and the objectives of the considered process, while the body is divided into three columns: the first and second ones refer to data governance rules that could be interesting from, respectively, an internal and an external point of view in respect to the TANGENT Project. The last column aims to collect information about stakeholders potentially involved in the specific process.

In particular:

- internal rules/ present rules that will be identified within the project to internally regulate the considered process among the Consortium partners,
- existing rules present examples of regulations and directives at the city or national level, that could be already applied by the case study and that will be, in that case, taken into account during the data sharing governance model definition,
- stakeholders (external to the Consortium) that already consider and regulate the specific process.

In the working session, each participant was participants were asked to compile the frames of the Miro Board by adding comments, notes, suggestions, or references through different post-it notes. The session focused the attention on different kinds of rules and stakeholders to collect, from the participants, useful information applied in their city. All such indications will be considered for the TANGENT data-sharing governance model definition. For each case study, the Miro Board was left open, also after the workshop, to the participants for further compilation and finalization.

Results and analyses of this session for each of the case studies will be presented in D2.2 “Data-sharing g Governance model”.

4.3 Cooperation for network traffic management

For the development and implementation of the TANGENT tool, multi-actor cooperation is necessary for Service 3 “transport network optimization for Transport Authorities” and its three functionalities are:

- Common Operational Picture (COP) generation support tool
- Response Plan generation support tool
- Simulation of pre-defined scenarios

The fusion of individual beliefs into a collective, consensus-based group opinion, can lead to the identification of the characteristics of the set of near-optimal solutions and to a selection of alternatives possessing the most fitting attributes for attaining the stakeholder's objectives.

4.3.1 COP Generation Support Tool and Required Consensus

The Common Operational Picture (COP) that is prepared as part of Service 3 is like a Template that is jointly developed from the TANGENT Dashboard by a set of different stakeholders in preparation for specific scenarios or incidents. It's necessary to define a COP for each different scenario/incident type where it should be used. In due time, the COP will be used to support Service 2's CIM functionality as described above. The COP generation was already described in more detail in D1.2 Section 1.8.1.2. Here we focus on the functional and technical architecture supporting it.

Before the generation of the COP, the actor(s) involved in its generation must perform the following actions, as illustrated:

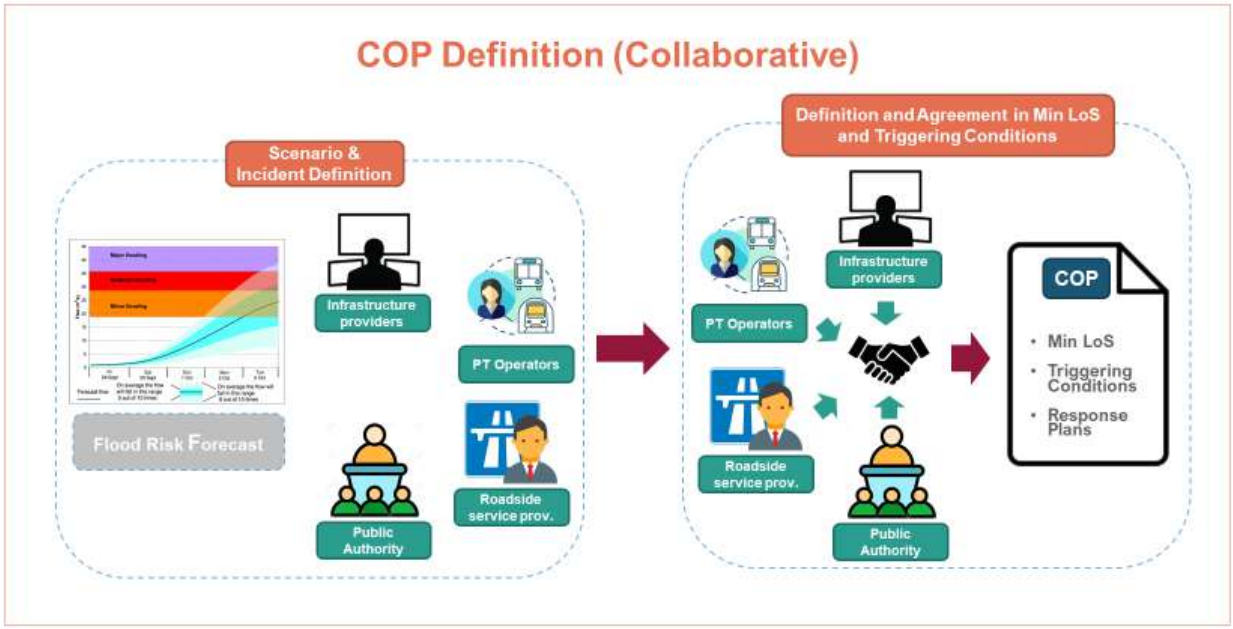
- Design and calibrate a transport model for the scenario(s) for which they wish to develop the response plan (e.g. adverse weather conditions, big events, etc.). For the generation of the transport models, the involved actors can use transport simulation software such as Aimsun Next, Visum, Vissim, etc. Furthermore, they may need support from internal or external transport modeller teams/departments.
- Define the minimum Level of Service (LoS) that the public authorities want to ensure. This minimum LoS can be defined by one or more thresholds (e.g. maximum delay of 25 mins in traffic at a specific road section, the maximum frequency of 20 minutes in a public transport line/service, etc.). To do this, for each of the thresholds that define the minimum LoS the user should set aspects such as:
    - Mode of transport: e.g. road transport, bus, metro, etc.
    - Transport network element: road section, public transport line, etc.
    - Indicator to be considered as LoS
    - LoS threshold
- Achieve consensus among all actors, on the triggering conditions that will launch the response plans that will ensure the fulfilment of the minimum LoS. Each triggering condition is defined by the following elements:
    - Mode of transport: e.g. road transport, bus, metro, etc.
    - Transport network element: road section, public transport line, etc.
    - Condition: e.g. delay > 10 mins, failure in PT line, average speed < 50% of free-flow speed, etc.
- Achieve consensus among all actors, on the response, and plans to apply for each triggering condition.

