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DELIVERABLE D6.1
[SPECIFICATION OF MULTIMODAL TRAVEL SOLUTION (ALPHA RELEASE)]

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[1] PU: Public; SEN: Sensitive, only for members of the consortium (including Commission Services)

Document history

Date	Name	Affiliation	Position/Project Role	Action/ Short Description
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11/05/2023	several	Hacon, VTI, GTSP, DLR, PKP, FE, IBDiM, IK	Task 6.1 Members	Contributors, providing input
24/05/2023	Anna Perras	Hacon	WP Leader, deliverable leader	providing input, writing general parts of the documents
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15/03/2023	Ira Kataria	Hacon	WP Leader, deliverable leader	Modifications and Finalisation
22/03/2024	Fabrizio Burro	Wabtec	Quality Manager	Final quality check and submission

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Executive Summary

Regional railways play a significant role, not only in serving rural areas in Europe, but also acting as feeders for passenger and freight traffic for the main network. Regional railway lines have an essential function as an environmentally friendly mode of transport. In combination with other public transport services, such as bus, micro mobility services, on-demand services, as well as cycling, walking, and driving, regional rail enables passengers to reach remote stations and places in rural areas.

To ensure the long-term viability of regional railways, among other factors, a high service quality and high customer satisfaction are required to make rail an attractive and preferred mode of transport. Regional rail services play an important role in achieving a high customer satisfaction. Every day, passengers rely on regional trains and other regional services for transportation. The key, not only to accomplish customer satisfaction, but to also increase service quality, reliability, and efficiency, is a sophisticated information service. The societal significance of a smoothly running rail service stems not only from railways being an important part of the infrastructure in many European countries, but also from the need to live, trade and travel more sustainably.

Within FP6-FutuRe WP6, a highly accurate multimodal travel solution is developed. The goal is to deliver transport service information for first and last mile services, while including passenger transportation and partly combining it with freight transportation. The service information shall be supplied both on-board of regional vehicles, e.g. via personal digital devices, and at regional rail stations. In rural areas with mostly low density of rail services, travellers need to be able to proceed with their journey once they have reached their final railway station. To cater to this need, in this deliverable D6.1, a solution is specified that can inform passengers about which mode is suitable to reach the final destinations. It is considered that there might be delays or other incidents that affect a transport services' operating schedule and that some travellers may have specific mobility restrictions. Interfaces between rail services and other mobility services, such as demand responsive transport, are helpful to adjust to different scenarios and to operate as efficiently as possible. A possible solution is developed in collaboration of several tasks within WP6 as well as in exchange with FP1-MOTIONAL.

The present document explains the Alpha Release outline of our solution, as well as the scope of collaboration with Destination 1 (FP1 -MOTIONAL). The initial specification of the Regional Rail Services solution is defined through user stories and use cases, that specify the key elements of the solution as of M6 of the project. Based on the use cases, a list of requirements has been derived, describing the requirements of the planned solution on a high level.

This document is describing the first set of specifications for the solution to be developed within FP6-FutuRe WP6/11. The Final Release Specifications (D6.2) will be based on this present deliverable and will describe the solution in a more detailed way, including technical descriptions of all system functionalities and components, an architecture description, UML diagrams, and a final list of use cases and list of functionalities to be developed and subsequently demonstrated in WP11.

List of Acronyms

Abbreviation / Acronym	Definition
AI	Artificial Intelligence
API	Application Programming Interface
CMS	Capacity Management and Planning System
DRT	Demand responsive transport
FP	Flagship Project
MaaS	Mobility-as-a-Service
OJP	Open API for distributed journey planning
PIS	Passenger Information System
POI	Point of Interest
PRM	Passengers with Reduced Mobility
PTO	Public Transport Operator
S2R	Shift2Rail
TE	Technical Enabler
TMS	Traffic Management System
TSP	Travel Service Provider
UC	Use Case
US	User Story
WP	Work Package

1. Introduction

Deliverable 6.1 reports on the specification for a Multimodal Travel Solution at the state of development as of M15 of the EU Rail project FP6-FutuRe within WP6, which develops regional rail services. The aim of the present document is to provide the base for all future technical developments and the implementation of the developed solution, not only in the Final Release phase of WP6, but also in the subsequent WP11. Results from preceding S2R projects were considered and will be kept in mind for the development of the solution during the FP6-FutuRe project.

This document provides an overview of the specifications done within Task 6.1 WP6 up until M6 of the project and during the revision phase. Additionally, it includes the scope of collaboration with FP1 pertaining to Task 6.1 (DRT integration in journey planning), Task 6.2 (Integration of traffic management systems and passenger information systems) and Task 6.4 (Provision of short- and long-term travel demand).

The deliverable lists all requirements that have been specified for the Multimodal Travel Solution as well as for the collaboration topics with FP1. These requirements are linked to a set of use cases, which are based on a set of user stories.

The deliverable is structured as follows: The definitions of important terms can be found in the list of definitions in section 2. The scope of collaboration with Flagship Project 1-MOTIONAL is covered in Chapter 3. The specification of the solution is outlined in Chapter 4, with Chapter 4.1 describing the scope and purpose of the solution, Chapter 4.2 including the user stories, Chapter 4.3 containing the use cases and lastly, Chapter 4.4 including the list of requirements. Chapter 5 contains the conclusion of the deliverable.

This Alpha Release document defines the scope of the planned solution at a high level. The corresponding deliverables for Task 6.1 (Deliverable 6.2), Task 6.2 (Deliverable 6.3) and Task 6.4 (Deliverable 6.5) will include detailed specifications for each topic, including list of functionalities to be developed in WP11.

2. Definitions

This glossary of terms reflects the status of the work in M15. It shall be improved and expanded during the work in WP6. The Final Release version of this document (D6.2) shall include an extended list of definitions.

Actors	In a system engineering context, the actors of a use case refer to the entities that interact with the system being designed. An actor can be a person, group of people, another system, or a hardware device. Actors are external to the system and initiate or participate in one or more use cases.
Multimodality	Refers to the use of different modes (or means) of transport on the same journey[2].
On-demand transport/Demand Responsive Transport (DRT)	Demand responsive transport is a shared transport service available to the public operated by a company – public or private or a public-private-partnership – with professional drivers with flexible schedule, and/or flexible stops and/or flexible routing. The service is provided by low-capacity road vehicles such as small buses, vans, or taxis. The key differentiation with traditional public transport is that services are provided as a response to the individual demand from customers usually done by ordering such service via a smartphone app or calling a booking hotline.
PRM	Person with reduced mobility means any person whose mobility when using transport is reduced due to any physical disability (sensory or locomotor, permanent or temporary), intellectual disability or impairment, or any other cause of disability, or age and whose situation needs appropriate attention[3].
System	The solution being developed refers to the software or hardware system that is being designed and built to meet specific user needs or requirements in a use case. This system can range from a simple standalone application to a complex network of interconnected components and may include both software and hardware components. The system being developed typically includes various subsystems, modules, and components that work together to perform specific functions and provide specific capabilities to users. It may also include interfaces and integrations with other systems, data sources, and external devices. Throughout the development process, the system is designed, implemented, tested, and validated to ensure that it meets the user needs and requirements identified through use cases and other methods.

[2]European Commission, Directorate-General for Mobility and Transport, https://transport.ec.europa.eu/transport-themes/logistics-and-multimodal-transport/2018-year-multimodality_en

[3] European Commission, Press corner, https://ec.europa.eu/commission/presscorner/detail/en/MEMO_12_422

Use Case	In system engineering, a use case refers to a description of a specific interaction between a user or external system and the system being developed. It can describe the sequence of events that occur when a user (or external system) performs a specific task or action using the system, including the input and output involved, as well as any relevant conditions or constraints. The use cases are often used to help identify and document system requirements and can also be used as a guide for the test cases of the functionality and usability of the system during development and implementation.
User Story	A user story is a requirement for a (software) system. It is expressed in natural language from a user's perspective.

