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ORCHESTRA Project Deliverable: D5.3

Plan for ORCHESTRA's Living Labs

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Deliverable Identification

Deliverable ID:	**D5.3**	Deliverable title:	Plan for ORCHESTRA's Living Labs
Release Number:		1.0	
Release Date:		2022-06-23	
Deliverable Description		Plan for the Living Labs, including: Stakeholders involved, tools to be used, systems to be integrated, scenarios to addressed (those to be simulated included), use cases to be piloted, and training sessions to be accomplished are described.	
Dissemination Level		PU = Public	
Deliverable Type		R = Report	
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Release History

Version	**Date**	**Internal Review Milestone Reached (if relevant)**	**Summary of main changes introduced in this version**
0.1	2021-12-20	PCOS	Document creation
0.2	2022-04-01	Intermediate proposed	Updated structure with a view to aligning the description of the two Living Labs
0.3	2022-06-10	External proposed	More detailed information on actors, harmonised description of operations, events and scenarios for both Living Labs
1.0	2022-06-30	Released	Minor formatting measures. Minor corrections.

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About ORCHESTRA

The problem addressed by ORCHESTRA is that traffic caused by transport has many negative effects. There are congestions, delays, emissions and negative impacts on urban environments, and in case of disruptions, there may be huge consequences on the efficiency and timeliness. These challenges are hard to handle due to lack of coordination between the different transport modes.

The long-term vision of ORCHESTRA is a future where it is easy to coordinate and synchronise the traffic management of all modes to cope with diverse demands and situations. The overall objective of ORCHESTRA is to provide European policy makers, public authorities, transport providers and citizens with new knowledge and technical and organisational solutions to enhance collaboration and synchronising of operations within and across transport modes.

The project will:

- Establish a common understanding of multimodal traffic management concepts and solutions, within and across different modes, for various stakeholders and multiple contexts
- Define a Multimodal Traffic Management Ecosystem (MTME) where traffic managements in different modes and areas (rural and urban) are coordinated to contribute to a more balanced and resilient transport system, bridging current barriers and silos
- Support MTME realisation and deployments, through the provision of tools, models, and guidelines – including the integration of connected and automated vehicles and vessels (CAVs)
- Validate and adjust MTME for organisational issues, functionality, capability and usability
- Maximise outreach and uptake of project results through strong stakeholder involvement

ORCHESTRA's main advancements beyond state-of-the-art are related to four focus areas:

- MTME facilitated by: 1) a Polycentric Multimodal Architecture (PMA) specifying how systems collaborate. 2) Flexible organizational and business models. 3) Simulation and training tools. 4) Policy and regulatory recommendations. 5) data governance and sharing framework
- Traffic orchestration supporting optimal traffic flows, adapted to current and foreseen situations and societal aspects. Data on ongoing and planned transports as well as other issues that may affect the traffic will be monitored and used in decision support and to facilitate resilience
- Coordination across modes and networks bridging current silos, ensuring best possible utilisation of transport system as a whole
- Traffic management supporting more optimal multimodal transport services and fleet operations, those carried out by CAVs included. Transport operations will be guided and controlled according to pre-defined rules and trade-offs between different optimisation targets.

The project will validate and evaluate the multimodal traffic management concept and related tools in its two Living Labs, both in Norway and Italy, covering freight and person transports across road, rail, water and air.

Legal disclaimer

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Executive Summary

The main result of this document is the presented plan for ORCHESTRA's living labs. There are two living labs, namely Herøya industrial park (Norway), dealing with goods transport, and Milan airport (Italy), dealing with passenger transport.

Herøya Industrial Park (HIP) is located in southern Norway and contains 80 businesses engaged in a wide range of industrial activities. Goods are transported to and from HIP by roads and by sea. The park is semi-restricted, with trucks being escorted by an escort car. There are four governance areas in the Herøya living lab: HIP, sea, railway and public roads. Actors and stakeholders in the Herøya living lab comprise national authorities as well as private entities, both of which act as traffic orchestrators. Different tools will be used in the Herøya living lab, such as a situations and geofencing data sharing tool allowing road owners and regulators to define areas with particular temporary properties in order to handle deviations. There are further multiple tools for gaining insights into ongoing activities and the management of a connected automated vehicle (CAV) as the aforementioned escort car. Different systems will be integrated for the living lab in order to provide a more complete picture of the ecosystem, including external traffic information on both roads and the sea. Three operations are proposed to reflect the different types of activities around the transport of goods at HIP. The operations cover the arrival of goods at HIP (to be piloted and simulated), the transfer of goods from incoming ships to trucks, and outgoing goods transport by truck (both to be simulated only). A happy flow is described first before considering different disruptive events. Before the start of the piloting activities, training sessions will be organised with operational management stakeholders for roads and the sea to familiarise them with the ORCHESTRA concepts and the tools used in the Herøya living lab.

Milan Malpensa airport is Italy's second largest international airport, comprising two runways and two passenger terminals. Passengers access the airport by car, bus or train, with a large emphasis on cars. There are five governance areas in the Milan living lab: Airspace, airport ground, railway, transfer node and road. Actors and stakeholders in the Milan living lab comprise public and private passenger traffic orchestrators involved in road, air, and rail traffic, as well as the airport managing company. The tools used in the Milan living lab focus on the sharing and representing of relevant information on the one hand, and providing guidance to users in disruption situations on the other hand. As the living lab will be mainly supported by simulations, a passenger emulator emulating passengers' travel requests will also be integrated. Two operations are proposed to illustrate the flow of passengers through the airport. One operation is dedicated to passengers travelling to a foreign destination, while the other operation concerns passengers arriving from a foreign destination. A happy flow is described first before considering different disruptive events. Before the start of the piloting activities, training sessions will be organised with the airport managing company and the air navigation service provider to familiarise them with the ORCHESTRA concepts and the tools used in the Milan living lab.

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Table of Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 953618. This document reflects only the author's view and the Agency is not responsible for any use that may be made of the information it contains.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 953618. This document reflects only the author's view and the Agency is not responsible for any use that may be made of the information it contains.

Table of Figures

List of Tables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 953618. This document reflects only the author's view and the Agency is not responsible for any use that may be made of the information it contains.

List of Abbreviations

Table 1: List of abbreviations

Abbreviation	Explanation
AIS	Automatic Identification System
API	Application Programming Intgerface
App	Application
CAV	Connected Autonomous Vehicle. Autonomous concierge car.
ETA	Estimated Time of Arrival
GA	Governance Area
HBT	Event based top system
HIP	Herøya Industrial Park, Porsgrunn, Norway
ID	Identifier
ISPS	International Ship Port facility
KPIs	Key Performance Indicators
MTME	Multimodal Traffic Management System
NPRA	The Norwegian Public Roads Administration, Statens vegvesen
MS	Milestones
MXP	Milano Malpensa
TCC	Traffic Control Centres
TMS	Traffic Management System
T1	Terminal 1
T2	Terminal 2
WP	Work package

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1 About this Deliverable

1.1 Why would I want to read this deliverable?

The plan for the living labs provides a background for the two living lab sites, and also provides details of the different activities that are planned in order to demonstrate the applicability and performance of the results of preceding work packages. As such, this deliverable also sets the stage for the evaluations that will follow.