Example: Due to flood risk forecasts caused by a heavy accumulation of rainfall in a few hours, the different actors involved in the mobility of the city, coordinated by the urban transport authority, decide to elaborate a COP to coordinate response plans in different situations depending on the amount of rainfall. In collaboration with the national meteorological agency, three possible scenarios are foreseen for three different levels of precipitation: 50 - 75 litres/m3 per hour, 75-100 litres/m3 per hour, and 100-125 litres/m3 per hour.

4.3.1.1 Functional Architecture

Figure 12 presents the diagram depicting the five steps that support the production of the COP, which are:

- Collaborative COP Definition
  - Scenario & Incident Definition
    - In this sub-step, the Scenario is declared and classified, and general COP parameters are set
  - Definition and Agreement in minimum Level-of-Service and Triggering Conditions
    - This sub-step is used to define the minimum Level-of-Service (LoS) for specific data items and the triggering conditions that will evoke the response plans.
- Transport Simulation Setup
  - Customized models for the scenario in hand are prepared in this step
- Response Plan Generation Setup and Monitoring
  - Response Plan Optimisation Setup
    - In this sub-step stakeholders cooperate to define the Response Plans applied for each Triggering Condition
  - Response Plan Optimisation
    - The Transport Model is optimized for each Response Plan
- Results Visualization
  - In this step, the compiled results (options and Key Performance Indicators (KPI) evolution) for each optimized Response Plan will be visible in the Dashboard
- Collaborative COP Preference and Consensus definition
  - Response Plan parameters are defined cooperatively to finalize the COP definition