Table 1 - Definitions

3. Scope of collaboration with Flagship Project 1

FP1-MOTIONAL (Destination 1) aims at improving planning and operation activities for rail and at enhancing the integration of services that complement rail services. This integration helps to provide door-to-door mobility. FP6-FutuRe (Destination 6) aims at revitalising regional lines by reducing costs and by increasing customer satisfaction. WP6 of FP6-FutuRe addresses specifically customer satisfaction by developing improved customer information services in regional areas. FP1-MOTIONAL and WP6 of FP6-FutuRe will collaborate on several topics.

3.1. Collaboration Topics

The nature of the collaboration between FP1 and FP6 WP6 may reach from the exchange of information, lessons learned and results to a joint effort for the preparation of certain developments. After aligning with FP1, several potential collaboration topics could be identified. In addition to that, several necessary interactions could be identified. The scope of collaboration is composed of the collaboration topics and interactions. The collaboration topics are listed in Table 2. Collaboration topics were outlined in the Grant Agreement of FP1-MOTIONAL and FP6-FutuRe and identified in collaboration meetings between FP1 and WP6 of FP6.

No.	Collaboration Topic
1	There will be alignment regarding the development of the interface of Traffic Management System (TMS) and Passenger Information System (PIS). The goal is to exchange real-time/disruption information provided by the TMS and capacity/passengers demand provided by the PIS.
2	There will be alignment regarding the standards being used. This will ensure compatibility between the solutions each FP is working on respectively.
3	There will be alignment and collaboration regarding the DRT interface for distributed trip planning; a common use case addressing OJP (Open API for distributed journey planning), and DRT is included in Section 4.3.
4	FP1 and FP6 will both be working on the standardization of interfaces regarding compatibility between multimodal travel solutions; FP6 will take the role to share the results with the System Pillar.
5	The collaboration on topics regarding the demonstrations in a later stage of the projects is being considered. This could be regarding the choice of operators and decisions on locations.
6	Interactions and collaboration are foreseen for the topic of short- and long-term demand predictions, to align the specifications of the systems related to this topic.

Table 2 - Collaboration Topics

3.2. Interactions

In preparation of the interactions between FP1 and FP6, collaboration meetings consisting of two or more representatives of the respective projects have taken place. An interaction table has been crafted, which is being used to track the interactions and manage the timeline. Overall, the bi-directional exchange of requirements and specifications will be an important collaboration topic. The collection and sharing of use cases, as well as the alignment of their content will take place in collaboration between the projects.
A list of interactions can be found in Table 3, in this table the main contributor to the respective interaction is highlighted in **bold** face in the column indicating the affected work package. If both contribute equally, both entries are in bold face. The timeline for the interactions is indicated in the rightmost column. Both projects started on December 1st, 2022.

	WP in FP1 and responsible partner	FP1 role	WP in FP6 and responsible partner	FP6 role	Expected in which month of the project?
1	WP12 (Rolf Gooßman, Hacon)	Considering FP6-WP6 list of use cases and requirements, T12.2.7 will develop TRL 6 interfaces for integration of TMS with other services (PIS).	**WP6** (Rolf Gooßman, Hacon)	Provide list of use cases and requirements and initial specification for PIS (Deliverable D6.1).	M15
2	WP19 (Marco Ferreira, Hacon)	Requirements for WP20 development to be received (DRT/OJP).	**WP6** (Ira Kataria, Hacon)	Regional Rail Services Requirements & Specifications (Deliverable D6.1 Alpha Release).	M15
3	WP20 (Marco Ferreira, Hacon)	Requirements for WP20 development to be received (DRT/OJP).	**WP6** (Ira Kataria, Hacon)	Regional Rail Services Requirements & Specifications (Deliverable D6.2 Final Release).	M20
4	WP20 (Marco Ferreira, Hacon)	Integrate DRT services into MaaS platform.	**WP6** **WP11** (Ira Kataria, Hacon)	Make DRT services available for integration by FP1.	M18
5	**WP19** (Marco Ferreira, Hacon)	Handover of Specification for Demand Forecast TE 23 and 24 in D19.1 (T19.6 and T19.7).	WP6 (Marco Ferreira, Hacon)	Receive Specification on short- and long-term travel demands.	M12

	WP in FP1 and responsible partner	FP1 role	WP in FP6 and responsible partner	FP6 role	Expected in which month of the project?
6	**WP26** (Michael Meyer zu Hoerste, DLR)	Collect Use Cases from all destinations, relevant for Transversal topics.	**WP6** (Ira Kataria, Hacon)	Provide aligned use cases making use of the digital enablers provided by TT (transversal topics).	M8 (Start alignment)
7	WP10 (Rolf Gooßman, Hacon)	Requirements relevant for FP1 WP12 development to be received (TMS-PIS integration).	**WP6** (Rolf Gooßman, Hacon)	Provide D6.3: Requirements and interface design for TMS-PIS.	M20

Table 3 - Interactions between FP1 and FP6

3.3. Dependencies between developments

The interactions planned between FP1 and FP6 WP6 lead to dependencies between the developments in both projects. These dependencies are listed in Table 4. The dependencies have to be identified and tracked to ensure that the schedule of both projects can be aligned accordingly. Some dependencies are not blocking any activity in the other project. Whenever this applies, it is mentioned in Table 4. The project that has to deliver to the dependant project is highlighted in **bold** face in the column indicating the affected work package. If both contribute equally, both entries are in bold face. The timeline for the interactions is indicated in the rightmost column. Both projects started on December 1st, 2022.

	FP1	Dependencies	FP6	Dependencies	Expected in which month of the project
1	WP12	FP1 depends on FP6 provision of use cases and requirements to better define the interfaces for integration of TMS with PIS.	**WP6**	Results from tasks 6.1 and 6.2 represent the dependency content required by FP1.	M15
2	WP19	FP1 depends on the provision of Regional Rail Services Requirements & specifications to be aligned with main line specifications produced in FP1. This dependency is not blocking	**WP6**	Results from tasks 6.1, specifically D6.1 Alpha Release represent the dependency content required by FP1.	M15

	FP1	Dependencies	FP6	Dependencies	Expected in which month of the project
		any activity on FP1.			
3	WP20	FP1 may consider the final version of Regional Rail Services Requirements & Specifications for the final WP20 development. This dependency is not blocking any activity on FP1.	**WP6**	The final results from tasks 6.1, specifically D6.2 Final Release represent the dependency content required by FP1.	M20
4	WP20	FP1 depends on the availability of DRT services from FP6 to be integrated on FP1 MaaS platform.	**WP6** **WP11**	The FP6 mobility platforms developed in tasks 6.1 and 11.1 should make DRT services available for integration by FP1.	M18
5	**WP19**	FP1 should handover the specification for Demand Forecast TE 23 and 24 developed in T19.6 and T19.7, which results will be included on D19.1.	WP6	Task 6.4 depends on FP1 results in term of specification on short- and long-term travel demands. The FP1 specifications should be considered and aligned with FP6 specifications. This dependency is not blocking any activity on FP6.	M12
6	**WP26**	FP6 should identify if their activities may benefit from the involvement of TT (transversal topics) tools provided by FP1. This interaction does not represent any dependency and is not blocking any activity on FP1.	**WP6**	FP6 should identify if their activities may benefit from the involvement of TT (transversal topics) tools provided by FP1. This interaction does not represent any dependency and is not blocking any activity on FP6.	M8 (Start alignment)

	FP1	Dependencies	FP6	Dependencies	Expected in which month of the project
7	WP12	FP1 depends on FP6 provision Requirements and interface design for TMS-PIS to implement the integration of TMS with PIS	**WP6**	FP6 should provide D6.3 Requirements and interface design for TMS-PIS, produced on task 6.2	M20

Table 4 - Dependencies between developments in FP1 and FP6 WP6

4. Specification of Regional Rail Services

This chapter includes the specification of the multimodal travel solution. It is divided into four subchapters:

- 4.1 – describing the scope and purpose of the solution;
- 4.2 – containing the user stories;
- 4.3 – listing the use cases;
- 4.4 – containing the requirements corresponding to the use cases and user stories.

4.1. Scope/Purpose

This deliverable covers the task 6.1 in FP WP6 as well as interactions of FP6 WP6 with FP1 - interactions appear in task 6.1 and in 6.2 and 6.4. The main goal within task 6.1 is to provide information on how to plan a journey from origin to destination, while taking multiple transportation modes into consideration and making sure that it is suitable to reach a traveller's final destination in regional areas, taking obstacles like delays into consideration. For this, an interface with different transport services and particularly dynamic (e.g. on demand) services is needed to enable the availability of information related to rail services at stations and onboard. This shall:

- enable smooth hassle-free transition of travellers between modes;
- provide timely, reliable information to travellers as they plan or use transportation media;
- promote new micro-mobility services offers in the covered area.