1.2 Intended readership/users

The intended readership for this deliverable is as broad as the deliverable itself. Industrial actors in the fields of freight and/or passenger transport might be interested in learning about the envisaged set-up of the different living lab activities, while organisations with a technical focus might find the explanations on the applications of tools insightful. Researchers might be interested in seeing how this deliverable plan the transition from theoretical work and models to evaluations. Last but not least, the ORCHESTRA project participants will be able to use this deliverable to obtain information about the living labs and how they support the project.

1.3 Relationship of this deliverable with other deliverables

The main goal of D5.3 is to provide a plan for ORCHESTRA's living labs. This plan serves to ensure that the living labs will deliver relevant results, taking into account needs and constraints defined by preceding work packages and achieving the data needed by parallel and following deliverables and work packages. In particular, D5.3 uses information from D2.1 (Initial target vision for multimodal traffic management) for the overall multimodal traffic management vision and D2.3 (Initial scenarios for multimodal traffic management) for the scenarios that need to be tested as part of the living labs. For the use cases, input is obtained from D3.1 (Initial use cases for multimodal traffic management), which describes the systems of interest and identifies the logical services. A major part of the living labs will be the use and demonstration of the technical tools for multimodal traffic management, and thus there is a strong connection with D4.1 (Initial version of technical tools). Finally, the results of D6.1 (Evaluation handbook) are used in D5.3 in order to make sure that the project's data collection plan is being followed so that the KPIs defined can be analysed later. This applies especially to the simulation scenarios.

The provision of a plan for the living labs in ORCHESTRA serves multiple purposes. Within WP5, a definition of the living labs is required by both D5.1 (Simulation Architecture) and D5.2 (Simulator) as these deliverables are strongly influenced by the plan for what can be affected physically in the living labs, and what needs to be simulated. D5.3 also sets up D5.4 (Final Living Labs) and D5.5 (Training trials for multimodal traffic management), which execute the plan of D5.3 and reports on the results. This includes both the piloting and simulating of scenarios and use cases, as well as the training sessions with relevant stakeholders. The training sessions will further also be used by D4.5 (Training Modules), which defines training modules for operative multimodal traffic management. Having taken input from D6.1 (Evaluation handbook), D5.3 will also provide output for D6.2 (Intermediate evaluation results from Living Labs) and D6.3 (Evaluation outcome). While D5.3 presents a plan and not results from the living labs as such (this will be the subject of D5.4 (Final Living Labs)), it allows preparing the evaluation of results to come.

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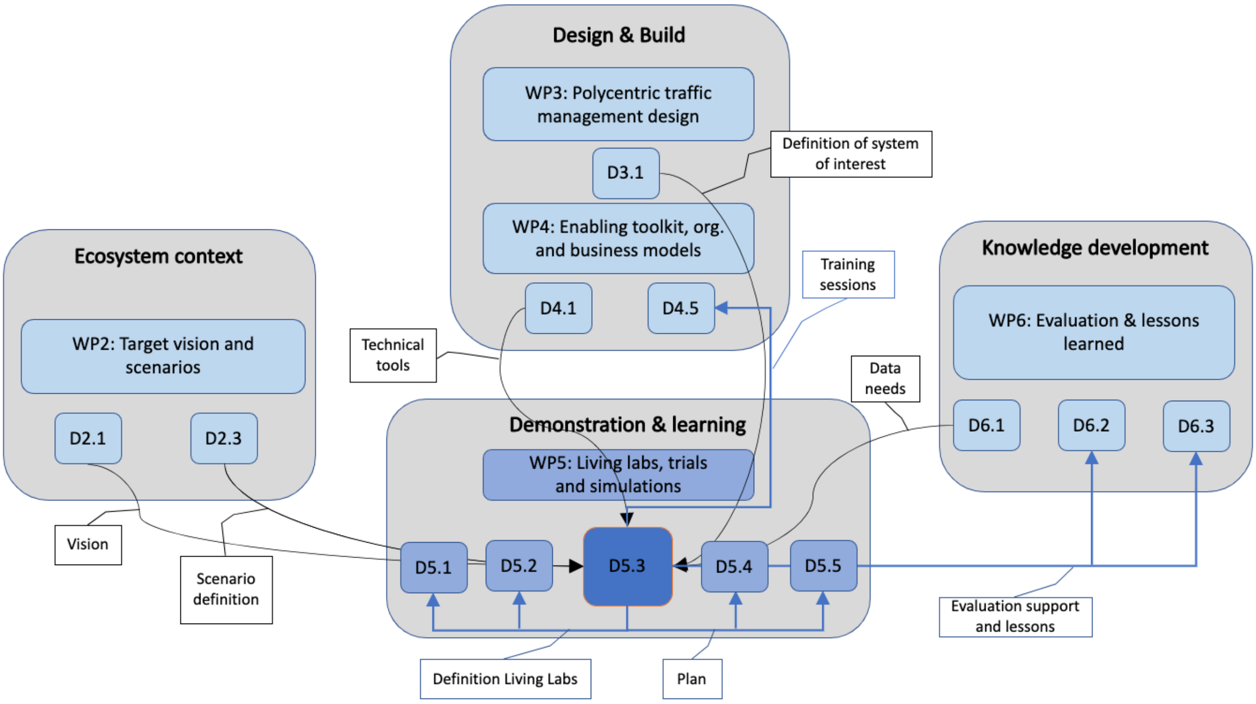

Figure 1: Relationship of D5.3 and other deliverables in ORCHESTRA

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2 Introduction

This document relates to ORCHESTRA's two living labs. The Herøya living lab addresses freight transport and focuses on the management of traffic connected to moving goods to, from and through Herøya industry park. The Milan living lab addresses passenger transport, with a focus on the traffic connected to people travelling by plane via Milan Malpensa airport.

2.1 Scope of the document

This document covers an initial plan for the living labs in Italy and in Norway, setting a framework for the implementations of both pilots and simulations that are to come. It aims to ensure that the living labs are correctly connected to other work packages and activities in the ORCHESTRA project. As such, it touches on many different topics involved in the living labs, ranging from tools that will be used to material provided for later evaluation. The full details of these topics go beyond the scope of this document and will be the subject of other deliverables.