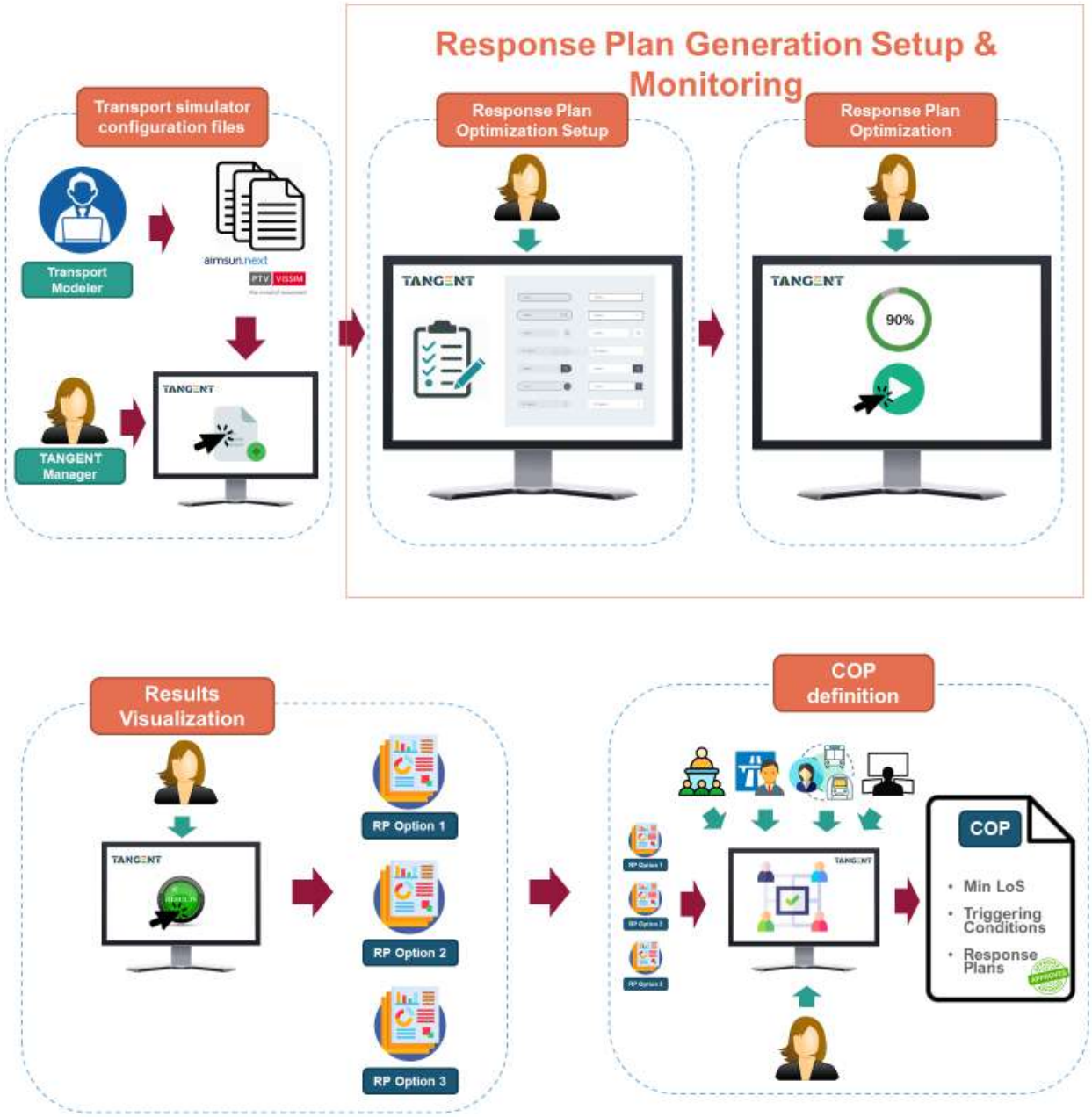


Figure 12: TANGENT COP (Service 3) Functional architecture

Each step / sub-step from the COP Generation workflow is now addressed in detail.

4.3.1.1.1 Scenario & Incident Definition

In this sub-step, the users will define the name of the COP, the involved actors, their cooperation process and other aspects of the scenario and related incident.

The involved actors' network preferences and objectives are fetched from their user profile (from the entity they belong to) and can be edited for each COP at this stage.

4.3.1.1.2 Definition and Agreement in minimum Level-of-Service and Triggering Conditions

In this sub-step, the users will define the Minimum Levels of Service (mLoS) associated with the COP that is being defined. For example, if the COP relates to road traffic, one of the mLoS could be that the maximum delay at a specific road section must be under 25 minutes. There can be several mLoS in a COP and each is defined for a specific data item at a specific location (city, road, etc.). If a mLoS is breached, a critical notification will be issued to all users with a Profile involved in the COP.

The Triggering Conditions are used to define when to apply specific Response Plans before the mLoS are breached. The Response Plan categories are identified in this step for each Triggering Condition. For example, in the COP of the previous example related to road traffic, there could be triggering conditions to change traffic lights timings (Response Plan category) after the delays are higher than 10 minutes (Triggering Condition) for the same specific location and to apply dynamic pricing (Response Plan category) when delays are higher than 15 minutes (Triggering Condition).

Actors with access to the COP definition can cooperate and agree on these elements.

4.3.1.1.3 Transport Simulation Setup

It is necessary to customize a transport model for the Response Plans involved in the COP, resulting from the previous step, so the model can be run and the response plans can be optimized. The customization of the transport model for the Response Plans is done outside the TANGENT Dashboard using the Aimsun Next simulator as a prototype[4] by a qualified transport modeller. The resulting files are uploaded to a local simulation server for each Case Study city.

In the TANGENT Dashboard, it will then be possible to trigger the Optimisation process by selecting the appropriate transport model and following the next steps.

4.3.1.1.4 Response Plan Optimisation Setup

In this sub-step, stakeholders cooperate to define the parameters for the Simulations of the Response Plans applied for each Triggering Condition. These parameters include selecting the pre-defined transport simulation model experiment that will be run as well as setting up particular options that are converted into Aimsun Next command line parameters when the model is run. It's important to note that the transport model is given as already calibrated for the type of day, and traffic conditions that the stakeholders want to replicate, as well as any other parameters that are relevant to the scenarios and experiments.

4.3.1.1.5 Response Plan Optimisation

Once the Response Plan Optimisation setup is complete the system launches the optimisation of the response plans in the background, using Artificial Intelligence techniques. The progress will be visible in the COP Generation on the TANGENT Dashboard. This process can take a long time (several hours).

[4] TANGENT is intended to be software agnostic and be able to integrate with any simulation software. For praticality Aimsun Next will be used as a prototype accessed through Service 3 modules that could in the future exchange with a different simulation software.

4.3.1.1.6 Results Visualization

Once the optimisation is finished for each response plan, the results of the optimisation will be visible in the Dashboard, including the solutions found for each Response Plan and different KPIs and graphs for each one to justify the solution.

4.3.1.1.7 Collaborative COP Preference and Consensus definition

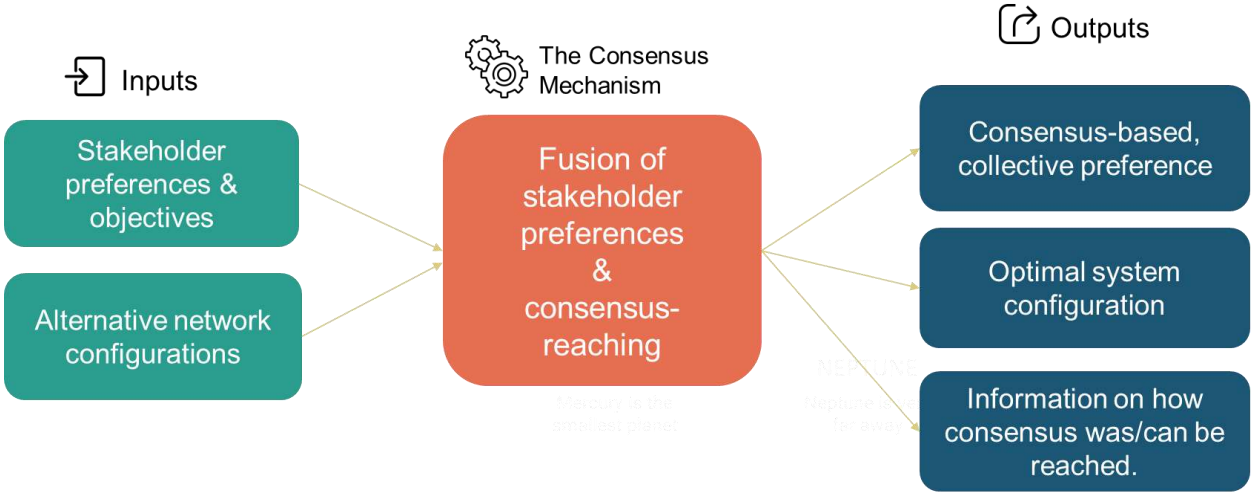
It's possible to use the Response Plan configuration results and KPIs provided by the Optimisation directly or to allow a final selection and configuration of the final Response Plans using multi-criteria and consensus decision methods.