Therefore, in this task, we are seeking to develop an information platform. This platform shall be open to anyone who is partaking in public transport within the regional area. An open API, aligned with European standards for distributed journey planning, shall be implemented so that information can be shared with and received by other systems to demonstrate this distributed journey planning, FP1 will query trips from the FP6 WP6 system which in return has to provide corresponding trip options.

Within subtask 6.1.1, an on-demand platform will be developed and integrated in the information platform to enable users to have seamless travel experience to their final destination. The on-demand platform shall import predictions of travel demand and determine how many vehicles are needed to answer this demand. To achieve this, a simulation system shall be used.

Subtask 6.1.2 aims at designing the Passenger Information System for regional rail service connection for persons with reduced mobility. The PIS will be designed to facilitate planning of a smooth journey including information about first/last mile, and about departure/transfer/arrival at stations by providing information on transport solutions adapted to PRM via applications accessible on personal digital devices or other information channels. The PIS will also process and

provide real-time information.

Task 6.2 considers the exchange of information between a Traffic Management System (TMS) and a PIS. Here, the TMS will be provided within FP1 and the PIS within FP6 WP6. On FP6 side, the PIS will provide travel demand forecast data to the TMS and receive updated timetable data from the TMS.

Task 6.4 is focused on the provision of short-and long-term travel demand prediction. Here, the specifications developed in FP1 for main lines, will be shared with FP6 to consider applicability to regional lines.

4.2. User Stories

In the following, user stories are listed that briefly describe features of the multimodal travel solution from a user's perspective in a natural way. The user stories are an established starting point in software development to specify requirements for a new system. A user story (US) describes the goal of a user who is interacting with the system and the benefit the user expects from the interaction. The user is characterized by a role so that the user represents a member of a group of similar users.

- **US1:**
  As a traveller, I want to get DRT options for first/last mile when traveling from/to a rural area where buses operate rarely and do not cover every small village, so that I will have a quick and smooth journey.

- **US2:**
  As an operator of a public transit service, I want that the multimodal travel solution does not provide DRT trips if there is public transportation available at the desired time so that DRT offers cannot entice customers away from public transit.

- **US3:**
  As an operator of a DRT service, I want to determine an optimal size of the fleet for the DRT service so that a good compromise regarding fleet costs and coverage of travel demand is achieved.

- **US4:**
  As a provider of a journey planning application, I want to make the journey planning service available to other applications so that the service can be made available for users in another region.

- **US5:**
  As a traveller who is planning a trip in the near future, I want to get trip options that take delay information into account so that I can choose a feasible and fast trip.

- **US6:**
  As a traveller who wants to plan a trip, I want to use a digital solution on my personal computer or on my smartphone for trip search so that I can easily plan my travel.

- **US7:**
  As a traveller who wants to plan a trip, I want to explore a map showing Points of Interests (POI) and select one of those as my destination so that I can get trip options bringing me to this POI.

- **US8:**
  As a passenger with reduced mobility, I want that a journey planning application takes my handicap into account in a comfortable way so that I can get suitable trip options without much effort.

- **US9:**
  As an operator of a TMS (i.e. as a Traffic Controller), I want to send updated timetable data to the PIS so that the travellers can be kept informed.

- **US10:**
  As an operator of a TMS (i.e. as a Traffic Controller), I want to receive travel demand forecast data from a PIS so that I can adjust the timetable and provide updated timetable data.

- **US11:**
  As a data analyst, I want to provide occupancy forecasts for vehicles in public transit so that travellers can be informed about expected occupancy and adjust their travel plans accordingly.

- **US12:**
  As a provider of a PIS, I want to display occupancy forecasts for vehicles in public transit so that travellers are informed about expected occupancy and adjust their travel plans accordingly.

User stories build the basis for use cases which describe in more detail how the role or the actor interacts with the system. Use cases will be presented in Subchapter 4.3.

4.3. Use Cases

This section lists the use cases that were derived from the user stories in Chapter 4.2 to provide solutions for several tasks of WP6. A use case outlines the interactions between actors and the system that shall be developed to reach a goal. Compared to a user story, a use case provides more details, e.g., dedicated steps describing the interaction, a list of actors and involved components.

Like the user stories were written for several of the tasks of WP6, correspondingly each use case, since it has been derived from the user story, as well corresponds to a task. The information about which task is related can also be found in each UC table.

The use cases will be shared with FP1 to identify if the use cases will benefit from the involvement of the transversal topics' tools provided by FP1.

4.3.1. UC-FP6-WP6-1.1.1 Travel planning for regional lines including a DRT service for first/last mile

This use case was derived from user story US1.

Name	Travel planning for regional lines including a DRT service for first/last mile
ID	UC-FP6-WP6-1.1.1
Description	User of the journey planning application does a trip search and gets trip options that include DRT for first/last mile
Related to task/subtask(s)	T6.1.1
Impact on other task(s)	T6.1.2
Interactions SP/FP	FP1 WP20 Task 20.1
Actor(s)	Traveller, Travel Service Provider (TSP) for Rail, Travel Service Provider for DRT
Trigger	Traveller wants to plan a trip
Pre-Condition(s)	• Available timetable data includes railway timetable data and information about DRT services (service area, operating hours etc.). • Availability of trip planning application.

Input	Trip Origin, Trip destination, Depart/Arrival Time
Result/Requirement	Trip options delivered to the traveller that include DRT options for first or last mile
Final State	The traveller receives trip options that include DRT for the first or last mile
Sequence	1. Traveller enters origin, destination, and desired departure/arrival time on a journey planning application. 2. Traveller triggers trip search. 3. The journey planning algorithm seeks trips considering the requirements set by the traveller. 4. Traveller receives trip options.
Involved components (System)	Journey planning application, TSP system, System of DRT provider
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.2. UC-FP6-WP6-1.1.2 Travel planning for regional lines taking into account rules of competition for Public Transit and DRT

This use case was derived from user story US2.

Name	Travel planning for regional lines taking into account rules of competition for Public Transit and DRT
ID	UC-FP6-WP6-1.1.2
Description	User of the journey planning application does a trip search and gets trip options that include DRT only if a DRT leg is in line with the rules of competition
Related to task/subtask(s)	T6.1.1
Impact on other task(s)	T6.1.2
Interactions SP/FP	FP1 WP20 Task 20.1
Actor(s)	Traveller, Travel Service Provider (TSP) for Public Transit, Travel Service Provider for DRT
Trigger	Traveller wants to plan a trip
Pre-Condition(s)	• Available timetable data includes public transit timetable data and information about DRT services (service area, operating hours etc.).

	• Data defining the rules of competition that are in force for the TSP (public transit) and the DRT service provider. • Availability of an API of the DRT system that can check the actual availability of a DRT vehicle for a specified trip leg. • Availability of trip planning application.
Input	Trip Origin, Trip destination, Depart/Arrival Time
Result/Requirement	Trip options delivered to the traveller that include DRT options for first or last mile only if in line with the rules of competition
Final State	The traveller receives trip options that include DRT for the first or last mile only if a DRT service is in line with the rules of competition
Sequence	1. Traveller enters origin, destination and desired departure/arrival time on a journey planning application. 2. Traveller triggers trip search. 3. The journey planning algorithm seeks trips considering the requirements set by the traveller. 4. Traveller receives trip options.
Involved components (System)	Journey planning application, TSP system, System of DRT provider
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.3. UC-FP6-WP6-1.1.3 Simulation of required DRT capacity based on predicted travel demand

This use case was derived from user story US3.