2.2 Role of the Living Labs

The living labs serve a number of purposes. First and foremost, the use of real use cases in one freight-oriented and one passenger oriented living lab aims to demonstrate the applicability and performance of the WP2 (Target vision and scenarios), WP3 (Polycentric traffic management design) and WP4 (Enabling toolkit, organisational and business models) outcomes. In supporting the evaluations, the living labs will be assessed and validated in WP6 (Evaluation and lessons learned). In this way, the living labs provide a bridge between the theoretical work done and practical implementations and tests, supporting the relevance of the project in a real-life context.

To pilot every envisaged scenario in a living lab would be neither efficient nor desirable, especially with respect to disruptive events. The living labs therefore also comprise a number of simulations, which allow to safely and thoroughly test different events.

2.3 How the Living Labs will be described

Since the Living Lab will be physically implemented, a process was established to identify the main interesting situations to be reproduced in the Lab. Some of the situations are too complex to be implemented, so the simulation will be introduced as a helping tool. The living lab description will be performed in two different deliverables: the D5.3 (Plan for ORCHESTRA’s Living Labs) and the D5.4 (Final Living Labs). In D5.3 different operations are described that are normally performed inside the interested network. For each operation, there are individuated possible events that can occur (notice: even the absence of events is considered for the description). Then, the connection between an operation and its relevant event will be used for the scenario definition in deliverable D5.4. D5.4 will then describe in detail each scenario that will be piloted and simulated and the relevant used use cases.

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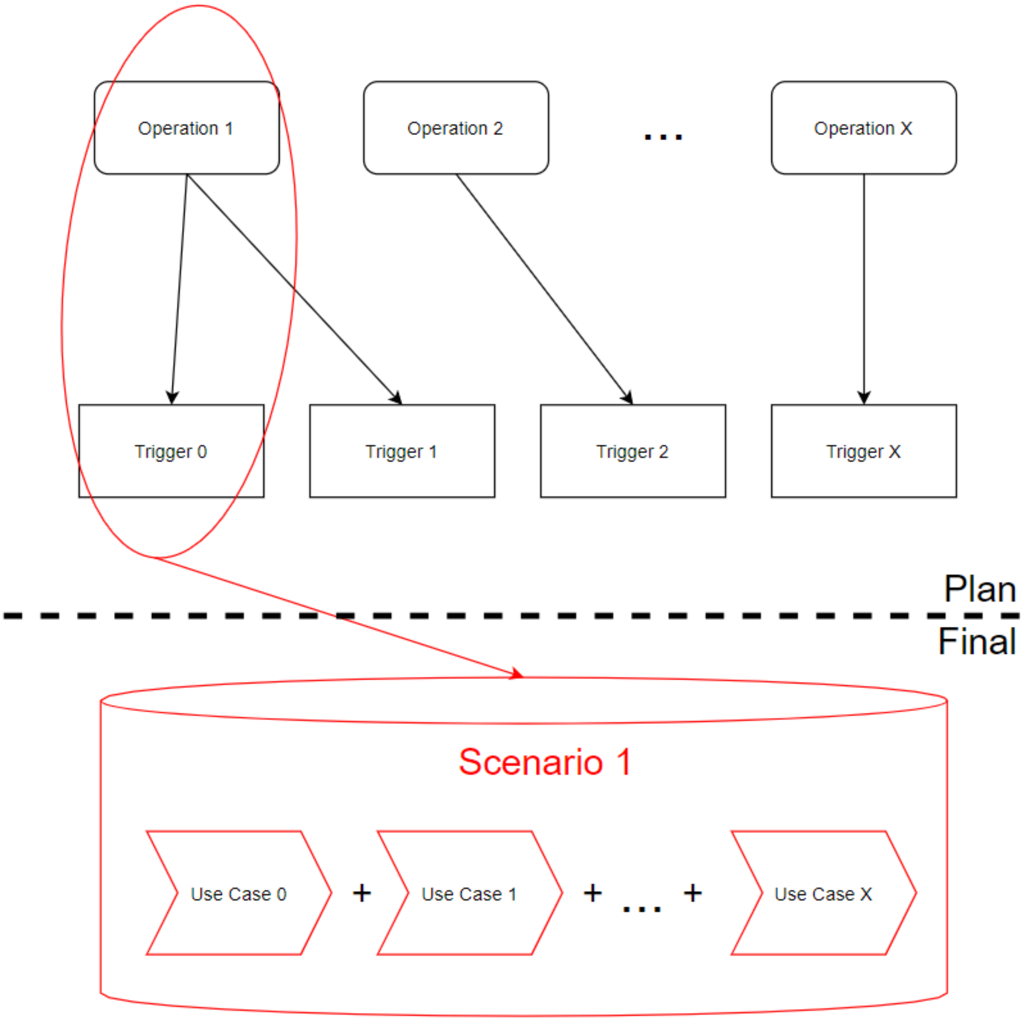

Figure 2: Living lab description process

A scenario definition is an artificial representation of a real-world operation. It tells how an operation will evolve and how actors will interact between each other to overcome unexpected/expected events that will occur.

This following template is used for the scenario descriptions:

- **Description of Scenario:** Narrative of the scenario (e.g., where are actors located, which means of transport is taken into account, how data is exchanged)
- **Purpose and Goal:** The operation that aims to be successfully performed.
- **Actors:** Name and role of the main actors that will play in the scenario.
- **Event:** Trigging event or action that triggered the enabling tools.
- **Use cases to be piloted:** Iterations of use cases that will be performed to build the scenario.

2.4 Timeline for the living labs

Figure 3 below shows an indicative timeline for the living labs, showing piloting and simulation activities and how the two planned evaluation rounds involving WP3, WP4 and WP6 will be fit in.

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Relevant project milestones MS6 and MS7 are shown for reference. Milestones are denoted “x” while activities lasting several weeks are coloured in.

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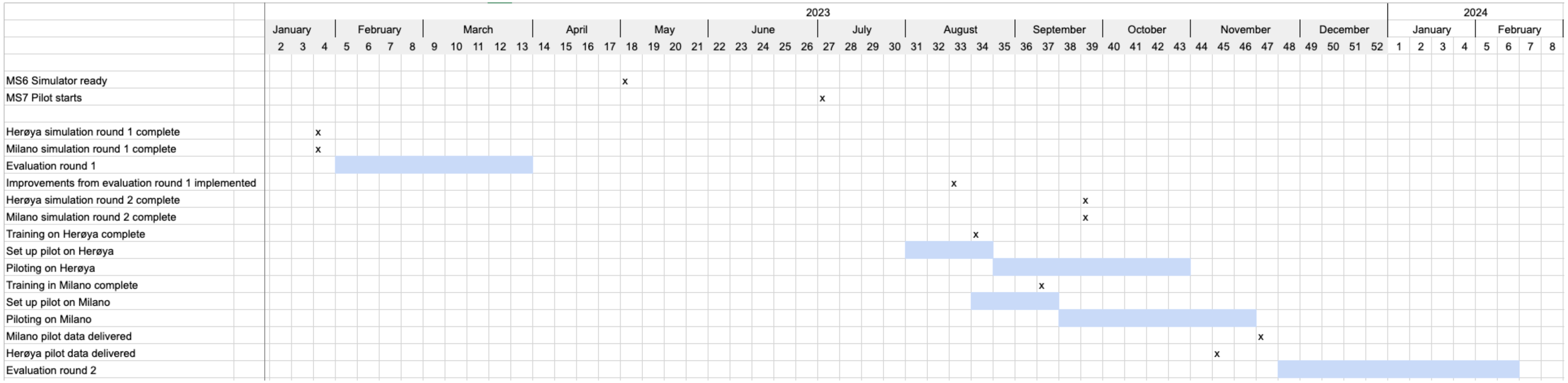