With multi-criteria and consensus decisions it's possible for the actors involved to cooperatively fine-tune the Response Plans that resulted from the optimisation process, namely by changing traffic signals configurations and adjusting transit or DRT services.

Whether multi-criteria and consensus decision is used or not, at the end of this step the COP is saved to it can later be used in the context of CIM.

4.3.2 Development of a consensus mechanism

The goal of developing consensus mechanisms in TANGENT cities is to shift from resource-intensive decision-making methods to more automated methods facilitating cooperation and consensus. Figure 13 presents a schematic view of the consensus mechanism to be implemented in the TANGENT services and its integration into the collaborative functionalities that require it.



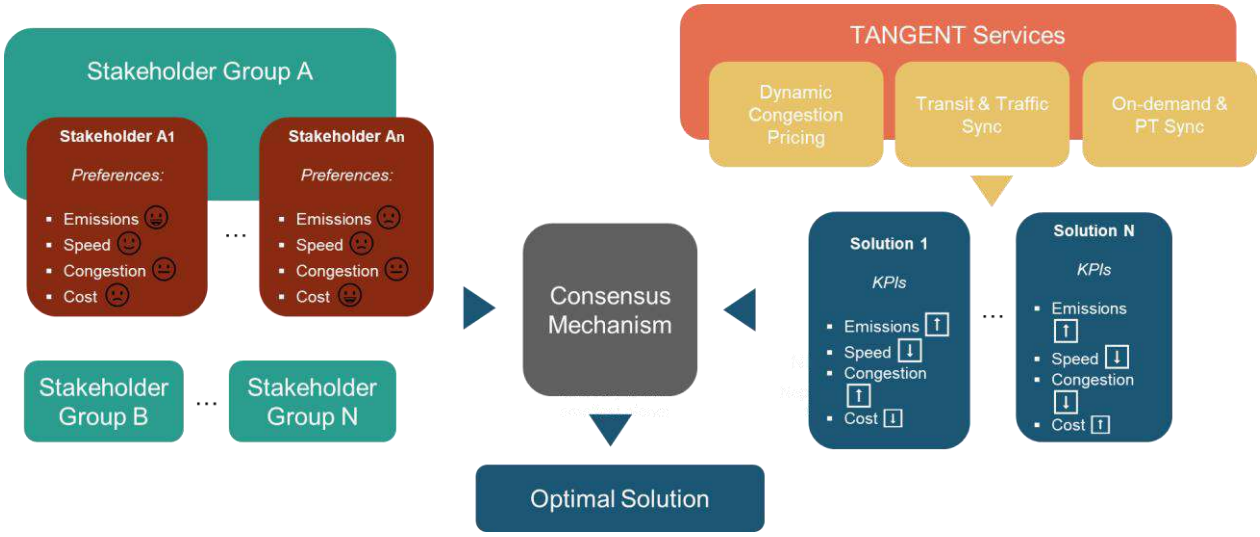


Figure 13. A schematic depiction of the consensus mechanism

4.3.3 Case studies preferences and results for multi-actor cooperation

This section highlights the responses to the questions asked to participants during the workshops regarding current practices and wishes in terms of multi-actor cooperation

In response to the question "Would you like to provide preference & trade-off information on general system objectives or specific system configurations?", for each case study, stakeholders have mentioned that:

Rennes	Stakeholders would like to provide preference & trade-off information on specific system configurations.
Manchester	Stakeholders would like to provide preference & trade-off information on general system objectives.
Lisbon	Stakeholders would like to provide preference & trade-off information on general system objectives.

Hence, Rennes would like to provide preferences and trade-off information on specific system configurations while Manchester and Lisbon would prefer to do so on general system objectives.

In response to the question "*How much are you willing to delegate to the consensus-reaching mechanism?*", for each case study, stakeholders have mentioned that:

Rennes	On average, stakeholders in Rennes are slightly willing to delegate to the consensus-reaching mechanisms.
Manchester	On average, stakeholders are most likely willing to delegate to the consensus-reaching mechanisms.
Lisbon	On average, stakeholders in Lisbon are slightly willing to delegate to the consensus-reaching mechanisms.

Hence, stakeholders in Rennes and Lisbon are less willing to delegate to the consensus-reaching mechanisms than stakeholders in Manchester.

In response to the question "*Have you ever used a decision support tool?",* for each case study, stakeholders have mentioned that:

Rennes	On average, stakeholders in Rennes have used decision support tools.
Manchester	On average, stakeholders have not used decision support tools.
Lisbon	About half of the stakeholders present during the workshop mentioned they already used a decision support tool.