Name	Simulation of required DRT capacity based on predicted travel demand
ID	UC-FP6-WP6-1.1.3
Description	DRT service provider runs simulations to determine the optimal capacity offer (number of vehicles, seats per vehicle)
Related to task/subtask(s)	T6.1.1
Impact on other task(s)	T6.1.2
Interactions SP/FP	
Actor(s)	Travel Service Provider for DRT, Travel Service Provider for Rail, Traveller

Trigger	DRT service provider wants to determine the capacity offer for an area where a DRT service shall be set up or wants to optimize the capacity offer in an area with already existing DRT service
Pre-Condition(s)	• Journey planning application for public transit in the area under consideration (area where a DRT service shall be set up or has already been set up). • Simulation system for DRT.
Input	Scenarios for DRT simulation system
Result/Requirement	Optimal capacity offer of the DRT service (number of vehicles, seats per vehicle)
Final State	An optimal capacity offer for the DRT service is known that can be used for the operational phase of the DRT service.
Sequence	1. DRT service providers runs simulation based on the derived demand for different scenarios reflecting different capacity offers. 2. DRT service providers analyses simulation results and derives optimal capacity offer for the DRT service.
Involved components (System)	Journey planning application, TSP system, DRT simulation system
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.4. UC-FP6-WP6-1.1.4 Support OJP trip search requests and include DRT in the response

This use case was derived from user story US4.

Name	Support OJP trip search requests and include DRT in the response
ID	UC-FP6-WP6-1.1.4
Description	External journey planning system (MaaS platform) can send a trip search request where start and destination are within the region of the FP6-FutuRe journey planning system. Via OJP, a corresponding request is sent to the FP6-FutuRe journey planning system that provides a response to the external system via OJP including public transit and DRT for last or first mile. So, the regional services of FP6 can be interfaced by FP1.

Related to task/subtask(s)	T6.1.1
Impact on other task(s)	
Interactions SP/FP	FP1 WP20 Task 20.1
Actor(s)	Traveller, External Journey Planning System (MaaS platform), Travel Service Provider for Rail (region of the FutuRe journey planning system), Travel Service Provider for DRT (region of the FutuRe journey planning system)
Trigger	Traveller wants to plan a trip in the region of the FutuRe journey planning system but uses an external journey planning application
Pre-Condition(s)	Available timetable data for the region of the FutuRe journey planning system includes railway timetable data and information about DRT services (service area, operating hours etc.) Availability of trip planning system for the external area and the region of the journey planning system; both have to support OJP.
Input	Trip Origin, Trip destination, Depart/Arrival Time
Result/Requirement	Trip options within the region of the FutuRe journey planning system delivered to the traveller via the external journey planning system
Final State	In the external journey planning system, the traveller receives trip options in the region of the FutuRe journey planning system that include DRT for the first or last mile
Sequence	1. Traveller enters origin, destination, and desired departure/arrival time in the external journey planning application. 2. Traveller triggers trip search. 3. External journey planning system (MaaS platform) sends trip request via OJP to the journey planning system for the FutuRe region. 4. The journey planning system for the FutuRe region seeks trips considering the requirements set by the traveller. 5. Journey planning system for the FutuRe region sends trip options via OJP to the external journey planning system. 6. Traveller receives trip options in the external journey planning system.
Involved components (System)	External journey planning system (MaaS platform), Journey planning system for the region in FP6-FutuRe, TSP system, System of DRT provider

Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.5. UC-FP6-WP6-1.2.1 Synchronization of operational processes among regional rail operators to adjust ad-hoc timetables

This use case was derived from user story US5.

Name	Synchronization of operational processes among regional rail operators to adjust ad-hoc timetables
ID	UC-FP6-WP6-1.2.1
Description	Realtime information of (at least) two rail operators is processed so that ad-hoc timetables and resulting trip options that take delays and cancellations of public transit services into account can be presented to travellers.
Related to task/subtask(s)	T6.1.2
Impact on other task(s)	
Interactions SP/FP	
Actor(s)	Rail operator 1, rail operator 2, journey planning system
Trigger	Journey planning system receives updates to the timetable according to the real-time situation from the connected operators.
Pre-Condition(s)	• Realtime information from Rail operator 1 and 2 (e.g. delay information, cancellations, platform changes). • Availability of journey planning system. • Journey planning system is equipped with static timetable data of rail operator 1 and rail operator 2.
Input	Static timetable data (schedule data), real-time data (delays, cancellations)
Result/Requirement	The journey planning system can provide trip options that take real-time data from rail operator 1 and 2 into account
Final State	Ad-hoc timetable that can be used to provide trip options that consider real-time data
Sequence	1. Journey planning system consumes real-time data of rail operator 1 and rail operator 2. 2. Journey planning system matches real-time data with static

	timetable data. 3. Journey planning system constructs ad-hoc timetable based on static and real-time data.
Involved components (System)	Journey planning system, real-time data source of rail operator 1 and real-time data source of rail operator 2
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.6. UC-FP6-WP6-1.2.2 Synchronization of operational process among regional rail operators and other services to adjust ad-hoc timetables

This use case was derived from user story US5.

Name	Synchronization of operational process among regional rail operators and other services to adjust ad-hoc timetables
ID	UC-FP6-WP6-1.2.2
Description	Realtime information of (at least) two rail operators is processed together with data from bus or DRT services so that ad-hoc timetables and resulting trip options that take delays and cancellations of public transit services and availabilities of DRT services into account can be presented to travellers.
Related to task/subtask(s)	T6.1.2
Impact on other task(s)	
Interactions SP/FP	
Actor(s)	Rail operator 1, rail operator 2, bus operator and/or DRT operator, journey planning system
Trigger	Journey planning system receives updates to the timetable according to the real-time situation from the connected operators
Pre-Condition(s)	• Rail operator 1 and 2 provide real-time information for their respective trains. • Bus operator provides real time information for its buses/DRT service provider can respond to requests for a vehicle needed within the current/next hour. • Availability of journey planning system.

	• Journey planning system is equipped with static timetable data of rail operator 1, rail operator 2, bus operator, and some necessary data from DRT service provider (e.g. service area, operating hours).
Input	Static timetable data (schedule data), real-time data of rail and bus operators (delays, cancellations); access to DRT service platform (i.e. ability to send a request and receive DRT service availability)
Result/Requirement	The journey planning system can provide trip options that take real-time data from rail operators and bus operator/DRT service provider into account
Final State	Ad-hoc timetable that can be used to provide trip options that consider real-time data
Sequence	1. Journey planning system consumes real-time data of rail operator 1, rail operator 2 and bus operator. 2. Journey planning system matches real-time data with static timetable data. 3. Journey planning system constructs ad-hoc timetable based on static and real-time data. 4. Availability of DRT service is checked ad-hoc upon trip request (if DRT is part of the calculated journey).
Involved components (System)	Journey planning system, real-time data source of rail operator 1, real-time data source of rail operator 2, real-time data source of bus operator/DRT system
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.7. UC-FP6-WP6-1.2.3 Trip search based on the ad-hoc timetable

This use case was derived from user story US5.

Name	Trip search based on the ad-hoc timetable
ID	UC-FP6-WP6-1.2.3
Description	Traveller does a trip search and gets results that take into account the real-time situation
Related to task/subtask(s)	T6.1.2
Impact on other task(s)	

Interactions SP/FP	
Actor(s)	Traveller, journey planning system
Trigger	Traveller wants to plan a trip that shall start within the next hour(s) or wants to be informed about the current situation of a trip
Pre-Condition(s)	• Availability of journey planning system. • Journey planning system is equipped with static timetable data of rail operator 1 and rail operator 2 and of other service providers such as a bus operator or a DRT service provider. • Journey planning system consumes real-time information for services of rail operator 1 and 2 and for bus and/or DRT.
Input	Static timetable data (schedule data), real-time data of rail and bus operators (delays, cancellations); access to DRT service platform (i.e. ability to send a request and receive DRT service availability)
Result/Requirement	The journey planning system can provide trip options that take real-time data into account
Final State	Trip search results based on the ad-hoc timetable.
Sequence	1. Traveller enters origin, destination, and desired departure/arrival time within the next hour(s) on a journey planning application. 2. Traveller triggers trip search. 3. The journey planning algorithm seeks trips based on static timetable and based on ad-hoc timetable. 4. Traveller receives trip options.
Involved components (System)	Journey planning system, real-time data source of rail operator 1, real-time data source of rail operator 2, real-time data source of bus operator/DRT system
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.8. UC-FP6-WP6-1.2.4 Passenger information portal providing personalized details about regional service connections

This use case was derived from user story US6.