Figure 3: Timeline for living labs

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3 Living Lab Herøya, Norway

3.1 Overview

Herøya Industrial Park (HIP) is one of the biggest industrial parks in Norway and is situated in the municipality of Porsgrunn in the Vestfold and Telemark county, 150 km south of Oslo. Herøya Industrial Park covers an area of 1.5 km^2. About 80 businesses with approx. 2'500 employees have established themselves at Herøya Industrial Park. They represent a wide range of sizes and sectors – from industrial and maintenance companies with many hundreds of employees to smaller start-ups with just a few employees.

The infrastructure of the industrial park consists of:

- Supply of hydroelectric power, cooling water, steam, gas, etc.,
- Quay facilities (1.5 km quay frontage) and prox. 900 calls per year,
- Connection to E-road network,
- Tank terminal,
- Logistic areas.

Overall figures for goods flow in the industrial park per year:

Table 2: Yearly goods flow at Herøya

Boats	~ 1.050
Trucks	~ 52.000
Raw material in	~ 2.020.000 tonnes
Products out	~ 4.364.000 tonnes

Herøya Industrial Park is connected to both road and sea. It has also been considered to reopen the railway to the industrial park, but that is not realized yet. All goods coming in or going out of the park are transported either by ship or by truck by a number of different actors.

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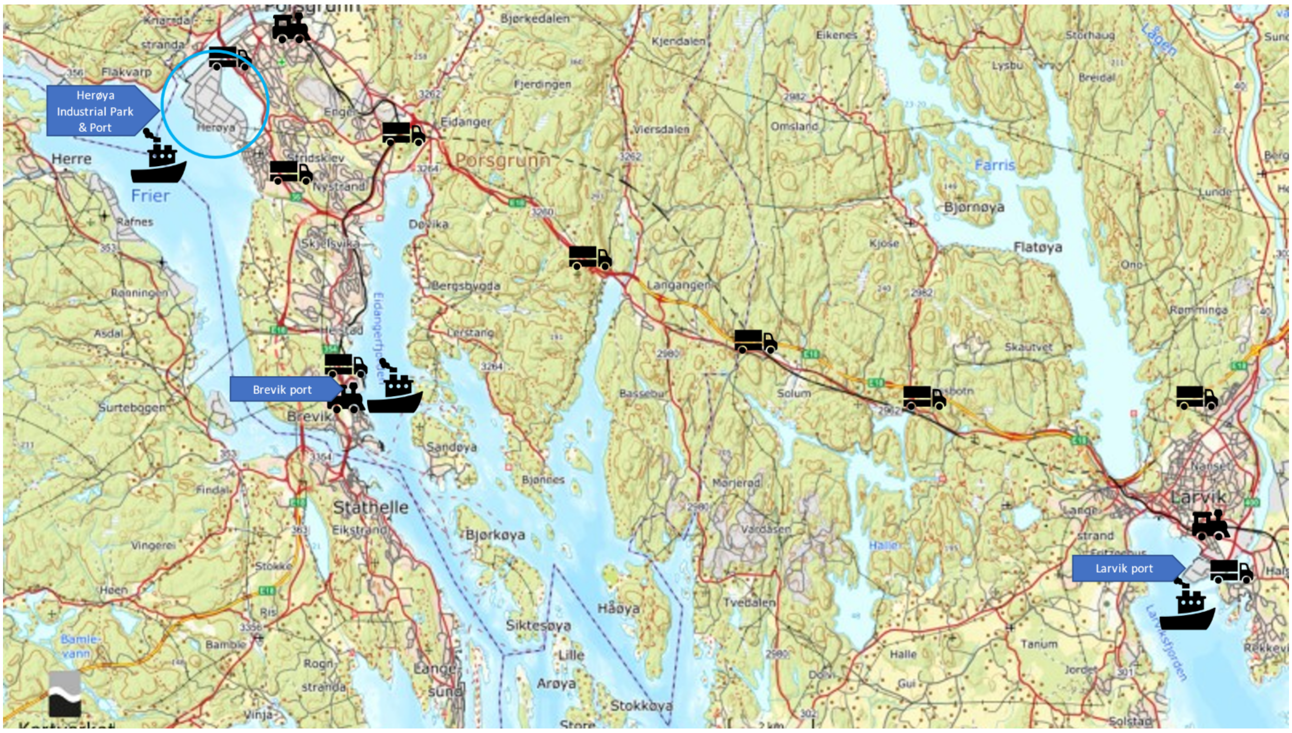

Figure 4: Map of HIP and surrounding area with transport connections

All the sea traffic is monitored by Kystverket. The situation on the roads is monitored by The Norwegian Public Roads Administration (NPRA). Bane Nor is responsible for the railroad. There is a number of different actors in every section shown in Figure 6, which gives Herøya a relevance for ORCHESTRA as a Living Lab.

Below is an illustration of Herøya showing the different ports and most used driving routs inside the park. The Industrial Park is partly a closed area, and this area is not open for public transportation. There are also strict security regulations in the area. Trucks need to be escorted inside the park by a service called the pilot car. The pilot car is available every day between 07:00 to 15:00, meaning that trucks that are not allowed to drive in the park without guiding needs to fit into this timeframe.