Hence, stakeholders in Rennes and Lisbon have more experience using decision-support tools than stakeholders in Manchester.

In response to the question "*Do you have in mind potential fields of application for the mechanism?*", for each case study, stakeholders have mentioned that:

Rennes	Stakeholders have mentioned that they have sometimes experienced problems of consensus in terms of impact exploitation (dealing with delays, etc.) versus the impact on clients or between frequency and punctuality.
Manchester	Stakeholders have mentioned that they have often experienced problems of consensus between modes, whether be highway & tram priority, current Greater Manchester operating modes such as bus operators and tram operators, pedestrians and traffic or bus priority and general traffic. More precisely, it was mentioned that motorway closures require diversion onto local roads, which helps motorway users but disadvantages bus passengers and local road users due to delays.
Lisbon	Stakeholders believe that decision support tools could be used when facing service disruption to help direct transport services from other operators to help, in autonomous driving projects or in supporting delivery/shipping companies in sustainable projects.

Hence, all case studies have been experiencing problems of consensus for different aspects of their network traffic management systems (prioritisation of modes, exploitation impact, service disruption, etc.).

In response to the question "What challenges can you foresee for the implementation of arbitration models for network optimisation?", for each case study, stakeholders have mentioned that:

Rennes	Stakeholders were not able to foresee challenges in the implementation of arbitration models for network optimisation during the workshop.
Manchester	Stakeholders would foresee some challenges for the implementation of arbitration models for network optimization, such as conflicting priorities or policy changes, conflict in priority between modes and operations, gaps in data and trust in applications and support advice. Differing political priorities in prioritising certain modes seems to be a challenge for a few stakeholders.
Lisbon	Stakeholders would foresee some challenges for the implementation of arbitration models for network optimization, such as regarding the validation processes, proving they are flawless and calibrating for different cities. Another challenge would be to face the competition for passengers among public transport operators in some parts of the city.

Hence, while Rennes were not able to foresee challenges in the implementation of arbitration models for network optimisation during the workshop, Manchester and Lisbon have identified some challenges, a common one being the prioritisation of modes. This challenge could be associated in both cities with the competition for passengers among public transport operators.

In response to the question " How often would you prefer to meet for the coordination of the case study implementation? How should the exchange take place? (bilateral calls, regular meetings, working sessions. , etc.)", for each case study, stakeholders have mentioned that:

Rennes	On average, stakeholders in Rennes would prefer to meet every 2 months for the coordination of Rennes' case study implementation. Local stakeholders would prefer to use individual input collection to cooperate during the implementation phase, followed equally by bilateral calls/meetings, regular meetings with all stakeholders and extended workshops/working sessions.
Manchester	Unanimously, stakeholders would prefer to meet every 2 months for the coordination of the Manchester case study implementation. Different forms of cooperation could be chosen for the implementation with a preference for bilateral calls and meetings and regular meetings with all stakeholders but cooperation could also take place during extended workshops and working sessions or through individual collection (e.g. questionnaires).
Lisbon	Stakeholders have mixed feelings regarding the frequency to meet for the coordination of the Lisbon case study implementation. Some would prefer to meet every 2 or 3 months while others would prefer to meet once a month. Stakeholders, however, seem to agree that regular meetings with all stakeholders and individual input collection would be their preferred way of cooperation between them and TANGENT partners.

Overall, stakeholders in each case study agree on the need to meet every 2 months on average for the coordination of the case study implementation. The form of these exchanges may vary, however, for each case study, from regular workshops to individual contributions through questionnaires.

4.3.4 Rennes: Cooperation preferences obtained from the previous questionnaire of the Stage 2.1 workshop

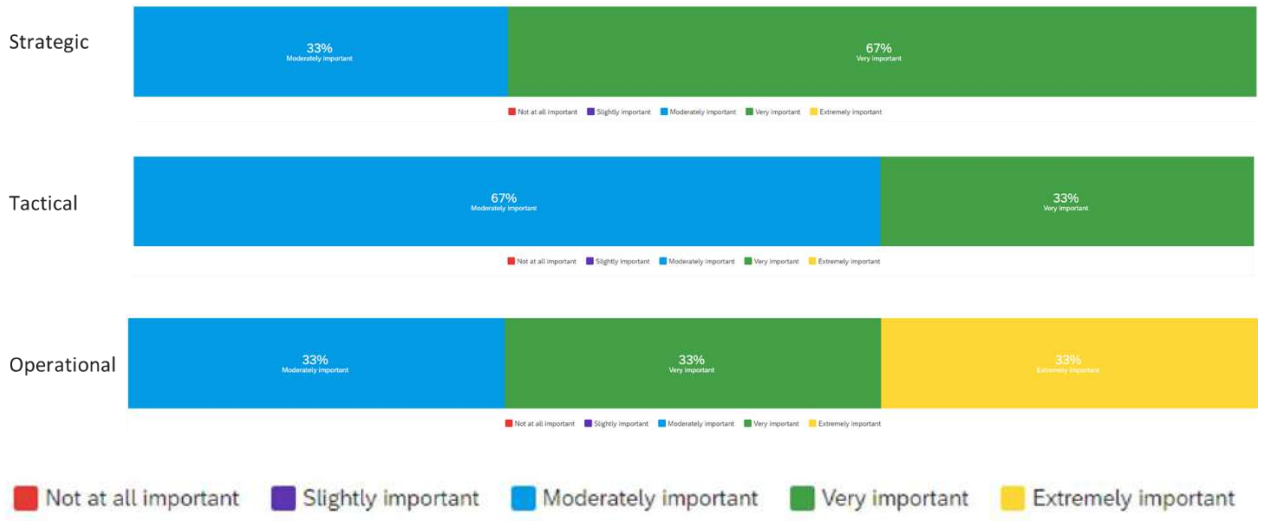


Figure 14: Rennes stakeholders' importance to cooperate with other stakeholders for the strategic, tactical and operational levels of control relating to transport network management