Name	Passenger information portal providing personalized details about regional service connections and services at stations
ID	UC-FP6-WP6-1.2.4
Description	Traveller does a trip search with individual settings and gets corresponding trip options as a result
Related to task/subtask(s)	T6.1.2
Impact on other task(s)	
Interactions SP/FP	
Actor(s)	Traveller, journey planning system
Trigger	Traveller wants to plan a trip
Pre-Condition(s)	• Availability of journey planning system. • Journey planning system is equipped with static timetable data.
Input	Static timetable data (schedule data) Station facility data (where relevant data exists), if possible, data can come from Travel service provider (TSP)
Result/Requirement	The journey planning system can provide trip options that take the settings of the user into account The journey planning system can provide trip options that take into account station facilities that matter for PRMs taking transfers at the station.
Final State	Trip search results that match the individual settings.
Sequence	1.Traveller enters origin, destination and desired departure/arrival time on the journey planning application. 2. Traveller sets individual search parameters (e.g. exclusion of certain types of vehicles, e.g. no bus, or exclusion of facilities that are not appropriate for PRM such as stairs). 3. Traveller triggers trip search. 4. The journey planning algorithm seeks trips taken into account the individual settings. 5. Traveller receives trip options.
Involved components (System)	Journey planning system

Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.9. UC-FP6-WP6-1.2.5 Passenger information portal provides a map showing Points of Interest that can be individually filtered by category

This use case was derived from user story US7.

Name	Passenger information portal provides a map showing Points of Interest that can be individually filtered by category
ID	UC-FP6-WP6-1.2.5
Description	Traveller can view points of interest (POIs) on a map, show/hide POIs based on their category and select POIs as start/destination of a trip search
Related to task/subtask(s)	T6.1.2
Impact on other task(s)	
Interactions SP/FP	
Actor(s)	Traveller, journey planning system
Trigger	Traveller wants to plan a trip to/from a POI
Pre-Condition(s)	• Availability of journey planning system. • Journey planning system is equipped with static timetable data and with POI data.
Input	Static timetable data (schedule data), POI data
Result/Requirement	The map of the journey planning system can show POIs and allows the user to select a POI as start or destination for a trip search
Final State	POI on the map was selected as start or destination for a trip search, i.e. has been passed to the input field of the trip search form
Sequence	1. Traveller opens the map of the passenger information portal. 2. Traveller activates the display of the desired category of POI. 3. Traveller selects a POI and chooses the POI as start or destination.
Involved components (System)	Journey planning system

Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.10. UC-FP6-WP6-1.2.6 Travel planning for specific user groups with reduced mobility (Selection of a default profile)

This use case was derived from user story US8.

Name	Travel planning for specific user groups with reduced mobility (Selection of a default profile)
ID	UC-FP6-WP6-1.2.6
Description	User of the journey planning application can choose a profile based on their specific travel needs, and the resulting trips take these specific needs into account (if supported in the data)
Related to task/subtask(s)	T6.1.2
Impact on other task(s)	
Interactions SP/FP	
Actor(s)	PRM Traveller, Travel Service Provider
Trigger	Traveller wants to plan a trip that considers her/his specific accessibility needs
Pre-Condition(s)	• Available timetable data includes information regarding accessibility features (esp. regarding station data, e.g. stairs/elevators). • Availability of trip planning application. • List of PRM profiles.
Input	Trip Origin, Trip destination, Depart/Arrival Time, PRM profile type
Result/Requirement	Trip options delivered to the traveller that take the selected PRM needs into account
Final State	The traveller receives trip options that cater to her/his specific needs in the journey planning application
Sequence	1. Traveller enters origin, destination and desired departure/arrival time on a journey planning application.

	2. Traveller selects a profile from a list of PRM profiles suited to their needs. 3. Traveller triggers trip search. 4. The journey planning algorithm seeks trips considering the requirements set by the traveller. 5. Traveller receives trip options.
Involved components (System)	Journey planning application, TSP System
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	

4.3.11. UC-FP6-WP6-1.2.7 Travel planning for passengers with reduced mobility with a personalised profile (Adjustment of a default profile)

This use case was derived from user story US8.

Name	Travel planning for passengers with reduced mobility with a personalised profile (Adjustment of a default profile)
ID	UC-FP6-WP6-1.2.7
Description	The user of the journey planning application can choose a profile based on their specific travel needs and adjust the default settings of this profile to her/his personal needs. The resulting trip will take these specific needs into account (if supported in the data)
Related to task/subtask(s)	T6.1.2
Impact on other task(s)	
Interactions SP/FP	
Actor(s)	PRM Traveller, Travel Service Provider
Trigger	Traveller wants to plan a trip that considers her/his specific accessibility needs
Pre-Condition(s)	• Available timetable data includes information regarding accessibility features. • Availability of trip planning application. • List of PRM profiles. • PRM not satisfied with trip option that were calculated taking into account the selected profile.

Input	Journey planning request based on a PRM profile, including personal settings
Result/Requirement	Trip options that take the selected PRM needs into account
Final State	The traveller receives trip options that cater to her/his specific needs in the journey planning application
Sequence	1. Traveller enters the view on settings. 2. Traveller adjusts the default settings of the previously selected profile as per their needs. 3. Traveller triggers another trip search. 4. The journey planning algorithm seeks trips considering the requirements set by the traveller. 5. Traveller receives trip options.
Involved components (System)	Journey planning application, TSP system
Responsible partner/person	Ira Kataria, Hacon Matthias Walter, Hacon
Notes	None

4.3.12. UC-FP6-WP6-2.1 Send updated operational plan and calculated forecast to PIS

This use case was derived from user story US9.

Name	Sending updated operational plan and calculated forecast provided by the TMS to passenger information services/systems (PIS)
ID	UC-FP6-WP6-2.01
Description	Following the updates of the operational plan and the calculated forecast in the TMS, specific relevant information is derived and sent to the PIS: • Expected delay in arrival and departure times of the trains; • Platform track changes; • Full or partial cancellations; • Incident information in relation to trains;
Related to task/subtask(s)	T6.2
Impact on other task(s)	T6.1.1, T6.4

Interactions SP/FP	FP1 WP12 Task 12.2.7
Actor(s)	Traffic Controller, TMS, PIS end user
Trigger	Scheduled or event-based triggers
Pre-Condition(s)	• Available operational plan including trains and operational restrictions (planned or incident based) impacting trains. • Availability of TMS. • Availability of integrated PIS / end customer application for the area covered by the TMS.
Input	• Baseline data for network topology and train characteristics, • Public timetable containing the trains of the TMS area, • Train position feeds (simulated), • Trip request.
Result/Requirement	Delay, track change and incident information delivered to the PIS.
Final State	The PIS end user receives delay information, track changes or incident information as part of the live trip information.
Sequence	1. (simulated) Train positions fed into TMS. 2. Update of operational plan in the TMS by Traffic Controller. 3. Train running forecast calculation performed in TMS. 4. Information derived from operational plan and train running forecast and transferred via interface to the PIS. 5. Information received by PIS. 6. PIS End user receives information in conjunction with his trip information.
Involved components (System)	TMS, PIS, Journey planning application
Responsible partner/person	Rolf Gooßmann, Hacon
Notes	None

4.3.13. UC-FP6-WP6-2.2 Usage of the number of expected travellers for timetable planning or traffic dispatching

This use case was derived from user story US10.

Name	Usage of the number of expected travellers for timetable planning or traffic dispatching
ID	UC-FP6-WP6-2.2
Description	As part of the demand forecast information, the Traffic management System (TMS) or Capacity Management and Planning System (CMS) receives the number of expected travellers from A to B in defined time windows being visualized for decision support in (re-) planning the timetable in CMS and/or changing the Operational Plan in TMS.
Related to task/subtask(s)	T6.2
Impact on other task(s)	T6.1.1, T6.4
Interactions SP/FP	FP1 WP6 Task 6.3.1, WP7 Task 7.5.1 and 7.6 FP1 WP12
Actor(s)	Timetable/Traffic Planner, Traffic Controller, TMS, PIS
Trigger	Scheduled trigger in TMS or CMS for looking up newly delivered input being available.
Pre-Condition(s)	• Available timetable (CMS) and related Operational Plan (TMS) including trains for which demand forecast information is available, i.e., expected travellers for relation A-B where A and B are starting and destination stations of the trains. • Availability of CMS and related TMS. • Availability of integrated PIS providing demand forecast for the area covered by the CMS/TMS.
Input	• Baseline data for network topology and train characteristics. • Public timetable containing the trains of the CMS/TMS area. • Source data allowing to derive demand forecast for at least a part of the network covered with planned timetables for trains.
Result/Requirement	Changes applied to the timetable (CMS) or the Operational Plan (TMS) based on forecasted demand.