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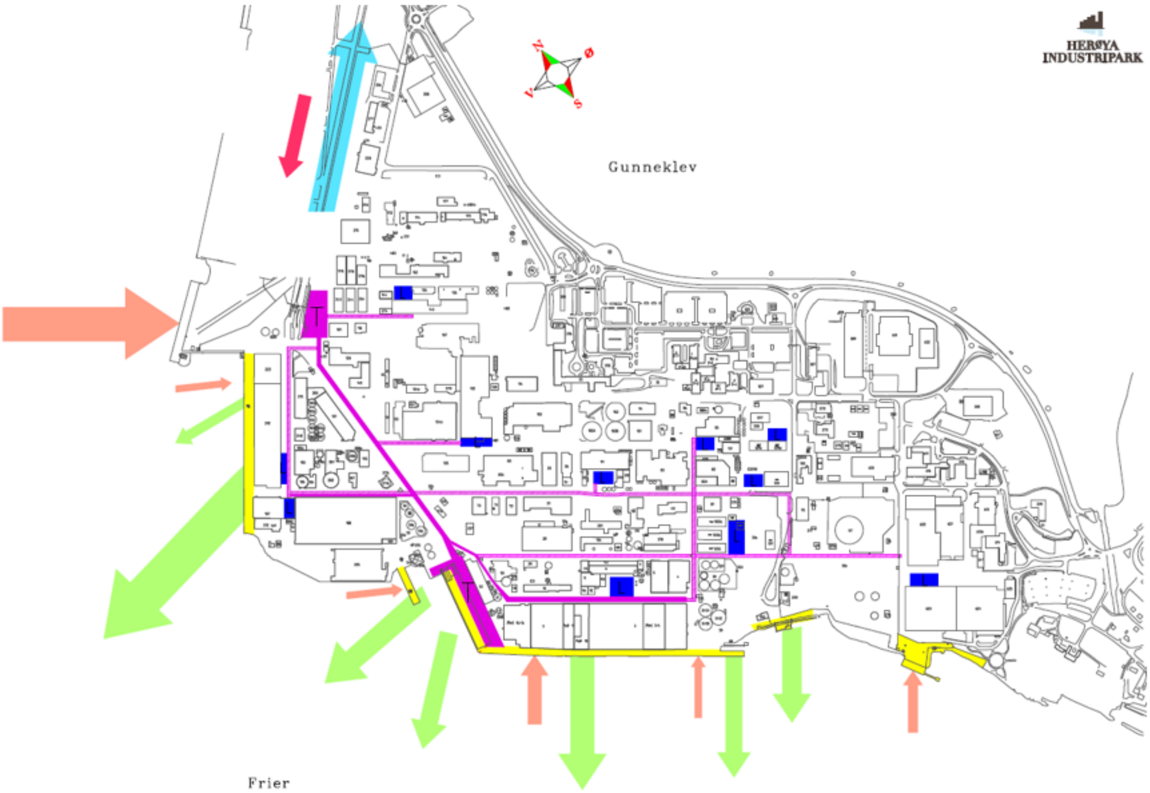

Figure 5: Traffic flow at Herøya

Key to Figure 5:

- The size of the arrows is proportional to the amount of goods transported.
- Green arrows represent goods leaving HIP by boat.
- Orange arrows represent goods incoming by boat.
- Blue arrows represent goods leaving HIP by truck.
- Red arrows represent goods incoming by truck.
- Pink lines indicate the main roads inside HIP, blue boxes indicate loading/unloading zones inside HIP.

The industry park is divided into different zones or governance areas, with different access levels. The map below shows the restricted industry area inside the red dotted line and the even more restricted International Ship Port facility (ISPS) area marked with yellow. There is also a security zone that reaches 150 metres from land (marked with red dotted line outside the first ports). The governance areas inside the park are shown in Figure 6 below.

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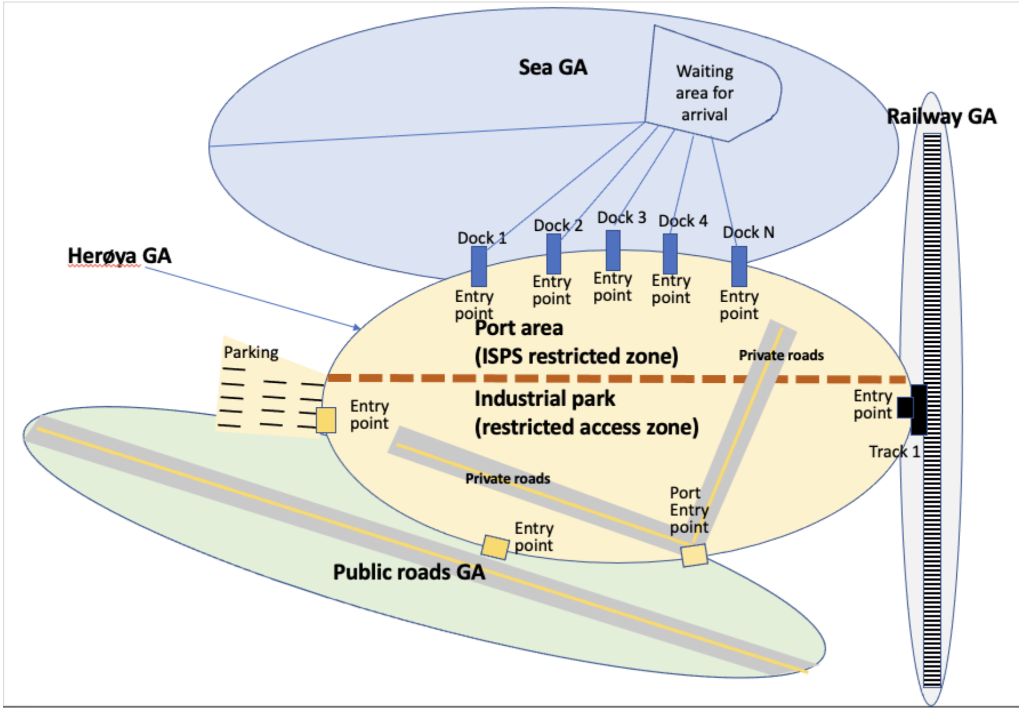

Figure 6: Herøya governance areas

3.2 Actors

The main actors involved are described as follows:

- Applied Autonomy is the operator of the CAV that will be used during the live pilot on Herøya. They will be responsible for deploying and managing the vehicle. They further provide solutions for data sharing inside HIP and collect data from existing operations to aid with optimal deployment of the CAV.
- Bane Nor is the Norwegian government agency responsible for owning, maintaining, and developing the Norwegian railway network. They orchestrate all rail transport in Norway.
- Bilfinger provides internal transport on Herøya, as well as other industrial services. They are responsible for some of the maintenance activities on Herøya, logistics operations, workshop manufacturing and installations, amongst other things.
- The county of Vestfold and Telemark as a network owner receives traffic related information from Herøya and manages the traffic on their network accordingly. In the event of disruptions on the county road network, the county will inform the NPRA VTS (the Norwegian Public Road Authorities' Traffic Control Centres, TCC), which can forward this information to Herøya.
- The Herøya TMS (Traffic Management System) is an internal traffic planner on Herøya, which manages the concierge car. This is the car that escorts incoming trucks to their destination inside the park.
- Kartverket (the Norwegian mapping and cadastre authority) is the national authority for providing geographical data and map services. It provides all maps used by other official actors and ensure that all maps are up to date.