In Rennes, stakeholders believe that it is very important to cooperate on strategic levels of control related to transport network management while being moderately important to cooperate on tactical levels. For operational levels of controls, stakeholders do not seem to agree on the level of cooperation often used, varying from moderately important to extremely important, as illustrated in Figure 14.

Regular cooperation regarding transport network management takes place with traffic managers, transport authorities, and public or private transport service operators, often with representatives of a non-profit or non-governmental organisation, less often with transport service operators and rarely with central and regional government or government agencies. Cooperative activities with other stakeholders often equally take place through formal exchanges such as meetings and workshops, and informal exchanges, through phone calls or emails.

Most of the time the decision-making process occurs at the highest level and is then communicated to the rest of the stakeholders if a decision must be made during a cooperative activity. About half of the time, stakeholders can still express their views and provide input when the decision-making process occurs at the highest level.

Reporting is used about half of the time to share communication between stakeholders during cooperation activities. Sharing data schemes, using data portals, and exchanging data during formal and informal meetings happen sometimes.

In terms of data governance, stakeholders have expressed their interest to cooperate on data exchange if data sharing is transparent and if access to decision-making is fair.

4.3.5 Manchester: Cooperation preferences obtained from the questionnaire of the Stage 2.1 workshop

Figure 15: Manchester stakeholders' importance to cooperate with other stakeholders for the strategic, tactical and operational levels of control relating to transport network management

In Manchester, stakeholders believe that cooperation is extremely important for operational and strategic levels of controls, and to a certain extent for tactical levels of controls, as illustrated in Figure 15.

Regular cooperation regarding transport network management takes place with central and regional government or government agencies, traffic managers, and public or private transport service operators, often with transport authorities, less often with transport service operators, and rarely with representatives of the public and non-profit or non-governmental organisations. Cooperative activities with other stakeholders mainly take place through informal exchanges (phone calls, emails) rather than through formal exchanges.

Stakeholders perceive that about half of the time the decision-making process occurs at the highest level and is then communicated to the rest of the stakeholders if a decision must be made during a cooperative activity. About half of the time, stakeholders can still express their views and provide input when the decision-making process occurs at the highest level. Sometimes the decision-making process is consensus-based, and stakeholders work together to find a mutually acceptable solution and make decisions by agreement.

Stakeholders have mentioned that reporting and informal exchanges are used most of the time to share information between stakeholders during cooperation activities. Sharing data schemes, using data portals, and exchanging data during formal meetings happen sometimes.

In terms of data governance, stakeholders in Manchester have expressed their interest to cooperate on data exchange if data sharing is transparent. Stakeholders have also expressed interest in cooperating regarding integrated transport services.

4.3.6 Lisbon: Cooperation preferences obtained from the questionnaire of the Stage 2.1 workshop

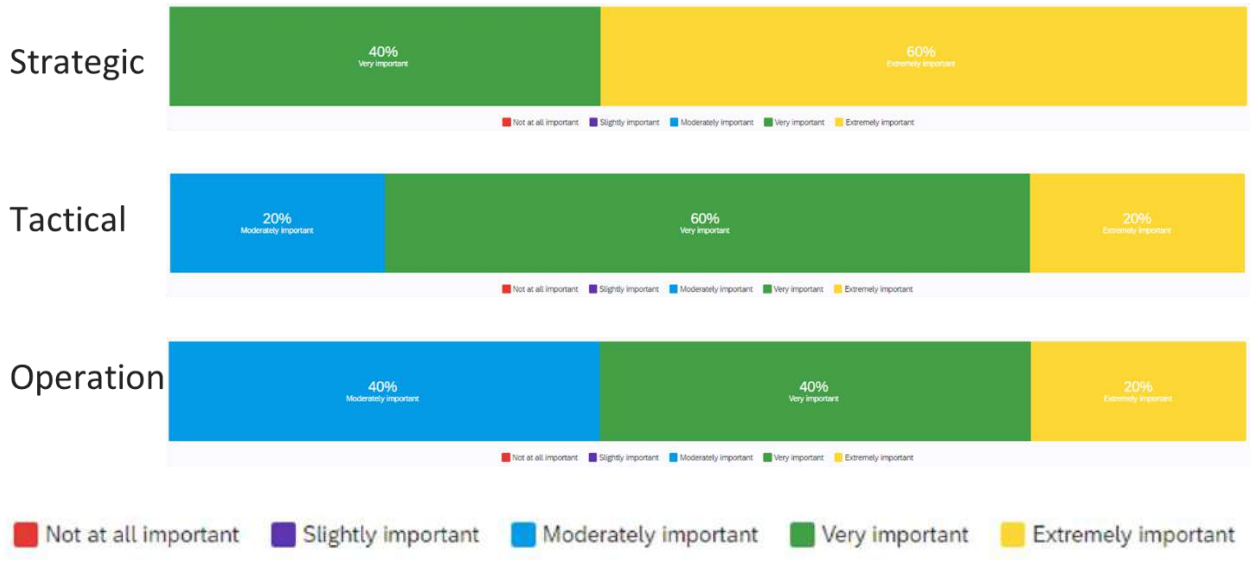


Figure 16: Lisbon stakeholders' importance to cooperate with other stakeholders for the strategic, tactical and operational levels of control relating to transport network management