Final State	The resulting timetable / Operational Plan addresses the forecasted travel/transport demand.
Sequence	1. The number of expected travellers from A to B in a defined time window is received by CMS. 2. Travel/transport demand window is generated in the CMS as part of the planning data and is available to CMS system logic and to the users of the CMS. 3. Different timetable change options are applied involving CMS timetable planner and the CMS: a. Let the planning system generate (an) extra train(s) from A to B with defined seat capacity. b. Decide a (partial) cancellation of a service due to non-sufficient demand. c. Decide on reducing or increasing the number of coaches for existing service(s) from A to B matching the demand. 4. CMS implements the change in the planned timetable. 5. CMS forwards the changed plan to TMS (if changes to be included in the current Operational Plan). 6. TMS updates Operational Plan (if changes to be included in the current Operational Plan).
Involved components (System)	CMS, TMS, PIS, Integration Platform
Responsible partner/person	Rolf Gooßmann, Hacon
Notes	None

4.3.14. UC-FP6-WP6-2.3 Receive and use travellers demand between subsequent stops

This use case was derived from user story US10.

Name	Receiving and using the number of expected travellers between subsequent stops of a given train for timetable planning or traffic dispatching
ID	UC-FP6-WP6-2.03
Description	As part of the demand forecast information, the TMS/CMS receives the number of expected travellers between subsequent stops of a given train being visualized for decision support in (re-) planning the timetable in CMS and/or changing the Operational Plan in TMS.

Related to task/subtask(s)	T6.2
Impact on other task(s)	T6.1.1, T6.4
Interactions SP/FP	FP1 WP6 Task 6.3.1, WP7 Task 7.5.1 and 7.6 FP1 WP12
Actor(s)	Timetable/Traffic Planner, Traffic Controller, TMS, PIS
Trigger	Scheduled, regular trigger in TMS or CMS for looking up newly delivered input being available.
Pre-Condition(s)	• Available timetable (CMS) and related Operational Plan (TMS) including trains for which demand forecast information is available, i.e., expected travellers between subsequent stops A-B of a given train. • Availability of CMS and related TMS. • Availability of integrated PIS providing demand forecast for the area covered by the CMS/TMS.
Input	• Baseline data for network topology and train characteristics. • Public timetable containing the trains of the CMS/TMS area. • Source data allowing to derive demand forecast for at least a part of the network covered with planned timetables for trains.
Result/Requirement	Changes applied to the timetable (CMS) or the Operational Plan (TMS) based on forecasted demand.
Final State	The resulting timetable / Operational Plan addresses the forecasted travel/transport demand.
Sequence	1. The number of expected travellers between subsequent stops of a given train is received by CMS. 2. The information is generated in the CMS and assigned to the respective train and its respective journey section A-B as part of the planning data. The information is available to CMS system logic and to the users of the CMS. 3. Timetable change involving CMS timetable planner and the CMS based on occupancy information between stops, decide on prioritization of trains and related re-planning (e.g., changing train sequence). 4. CMS implements the change in the planned timetable. 5. CMS forwards the changed plan to TMS (if changes to be included in the current Operational Plan). 6. TMS updates Operational Plan (if changes to be included in the current Operational Plan).

Involved components (System)	CMS, TMS, PIS
Responsible partner/person	Rolf Gooßmann, Hacon
Notes	None

4.3.15. UC-FP6-WP6-2.4 Receive and use travellers embarking/disembarking flow on stations

This use case was derived from user story US10.

Name	Receiving and using the number of expected travellers embarking/disembarking at the stations for timetable planning or traffic dispatching
ID	UC-FP6-WP6-2.04
Description	As part of the demand forecast information, the TMS/CMS receives the number of expected travellers embarking/disembarking at the stations being visualized for decision support in (re-) planning the timetable in CMS and/or changing the Operational Plan in TMS.
Related to task/subtask(s)	T6.2
Impact on other task(s)	T6.1.1, T6.4
Interactions SP/FP	FP1 WP6 Task 6.3.1, WP7 Task 7.5.1 and 7.6 FP1 WP12
Actor(s)	Timetable/Traffic Planner, Traffic Controller, TMS, PIS
Trigger	Scheduled, regular trigger in TMS or CMS for looking up newly delivered input being available.
Pre-Condition(s)	• Available timetable (CMS) and related Operational Plan (TMS) including trains for which demand forecast information is available, i.e., expected travellers between subsequent stops A-B of a given train. • Availability of CMS and related TMS. • Availability of integrated PIS providing demand forecast for the area covered by the CMS/TMS.
Input	• Baseline data for network topology and train characteristics.

	• Public timetable containing the trains of the CMS/TMS area, • Source data allowing to derive demand forecast for at least a part of the network covered with planned timetables for trains.
Result/Requirement	Changes applied to the timetable (CMS) or the Operational Plan (TMS) based on forecasted demand.
Final State	The resulting timetable / Operational Plan addresses the forecasted travel/transport demand.
Sequence	1. The number of expected travellers between subsequent stops of a given train is received by CMS. 2. The information is generated in the CMS and assigned to the respective train and its respective journey section A-B as part of the planning data. The information is available to CMS system logic and to the users of the CMS. 3. Timetable change involving CMS timetable planner and the CMS decide on required exceptional dwell time at stations for consideration of unexpected number of people embarking/disembarking at the station. 4. CMS implements the change in the planned timetable. 5. CMS forwards the changed plan to TMS (if changes to be included in the current Operational Plan). 6. TMS updates Operational Plan (if changes to be included in the current Operational Plan).
Involved components (System)	CMS, TMS, PIS
Responsible partner/person	Rolf Gooßmann, Hacon
Notes	None

4.3.16. UC-FP6-WP6-4.1 Forecast Occupancy of Vehicles using Journey Planning Requests Data

This use case was derived from user story US11.

Name	Forecast Occupancy of Vehicles using Journey Planning Requests Data
ID	UC-FP6-WP6-4.01
Description	This use case involves predicting the occupancy of transportation vehicles based on journey planning requests data

	(or other sources), which includes information about the origin, destination, and expected time of travel for customers.
Related to task/subtask(s)	T6.4
Interactions SP/FP	Interaction with FP1 WP19 to align specification between main line and regional lines
Actor(s)	MaaS platform
Trigger	New journey planning request data received
Pre-Condition(s)	Journey planning requests data is available, historical vehicle occupancy data is collected
Input	Journey planning request data (origin, destination, expected travel time)
Result/Requirement	Predicted occupancy for specific routes and time slots
Final State	The system provides forecasted occupancy information for various routes and time slots.
Sequence	1. Gather journey planning request data, including origin, destination, and expected travel time. 2. Train the machine learning model using historical vehicle occupancy data and journey planning request data. 3. Receive a new journey planning request. 4. Apply the trained model to predict vehicle occupancy for the requested journey. 5. Store the forecasted occupancy information for future reference.
Involved components (System)	Data Analytics Platform, Machine Learning Model
Responsible partner/person	Marco Ferreira (HACON)
Notes	The accuracy of the occupancy forecast may vary based on the quality and completeness of the journey planning request data.

4.3.17. UC-FP6-WP6-4.2 Display Forecasted Occupancy Information to Travelers when Planning Trips

This use case was derived from user story US12.