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- Kystverket Brevik (the Norwegian Coastal Authority, NCA) monitors and manages all sea traffic and is further responsible for all sea infrastructure. The local office in Brevik is the contact point for Herøya.
- NPRA VTS can be understood as a node connecting one network (HIP as a private road owner) to another (public road both county/municipality and state roads). This involves the use of an HBT (Hendelsbasert Toppsystem – "Event based top system"). An event is a situation on or alongside the road which influences the traffic and can result in delays or an increased risk of accidents. The HBT is designed to give traffic operators at the TCCs a common, harmonised, integrated and user-friendly work environment. The solution supports the operators in handling situations from start to finish. This includes functionalities for traffic management and for the production and distribution of road and traffic announcements. The logging of events and activities is done in a database, from which reports and statistics can be obtained.
- Truck transport providers deliver goods and provide transport to Herøya from outside the park. They operate their own fleets of vehicles and rely on a concierge car to guide them to their final destination once they have arrived at the entry to the park.
- Yara is a chemical company and one of the biggest actors on Herøya. As part of their operations, they manage their own fleet of vehicles on Herøya which transport various goods around the park. They thereby provide internal transport services.

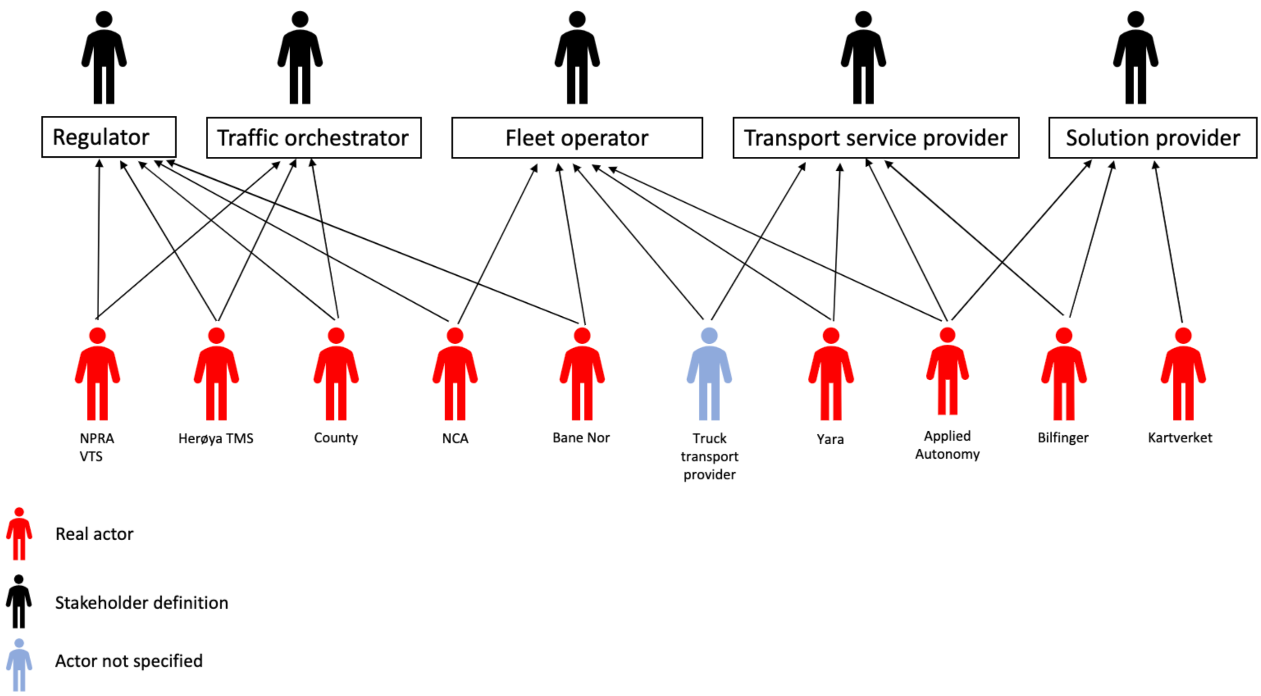

Figure 7: Actors-Stakeholders definition on Herøya

The term "Real actor" specifies the actors that have been already allocated to a specific company.

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Table 3: Description of actors on Herøya

Actor	Related Stakeholder	Description
Applied Autonomy	Fleet operator, Transport provider, Solution provider	Operator of the CAV fleet, providing solutions for data sharing inside HIP
Bane Nor	Regulator, Traffic orchestrator	Railway orchestrator in charge of trains and the rail network
Bilfinger	Solution provider, Transport service provider	Provide industrial services inside HIP, including transport on internal roads
County	Regulator, Traffic orchestrator	Manages traffic on the network of county roads
Herøya TMS	Regulator, Traffic orchestrator	Herøya internal traffic planner, manages the concierge car
Kartverket	Solution provider	National authority for providing geographical data and map services
Kystverket Brevik (NCA)	Regulator, Traffic orchestrator	Provides live sea traffic data and orchestrates sea traffic
NPRA VTS	Regulator, Traffic orchestrator	Orchestrates traffic according to regulations in the event of incidents
Truck transport provider	Fleet operator, Transport service provider	Operates a fleet of trucks, providing transport on national roads
Yara	Fleet operator, Transport service provider	Operate their own fleet of vehicles, providing transport on internal roads

3.3 Tools to be used

There are a number of different tools which will be used in the Herøya Living Lab. This section provides a preliminary overview, full details on all the tools described below can be found in D4.1. This includes tools that will be used only in preparation of and during the pilot, tools that will only be used for the simulations, and tools that will be used for both.

In preparation of the pilot on Herøya, a **mobility insights tool** will be used to get insight into today's operation and usage of manually driven guiding vehicles. The knowledge gained will be used in planning how the CAV shall be utilised. Another tool used to prepare the optimal deployment of the CAV on Herøya is the **activity registration app**, which documents where and what the manual guiding vehicle is doing.

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Both before and during the pilot, a **situation awareness tool** will be used to provide a real-time view of connected vehicles and available road sensors.

There will also be a **situations and geofencing data sharing tool**, which allows road owners and regulators to inform the road users on deviating situations on the roads. This could for example be that a road is closed or road work is ongoing. Geographic areas (geofences) could also be temporarily regulated, for instance extra rush hour cost, or some benefits of using zero-emitting transport in an area. This tool will therefore be used both during the pilot and during the simulations in order to handle real deviating situations and also simulate different types of deviations.

For the actual deployment of the CAV, both during the pilot and during the simulations, there will be two separate tools handling different aspects of the operations. In a first step, a **transport ordering tool** will be used by truck drivers arriving at Herøya to order a guiding vehicle for escort inside the industrial park. In a second step, a **dispatch tool** will optimise the usage of available connected vehicles according to the received transport orders.