In Lisbon, stakeholders believe that it is extremely important to cooperate on strategic levels of control related to transport network management. For tactical and operational levels of control, stakeholders in Lisbon seem to agree that it is very important to cooperate, as illustrated in Figure 16.

Regular cooperation regarding transport network management takes place with transport authorities, traffic managers and representatives of the private sector, less often with transport service operators and rarely with civil society or non-governmental organisations

Cooperative activities with other stakeholders often equally take place through formal exchanges, meetings and workshops, and informal exchanges, through phone calls or emails.

Sometimes the decision-making process occurs at the highest level and is then communicated to the rest of the stakeholders if a decision must be made during a cooperative activity, sometimes stakeholders can still express their views and provide input when the decision-making process occurs at the highest level. Sometimes the decision-making process is consensus-based, and stakeholders work together to find a mutually acceptable solution and make decisions by agreement.

Informal exchanges are used most of the time to share information between stakeholders during cooperation activities. About half of the time, reporting is used to share information between stakeholders. Sharing data schemes, using data portals, and exchanging data during formal meetings happen sometimes.

In terms of data governance, stakeholders have expressed their interest to cooperate on data sharing if cooperation benefits the stakeholders' company and if the allocation of the operational cost is fair. Stakeholders have also expressed interest in cooperating regarding integrated transport services.

5 Conclusions

This deliverable looked into the background for multi-actor cooperation in TANGENT, described the methodology followed for the discussion and set-up of multi-actor cooperation models in WP1, and presented the results of these analyses with each case study site. It will support further activities in WP2 in terms of data-sharing governance and cooperation, in WP5 in terms of optimization of transport network management within a multi-actor setting, and in WP7 in terms of the tool implementation in each case study cities and the stakeholders' engagement during that phase.

As a result of Stage 2.2 workshops, we were able to come to some conclusions on existing and preferred multi-actor cooperation mechanisms for each of the case studies. Rennes would like to provide preferences and trade-off information on specific system configurations while Manchester and Lisbon would prefer to do so on general system objectives. Stakeholders in Rennes and Lisbon are less willing to delegate to the consensus-reaching mechanisms than stakeholders in Manchester. Stakeholders in Rennes and Lisbon have more experience using decision-support tools than stakeholders in Manchester. All case studies have been experiencing problems of consensus for different aspects of their network traffic management systems (prioritisation of modes, exploitation impact, service disruption, etc.). While Rennes were not able to foresee challenges in the implementation of arbitration models for network optimisation during the workshop, Manchester and Lisbon have identified some challenges, a common one being the prioritisation of modes. This challenge could be associated in both cities with the competition for passengers among public transport operators. Overall, stakeholders in each case study agree on the need to meet every 2 months on average for the coordination of the case study implementation. The form of these exchanges may vary, however, for each case study, from regular workshops to individual contributions through questionnaires.

Further information was gathered regarding multi-actor cooperation through the WP1 questionnaire which highlighted key information for the further development of multi-actor cooperation mechanisms and arbitration models. Not all case studies value the need for cooperation at the same level. For example, stakeholders in Rennes and Lisbon believe in the importance of cooperating on the strategic level. Stakeholders in Lisbon seem to much more value the importance to cooperate at the strategic level more than in Rennes and also agree on the high importance to cooperate on the operational and tactical levels. In Manchester, stakeholders believe in the high importance of cooperating at both the operational and strategic levels. Regular cooperation regarding transport network management takes place with different stakeholders in each city and therefore cooperation mechanisms are different from one city to another. For example, in Rennes and Lisbon, stakeholders cooperate both through formal and informal exchanges, while in Manchester cooperative activities mainly take place informally.

Existing decision-making processes in each of the case studies occur at different levels and stakeholders are involved at different stages of the decision-making process. In Rennes and Manchester, decision-making occurs at the highest level and is then communicated to stakeholders. But stakeholders seem to express their views and provide input in the decision-making process more often in Manchester than in Rennes. In Lisbon decision-making processes vary equally, sometimes it is at the highest level only, sometimes with the input of stakeholders and sometimes it is consensus-based.

Communication between stakeholders takes different forms in each case study. In Rennes, reporting is most commonly used to share information. In Manchester and Lisbon, however, communication happens more through informal exchanges. In terms of data governance, preferences vary in each case study. Stakeholders in Rennes and Manchester have expressed their interest to cooperate on data exchange if data sharing is transparent and if access to decision-making is fair. In Lisbon, however, stakeholders have expressed their interest to cooperate on data sharing if cooperation benefits the

stakeholders' company and if the allocation of the operational cost is fair. In Manchester and Lisbon, stakeholders have also expressed interest in cooperating regarding integrated transport services.