Name	Display Forecasted Occupancy Information to Travelers when Planning Trips
ID	UC-FP6-WP6-4.02
Description	This use case involves displaying forecasted vehicle occupancy information to travellers when they plan their trips through a trip planning interface.
Related to task/subtask(s)	T6.4
Interactions SP/FP	Interaction with FP1 WP19 to align specification between main line and regional lines
Actor(s)	Travellers
Trigger	Traveller initiates the trip planning process
Pre-Condition(s)	Traveller uses journey planning tool Forecasted vehicle occupancy data is available
Input	Journey planning request data (origin, destination, expected travel time)
Result/Requirement	Display of forecasted vehicle occupancy information for the proposed journeys
Final State	The traveller receives relevant forecasted occupancy information for trip planning.
Sequence	1. Traveller enters their origin, destination, and preferred time of travel. 2. The trip planning interface displays several trip option and fetches forecasted vehicle occupancy information for the journeys. 3. Display the forecasted vehicle occupancy to the traveller on the trip planning interface.
Involved components (System)	Journey Planning app, Data Analytics Platform
Responsible partner/person	Marco Ferreira (HACON)
Notes	The displayed forecasted occupancy information is for planning purposes and may not reflect real-time changes in vehicle availability.

4.3.18. UC-FP6-WP6-4.3 Estimation of Mobility Demand beyond Rail (First/Last Mile Analysis)

This use case was derived from user story US3.

Name	Estimation of Mobility Demand beyond Rail (First/Last Mile Analysis)
ID	UC-FP6-WP6-4.03
Description	This use case involves estimating mobility demand beyond rail transportation by conducting a first/last mile analysis. Travel Service Providers can analyse areas with high demand and low offering. This allows them to create adapted offers for seamless transportation connections between rail stations and surrounding locations.
Related to task/subtask(s)	T6.4
Interactions SP/FP	
Actor(s)	Travel Service Providers (Rail and others)
Trigger	Availability of journey planning requests data
Pre-Condition(s)	Journey planning requests data are available, historical travel demand data is collected
Input	Journey planning requests data, historical travel demand data
Result/Requirement	Estimated mobility demand for first/last mile connections and identification of areas with high demand and low offering.
Final State	Travel service providers have insights into areas with high mobility demand and can plan and optimize first/last mile connections accordingly.
Sequence	1. Collect rail transportation data, including station locations, schedules. 2. Collect historic travel demand data based on journey planning requests data. 3. Train the machine learning model using historical travel demand data combining rail and other modes in the surrounding areas. 4. Estimate the mobility demand for first/last mile connections between rail stations and surrounding locations. 5. Identify areas with high demand and low offering based on the analysis results. 6. Provide data insights for travel service providers through the demand analytics dashboard.

Involved components (System)	Data Analytics Platform, Demand analytics dashboard
Responsible partner/person	Marco Ferreira (HACON)
Notes	The accuracy of the demand estimation depends on the quality and completeness of the available data.

4.4. Requirements

The use cases listed in Chapter 4.3 specify either the multimodal travel solution including features for PRM (use cases in Sections 4.3.1 through 4.3.11) or related features that are characterized by interactions with FP1 (use cases in Sections 4.3.12 through 4.3.18). For all these use cases, requirements for the system to be developed were derived and are listed in Table 5. In the table, each requirement is given an ID associating it with the corresponding task and use case ID. FRQ corresponds to a Functional Requirement and NFRQ corresponds to Non-Functional Requirement.

Use case ID Use case name (Related user story)	Requirement ID	Requirement
UC-FP6-WP6-1.1.1 Travel planning for regional lines including a DRT service for first/last mile (US1)	T6.1_UC1.1.1_FRQ01	The system must be able to gather data from public Travel Service Provider system (timetable data) and DRT service provider system (including service area and operating hours).
	T6.1_UC1.1.1_FRQ02	The journey planning application must be able to compute trips that combine public transport legs with DRT legs for first and/or last mile.
	T6.1_UC1.1.1_FRQ03	The journey planning application must have a user interface allowing travellers to input their origin, destination, and desired departure/arrival time.
	T6.1_UC1.1.1_FRQ04	The system shall be able to integrate with the API of the DRT system to check the availability of a DRT vehicle for a specified trip leg.

Use case ID Use case name (Related user story)	Requirement ID	Requirement
	T6.1_UC1.1.1_NFRQ01	The trip search functionality should provide responses within a reasonable duration to ensure timely retrieval of trip options.
UC-FP6-WP6-1.1.2 Travel planning for regional lines taking into account rules of competition for Public Transit and DRT (US2)	T6.1_UC1.1.2_FRQ01	The system must be able to gather data defining the rules of competition for public transit and DRT services.
	T6.1_UC1.1.2_FRQ02	The system must be able to compute trips that stick to the rules of competition (e.g. no DRT offer parallel to a public transit service).
	T6.1_UC1.1.2_NFRQ01	The system should integrate and process the data within a reasonable amount of time and with accuracy, to provide reliable trip options, without discrepancies.
UC-FP6-WP6-1.1.3 Simulation of required DRT capacity based on predicted travel demand (US3)	T6.1_UC1.1.3_FRQ01	There must be a simulation system specifically designed for DRT services.
	T6.1_UC1.1.3_FRQ02	The simulation system must process travel demand data and assign a given set of vehicles to DRT trip requests derived from the travel demand data.
	T6.1_UC1.1.3_FRQ03	The simulation system must provide metrics after a simulation run that allow to assess the service quality reached for a given scenario.
UC-FP6-WP6-1.1.4 Support OJP trip search requests and include DRT in the response (US 4)	T6.1_UC1.1.4_FRQ01	The system must be able to receive a trip search request from an external system via the OJP protocol and process it internally.
	T6.1_UC1.1.4_FRQ02	The system must be able to send a response for a trip search request containing trip options to an external system via the OJP protocol.

Use case ID Use case name (Related user story)	Requirement ID	Requirement
	T6.1_UC1.1.4_FRQ03	The system must be able to support the OJP protocol not only for public transit but also for DRT.
	T6.1_UC1.1.4_NFRQ01	The system should integrate with the external journey planning system in a robust and reliable manner.
UC-FP6-WP6-1.2.1 Synchronization of operational processes among regional rail operators to adjust ad-hoc timetables (US5)	T6.1_UC1.2.1_FRQ01	The system must be able to interface with real-time data feeds of rail operators.
	T6.1_UC1.2.1_FRQ02	The system must be able to process real-time data feeds and match real-time data to static timetable data.
	T6.1_UC1.2.1_NFRQ01	The system must process and match real-time data quickly and with high frequency.
UC-FP6-WP6-1.2.2 Synchronization of operational process among regional rail operators and other services to adjust ad-hoc timetables (US5)	T6.1_UC1.2.2_FRQ01	The system must be able to interface with real-time data feeds of bus operators.
	T6.1_UC1.2.2_FRQ02	The system must be able to interface with the system of a DRT service provider for checking latest availability of data.
UC-FP6-WP6-1.2.3 Trip search based on the ad-hoc timetable (US5)	T6.1_UC1.2.3_FRQ01	The system must be able to provide trip options that are enriched with real-time data (e.g. delay information).
	T6.1_UC1.2.3_FRQ02	The system must be able to calculate trip options that are feasible in regard to static timetable data as well as trip options that are feasible with respect to real-time data.
	T6.1_UC1.2.3_NFRQ01	The system must respond to trip requests with a desired departure time within the next two hours (i.e. within the relevant time window for real-time data) almost as fast as to trip requests for tomorrow or

Use case ID Use case name (Related user story)	Requirement ID	Requirement
		yesterday, which are searched on static timetable data.
UC-FP6-WP6-1.2.4 Passenger information portal providing personalized details about regional service connections (US6)	T6.1_UC1.2.4_FRQ01	The system must be able to process user input, including origin, destination, and preferred time of travel and additional individual settings.
	T6.1_UC1.2.4_FRQ02	The system must be able to provide trip options that correspond to the user's input.
	T6.1_UC1.2.4_FRQ03	Selecting origin and destination locations must be supported by the system by providing a list of suggestions upon keyboard entry of (parts of) the location's name.
	T6.1_UC1.2.4_NFRQ01	The system must provide trip options within an acceptably short amount of time.
	T6.1_UC1.2.4_NFRQ02	The system must present the trip options in a clear and informative way.
UC-FP6-WP6-1.2.5 Passenger information portal provides a map showing Points of Interest that can be individually filtered by category (US7)	T6.1_UC1.2.5_FRQ01	The system must feature a map view that presents Points of Interest to the user.
	T6.1_UC1.2.5_FRQ02	The system must be able to show/hide POIs depending on their category when the user activates/deactivates the display for the respective category of POIs.
	T6.1_UC1.2.5_FRQ03	The system must offer the option to select a POI in the map view as start or destination for the next trip search.
	T6.1_UC1.2.5_NFRQ01	The map must not be cluttered by icons representing POIs.
UC-FP6-WP6-1.2.6 Travel planning for specific user groups with reduced mobility	T6.1_UC1.2.6_FRQ01	The system must provide a view that offers a list of profiles for different types of PRM from which one profile can be selected by the user.
	T6.1_UC1.2.6_FRQ02	Depending upon the selected profile,