In order to extend the pilot, a **job generation tool** will be used. In contrast to the dispatch tool, this tool will stochastically generate simulated demand and traffic parameters, and also use an algorithm to provide optimised traffic management solutions. Akin to the transport ordering tool used in the pilot, a **booking tool** will be used in the simulations in order to consider different appointment booking scenarios for incoming trucks. The simulated part of the Herøya Living Lab will also enjoy use of a network representation tool which provides a visualisation of the network as a whole and various dynamic aspects thereof.

The data that is generated in the Herøya Living Lab will be shared between the registered tools and stakeholders via a **data sharing infrastructure tool** based on a ledger.

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Table 4: Tools for Herøya

Tool	Application ("why")	Functioning ("how")
Mobility insights	Gain insights into ongoing operations to plan use of CAV	App installed in manually driven vehicle
Activity registration	Gain insight into what the manual guiding vehicle is doing	Toggle buttons activated by driver to input information
Situation awareness	Monitor fleet and road conditions	Real-time web solution for authorised users
Situations and geofencing data sharing	Handle deviations and regulate traffic flows	Using web solution to make 3rd parties aware of situations and define geofences for regulation
Transport ordering	Allow truck drivers to order a CAV	App to be used by truck drivers
Dispatcher	Optimise use of CAVs	Algorithm taking input from transport ordering tool
Job generation	Simulate bundling of incoming demand	Model based on Python and Gurobi
Booking	Simulate demand from incoming trucks	Under development
Data sharing infrastructure	Secure data sharing and optimisation of traffic	REST APIs for using IOTA Identities and Distributed Ledger

3.4 Systems to be integrated

In the Herøya Living Lab, a number of different systems will be integrated or connected in order to shape and represent a multimodal traffic management ecosystem (MTME). In order to be able to test the hypotheses proposed by the project in the context of an industrial park, both the transport and the traffic systems of the larger ecosystem require that connections are made which are not present today.

In the pilot part of the Living Lab, where a CAV will operate as a guiding vehicle, said vehicle needs to be connected to a fleet management system. The system flagging deviating situations inside the industrial park on Herøya will also be part of the MTME, allowing the fleet management to optimise deployment of the CAV on the one hand and inform the traffic orchestrator on the other hand. Deviations are for example the accidental release of poisonous gases, which is detected by dedicated sensors and communicated via the park's security centre.

For the simulations, where a bigger ecosystem including operations with multiple CAVs can be considered, data is available from different systems. The NPRA provides traffic information for traffic outside of Herøya via a website (https://www.vegvesen.no/trafikk/), which can be used as a baseline for modelling traffic density and traffic disruptions based on real-life data. Similarly, the Norwegian Coastal Administration provide tracking data for ships (an automatic identification system (AIS) tracking service provided on these websites: https:/kart.kystverket.no

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and https://www.vesselfinder.com/). This data will be especially useful in the booking tool and optimisation algorithm, as the delay of a vessel has significant implications for the traffic inside the industrial park. For the purpose of simulating a multimodal traffic ecosystem in general, it may also be relevant to include data on trains (to be found for example here: https://www.banenor.no/reisende/togkart/). This is however less relevant for Herøya as a Living Lab as there are currently neither train connections to the industrial park nor any plans for building such connections.

3.5 Operations

3.5.1 Operation 1 – Incoming goods transport to Herøya (simulated + piloted in living lab)

Description of Scenario:

Incoming trucks arrive at the neighbouring city of Larvik by ship/ferry. The trucks then travel by road from Larvik to Herøya.

Herøya concierge service orchestrates incoming traffic by queueing trucks, and they manage an escort car service that guides trucks to their destination. In the operation a Connected Autonomous Vehicle (CAV) is used to minimize wait times for a manual concierge pilot car, and directly escort trucks to their destination, which either is a factory or a warehouse.

Purpose and Goal:

This operation describes the traffic model with incoming cargo flow to Herøya, flowing through the 3 traffic orchestrator domains: ship, road, and Herøya-internal (on private roads).

Planning of the last leg can be affected by events at sea and at the road that necessitates re-planning of internal pilot car service. Internal events like for example roadblocks can also lead to re-routing of current trip and re-planning of later trips.

Actors:

1. Kystverket Brevik (NCA)
2. NPRA VTS: Vegtrafikksentralen
3. Herøya TMS
4. Applied Autonomy

3.5.1.1 Event 1.1 – Incoming transport, happy flow (living lab pilot + simulated input)

Incoming truck transport arrives via sea to Larvik port, and then via public roads to Herøya entrance – during the manned opening hours of Herøya entrance. At Herøya entrance a CAV pilot car is waiting, and autonomously guides the truck transport to its Herøya-internal destination before returning to the entrance to be able to assist more trucks.

3.5.1.2 Event 1.2 – Incoming ship transport is delayed (living lab + simulated input)

Ship or road traffic events lead to truck ETA to Herøya being delayed.

- Herøya TMS receives notification from transport company.
- Herøya TMS receives notification from ship orchestrator (Kystverket).

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- Herøya TMS receives notification from public road traffic orchestrator Vegtrafikksentralen.
- Herøya TMS monitors live sea traffic directly via live system at Kystverket.
- Herøya TMS monitors live road traffic directly via live system at Vegtrafikksentralen.
- Traffic jams in morning/afternoon rush.
- Herøya TMS re-plans meetup-time for CAV pilot car at Herøya in Herøya Traffic Management System.
- Possibly re-organizing of queue of trucks waiting to be guided to their destination.
- Possibly notification to other transport companies regarding delays.
- Possibly confirmation notifications from truck transport providers where they confirm later arrival times.

3.5.1.3 Event 1.3 – Incoming truck transport is accelerated (living lab pilot + simulated input)

Truck managed to board an earlier than planned ferry from Denmark to Larvik.

- Herøya TMS receive notification from transport company.
- Herøya TMS recalculates CAV pilot car schedule.
- Herøya TMS notifies truck transport company on optimal arrival time.
- Possibly re-organizing of queue of trucks waiting to be guided to their destination.

3.5.1.4 Event 1.4 – Herøya internal transport is delayed (living lab pilot + simulated input)

Local Herøya events lead to cascading delays for CAV pilot.

- Herøya TMS re-routes and re-plans internal transport missions/jobs.
- Herøya TMS notify transport companies, so that they can plan for later arrival.
- Organize queueing of incoming trucks.

3.5.1.5 Event 1.5 – Incoming trucks arrive out of opening hours (living lab pilot + simulated input)

The Herøya cargo gate is not manned 24/7, so any truck transports arriving outside of opening hours today will have to wait until opening hours to be piloted to their destination.