Through the analysis of existent research and experiences on multi-actor cooperation, as well as the discussions lead in WP1 co-creation processes, TANGENT has established a conceptual and methodological framework to guide multi-actor cooperation for case study implementation. The guiding principles, cooperation context and available resources were discussed as a baseline for a continued effort of building effective cooperation for NTM in TANGENT.

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Annex I Detailed description of stakeholders & their relation to TANGENT project in each case study

Rennes

Stakeholders name	Type of stakeholder	Relation to TANGENT
EEGLE	SME working on technical basis for the development of digital services based on cartographic and analytical data visualization, user rights management and mass processing capabilities.	Working on the data management to feed their own development.
ID4CAR	Cluster	To make sure the consortium runs smoothly to achieve Rennes goals.
KEOLIS Rennes (operating Rennes Metropole "STAR" transport network)	PTO Public transport operator	Interested in the assessment of the effectiveness of the actions and in the interface with the hypervision system and with the overall transport system management.
IRISA	Academic lab - working on data and mobility projects - including RUDI	Interested in the assessment of the effectiveness of the actions and in the interface with their own projects (monitoring air quality)
Air Breizh	Association working on air quality	To be further defined
CEREMA	National research centre with a lab on mobility	To be further defined
DIRO	Manage the national road network	Road infrastructure managers involved in the area chosen for Rennes case study
SNCF	Manage the rail national service	Impact of Tangent outcomes on the development of intermodal mobility hubs
Brittany region	Regional PTA (management of regional roads, trains, interurban coaches...)	Impact of Tangent on the overall regional mobility system

Stakeholders name	Type of stakeholder	Relation to TANGENT
Citédia	Urban Services Operator for Rennes Métropole (car & cycle parks, performance halls, leisure facilities, company offices...)	Mainly links between management of car & cycle parks and mobility
Rennes Métropole	Local Authority - PTA - different services involved (Road/infrastructure management, transport and mobility management, Innovation, etc.)	Improving internal expertise on traffic management, in particular through the capacity to integrate large datasets and thanks to exchange of good practices with other European cities. Tangent to contribute to achieving the goals of the 2030 Urban Travel Plan (PDU) Feeding Rennes Métropole Public Data Service with a case study on mobility.
County council (Ille-et-Vilaine)	County council PTA (management of county roads)	Impact of Tangent on the overall local mobility system
DREAL Service infra, sécurité et transport et unité mobilité	Regional representative of the national Ministry of environment , planning and housing	Impact of Tangent on environment and planning at the regional level. NB: A global study of the west access (area of case study) of Rennes Métropole is conducted by Rennes Métropole and the DREAL. In this study, some aspects have already been validated: A west – east trambus by 2030 ; Park and ride installation by 2030
Ademe	National agency for environment	Air quality and energy efficiency; possibly exploitation and dissemination of results
AUDIAR	Rennes Métropole agency (studies and consultancy on urban planning)	Impact of tangent on planning policies, behaviours and infrastructure
CCI	Chamber of commerce and industry	Impact of Tangent on the companies installed on the case study area (which is mainly an industrial activity area)
Emergency services	Police, Fire, ambulance	Congestion and operating services with reliable journey times. Able to attend incidents in timely manner

Greater Manchester

Stakeholders name	Type of stakeholder	Relation to TANGENT
Metrolink	TfGM operated tram	Congestion and operating uninterrupted transport services with reliable journey times for customers
National Highways	Manage the motorway network in England	
TfGM Control Centre	Manage the transport network from central control centre. Communicate with bus, tram and customers	Managing events/incidents on the transport network. Ensuring assets and traffic management tools are operational and providing customer information
10 local authorities	Local government agency providing local services in each of the ten Greater Manchester districts	Efficient transport network for all road users. Reducing congestion, improving air quality, modal shift
TFGM	ITS and Urban Traffic Control teams	Efficient transport network for all road users. Reducing congestion, improving air quality, modal shift
Emergency services	Police, Fire, ambulance	Congestion and operating services with reliable journey times. Able to attend incidents in timely manner

Lisbon

Stakeholders name	Type of stakeholder	Relation to TANGENT
Carris	Public transport operator in the City of Lisbon; operates bus and trams	Congestion and operating uninterrupted transport services with reliable journey times for customers
A-to-Be	ITS technology supplier	
Via Verde	Mobility services provider; offers payment solutions for road tolls, off-street parking, on-street parking and is piloting a solution for public transport/MaaS	

Fertagus	Public transport operator - suburban rail and feeder buses	Congestion and operating uninterrupted transport services with reliable journey times for customers
Transtejo & Soflusa	Public transport operator - Ferries	Congestion and operating uninterrupted transport services with reliable journey times for customers
Lisbon Municipality	Local authority and public transport authority in the City of Lisbon. Responsible for road management in Lisbon.	Promotion of resilient networks; insights for traffic planning and management
Transportes Metropolitanos de Lisboa	Public Transport Authority for the metropolitan area. Manager of suburban bus public service contracts. Management of the multimodal public transport ticketing system.	Congestion and operating uninterrupted transport services with reliable journey times for customers
EMEL	Mobility and Parking Company of Lisbon. Management of on-street and off-street parking shared bikes and traffic signals in the city of Lisbon	Promotion of resilient networks; insights for traffic planning and management
IP	Management of transport infrastructure, including national roads, rail network and stations.	Promotion of resilient networks; insights for traffic planning and management
ANSR	Responsible for road safety	Response to emergencies