Use case ID Use case name (Related user story)	Requirement ID	Requirement
(Selection of a default profile) (US8)		the system must apply corresponding parameter values for the trip search request.
	T6.1_UC1.2.6_NFRQ01	The user must be made aware that a certain profile is active for his/her trip searches.
UC-FP6-WP6-1.2.7 Travel planning for passengers with reduced mobility with a personalised profile (Adjustment of a default profile) (US8)	T6.1_UC1.2.7_FRQ01	The system must enable a user to change default parameter values that are associated with a profile.
	T6.1_UC1.2.7_FRQ02	If a user profile was selected and parameter values have been adjusted, the system must apply the parameter values of the selected profile considering the adjusted values for the trip search request.
	T6.1_UC1.2.7_FRQ03	The system must offer the option to reset changed parameter values of a profile to their default value.
	T6.1_UC1.2.6_NFRQ01	The user must be made aware when parameter values of the selected profile deviate from their default value.
UC-FP6-WP6-2.1 Send updated operational plan and calculated forecast to PIS (US 9)	T6.2_UC2.1_FRQ01	The TMS must be able to send updated departure/arrival times of the operational plan and forecasted departure/arrival times (delay information) to the PIS.
	T6.2_UC2.1_FRQ02	The TMS must be able to send platform/track changes to the PIS.
	T6.2_UC2.1_FRQ03	The TMS shall be able to send incident information to the PIS.
	T6.2_UC2.1_FRQ04	The TMS must be able to send a cancellation of a complete trip/service (full cancellation) and of some stops of a trip/service (partial cancellation) to the PIS.
	T6.2_UC2.1_FRQ05	The TMS must be able to send incident information in relation to trains to the PIS.
	T6.2_UC2.1_FRQ06	The PIS must be able to match the

Use case ID Use case name (Related user story)	Requirement ID	Requirement
		data received from the TMS to the timetable data kept in the PIS.
UC-FP6-WP6-2.2 Usage of the number of expected travellers for timetable planning or traffic dispatching (US 10)	T6.2_UC2.2_FRQ01	The PIS must be able to estimate the expected number of travellers from A to B in a defined time window based on historic trip request data.
	T6.2_UC2.2_FRQ02	The PIS must be able to send the expected number of travellers from A to B in a defined time window to the TMS.
UC-FP6-WP6-2.3 Receive and use travellers demand between subsequent stops (US 10)	T6.2_UC2.3_FRQ01	The PIS must be able to estimate the expected number of travellers between subsequent stops of a given train based on historic trip request data.
	T6.2_UC2.3_FRQ02	The PIS must be able to send the expected number of travellers between subsequent stops of a given train to the TMS.
UC-FP6-WP6-2.4 Receive and use travellers embarking/disembarking flow on stations (US10)	T6.2_UC2.4_FRQ01	The PIS must be able to estimate the expected number of travellers that embark/disembark at a stop of a given train based on historic trip request data.
	T6.2_UC2.4_FRQ02	The PIS must be able to send the expected number of travellers embarking/disembarking at a stop of a given train to the TMS.
UC-FP6-WP6-4.1 Forecast Occupancy of Vehicles using Journey Planning Requests Data (US11)	T6.4_CA03_FRQ01	The system must be able to gather data relevant for occupancy forecast: • Journey planning requests (including origin, destination, and expected travel time) • Vehicle occupancy sensor data (optional)
	T6.4_CA03_NFRQ01	The system must be able process the collected data in reasonable time.
	T6.4_CA04_FRQ01	The system must be able to train a

Use case ID Use case name (Related user story)	Requirement ID	Requirement
		machine learning model using historical vehicle occupancy data and journey planning request data.
	T6.4_CA04_FRQ02	The system must be able to process the data and update the occupancy model considering historic data.
	T6.4_CA04_FRQ03	The system must be able to receive a new journey planning request and apply the trained model to predict vehicle occupancy for the requested journey.
	T6.4_CA04_FRQ04	The system must be able to inform the MaaS platform about the new occupancy model.
	T6.4_CA04_NFRQ01	The system should keep the occupancy model as updated as possible.
UC-FP6-WP6-4.2 Display Forecasted Occupancy Information to Travelers when Planning Trips (US12)	T6.4_CA05_FRQ01	The system must be able to process user input, including origin, destination, and preferred time of travel.
	T6.4_CA05_FRQ02	The system must be able to fetch forecasted vehicle occupancy information for the proposed journeys based on the user's input.
	T6.4_CA05_NFRQ01	The trip planning interface should be user-friendly and intuitive, making it easy for travellers to enter their information.
	T6.4_CA06_FRQ01	The system must be able to generate several trip options based on the user's input and available forecasted occupancy information.
	T6.4_CA06_FRQ02	The system must be able to display the forecasted vehicle occupancy information to the traveller on the trip planning interface.
	T6.4_CA06_NFRQ01	The trip planning interface should be user-friendly and intuitive, making it easy for travellers to understand the

Use case ID Use case name (Related user story)	Requirement ID	Requirement
		displayed forecasted occupancy information.
UC-FP6-WP6-4.3 Estimation of Mobility Demand beyond Rail (First/Last Mile Analysis) (US3)	T6.4_CA07_FRQ01	The system must be able to train a machine learning model using historical travel demand data, combining rail and other modes in the surrounding areas.
	T6.4_CA07_FRQ02	The system must be able to estimate the mobility demand for first/last mile connections between rail stations and surrounding locations.
	T6.4_CA07_NFRQ01	The system should be reliable and available for request for forecasted occupancy information whenever required by the TSP.
	T6.4_CA08_FRQ01	The system must be able to analyse the estimation results and identify areas with high demand and low offering.
	T6.4_CA08_FRQ02	The system must provide data insights for travel service providers through a demand analytics dashboard.
	T6.4_CA08_NFRQ01	The system must ensure the accuracy and completeness of the available data to improve the accuracy of demand estimation.

Table 5 – List of requirements per use case

5. Conclusions

The present deliverable D6.1 describes the Alpha Release specifications for a regional rail services solution. The service to be developed is an information platform, combining information about travel options including rail services and other transport services, including but not limited to on-demand services. The focus is on the connection from rail with first and last mile transport, especially in rural areas.

The scope of collaboration with FP1 -MOTIONAL is described. It will include the development of interfaces for data exchanges regarding Demand Responsive Transit and travel demand forecast.

The specification of the Regional Rail Services solution is defined through user stories and use cases, that specify the key elements of the solution as of M15 of the project. Use cases 1.1.1 to 1.1.4 focus upon integration of DRT services for the first and last mile connections. Use cases 1.2.1 to 1.2.3 describe the synchronisation of real time timetables to adjust ad-hoc timetables considering changes in the planned schedule. Use cases 1.2.4 and 1.2.5 elaborate on personalised passenger information portals. Further, use cases 1.2.6 and 1.2.7 are specifying travel planning for specific user groups, especially PRM.

Moreover, covering the scope of interactions with FP1, use cases 2.01 to 2.04 define the interface between TMS and PIS. While use cases 4.01 to 4.03 are focused upon travel demand prediction for regional lines. Based on each use case, requirements have been derived. In the upcoming deliverables for Task 6.1 (Deliverable 6.2), Task 6.2 (Deliverable 6.3) and Task 6.4 (Deliverable 6.5) detailed specifications for each topic will be included, specifying UML diagrams, components, interfaces and standards, algorithms descriptions, and as an outcome, a list of functionalities to be developed in WP11. These functionalities will be demonstrated within WP11 up to suitable Technology Readiness Levels.

6. References

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