- Herøya TMS performs online pre-registration and ID validation of incoming truck drivers.
- Herøya TMS plans time slots for autonomous CAV pilot car, enabling out of opening hours operation, and minimizing traffic congestion in the first of the opening hours.

3.5.2 Operation 2 – Ship transport with cargo re-load for further transport (simulated)

Description of scenario:

Herøya port is not an actual transit port, but only a port that is a starting point or an endpoint for shipping cargo to or from the factories at Herøya. The living lab is therefore not able to physically

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test e.g., goods re-loading for further transport on rail or road. Therefore, these use cases need to be simulated instead. Ships do arrive at the port of Herøya with raw material goods that are loaded into the quay storage area, and Herøya-produced cargo is loaded onto outgoing ships though.

To test multimodal transport through the port, we need to define several fully or partly simulated use cases.

Purpose and Goal:

This largely simulated scenario describes the traffic model with incoming cargo directly to Herøya by sea, from the ports of Brevik to Herøya, and further on to the railroad (preferred) or road from Herøya. With unforeseen events on the railway, it will be necessary to reschedule the train-departure times, or trucks must be used instead of trains for the transport of goods on land.

Actors:

1. Kystverket (NCA)
2. Bane Nor
3. Vegtrafikksentralen (NPRA VTS)
4. Truck transport provider(s)
5. Herøya TMS

3.5.2.1 Event 2.1: Incoming ships are delayed (simulated)

Incoming ships are delayed because of bad weather conditions. The delayed departure of the ship has an impact on the train time schedule, and Bane Nor needs to be alerted. Bane Nor needs to update the schedule for the train.

- The ship operator notifies Kystverket (NCA)
- As a part of the information flow in the transport chain, the ship operator notifies any truck transport providers that have booked transport on the affected ship
- The ship operator notifies Herøya TMS
- Kystverket (NCA) updates the estimated arrival time in their system (if ETA exists as option in this case)
- Herøya TMS notifies truck transport provider(s)
- Truck transport provider(s) notify Vegtrafikksentralen (NPRA VTS)
- Herøya TMS notifies train transport provider(s) if applicable
- If applicable, Train transport provider(s) notify Bane Nor
- Bane Nor updates the train schedules based on the new information

3.5.2.2 Event 2.2: Train as transport mode is unavailable because of event (simulated)

There is an event on the single-track railroad to Herøya that leads to a full stop in both incoming and outgoing traffic to/from Herøya. Incoming railway cargo needs to be reloaded onto trucks to reach Herøya and the ship terminal at Herøya. Outgoing railway cargo must be shipped via trucks instead of trains.

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- Bane Nor notifies Herøya TMS, Vegtrafikksentralen (NPRA VTS) and Kystverket (NCA) that trains cannot access Herøya port.
- Bane Nor notifies train transport provider(s)
- As a part of the information flow in the transport chain, the transport service provider or the cargo owner organising the transport is informed, and transport chains that have not started yet are re-planned.
- Herøya port loads goods to trucks and temporary storage instead of trains.

3.5.2.3 Event 2.3: A crane for loading goods from ship is broken (simulated).

Ships that have planned to use the port with a broken crane needs to either reroute to another port location at Herøya, or to another port altogether (e.g. Larvik). If the ships have already arrived Herøya, anchoring in a queue is also an option if available anchoring locations are currently available.

1. The port crane operator notifies incoming ships, either directly to ship operators or via Kystverket (NCA)
2. The port operator organizes port queueing via anchoring together with Kystverket (NCA)
3. Herøya organises alternate docking position with usage of alternate cranes.
   a. Kystverket (NCA) assigns ships to new port location at Herøya
   b. Goods are moved internally at Herøya to the original port at Herøya by reach-stackers and tug-masters

3.5.3 Operation 3 – Outgoing goods transport from Herøya port to Brevik and Larvik ports by truck (simulated scenario)

Description of Scenario:

Outgoing goods transport by truck to either the port of Larvik or the port of Brevik. Trucks must be guided/piloted to their Herøya internal pick-up locations by the CAV pilot car. There are different travel times to the Brevik and Larvik ports, and their shipping schedules are different.

Herøya orchestrates incoming pick-up traffic by queueing and prioritizing trucks and manages an escort car service that guides trucks to their pick-up locations. In the operation a Connected Autonomous Vehicle (CAV) is used to pilot the trucks in and out of Herøya industry park. Time-critical transports are prioritized.

Purpose and Goal:

This scenario describes a traffic model with outgoing cargo flow from Herøya, flowing through the 3 traffic orchestrator domains: Herøya-internal, road and ship. Two transport providers (Herøya pilot service and the truck company) need to plan and synchronize their vehicles to provide efficient outgoing goods transport.

Actors:

1. Truck transport provider
2. Kystverket Kystverket (NCA)
3. Vegtrafikksentralen Vegtrafikksentralen (NPRA VTS)

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4. HIP TMS

3.5.3.1 Event 3.1 - Incoming trucks arrive too late for goods pick-up (simulated)

Other events may occur and affect the truck transport providers, like e.g., a strike. This means that outgoing traffic is hindered by lack of trucks to transport good out from Herøya.

- Truck transport providers notifies Herøya of delays for incoming trucks.
- Herøya notifies Kystverket and Bane Nor about disruptions to outgoing traffic.
- Herøya needs to re-organise the internal traffic to:
    - Avoid filling up temporary goods storage space.
    - Make sure that the ‘next’ possible outgoing transport is prioritised before transports further ahead in time.

3.6 Use cases to be piloted

This section describes the scenarios which will be addressed in the simulation and the piloting part of the project. Scenarios are built by combining the proposed operations and events. A scenario is composed by several use cases. The use cases proposed in this table are not binding and can be modified during the living lab development.

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Table 5: Use cases to be piloted/simulated on Herøya

Scenario to be addressed	Reference	Piloted	Simulated	Use cases
Incoming goods transport to Herøya, without any issue.	Operation 1, Event 1.1	X	X	- Incoming truck arrives at Herøya - CAV escorts trucks to their internal destination
Incoming ship transport to Herøya is delayed	Operation 1, Event 1.2	X	X	- Notify the delay - Reorganize the queue of truck - Disseminate the delay to others company - Overcome the delay
Incoming truck transport to Herøya is accelerated	Operation 1, Event 1.3	X	X	- Notify the Travel acceleration - Replan the CAV schedule - Replan the truck waiting queue
Internal transport at Herøya is delayed and will affect incoming transport	Operation 1, Event 1.4	X	X	- Events detection and delay estimation - Replan internal transport - Notify the transport companies - Reorganise the truck waiting queue
Incoming trucks arrive at Herøya out of the opening hours	Operation 1, Event 1.5	X	X	- Preregistration of incoming trucks - CAV planning for out of hours operation - Escort trucks to their destination
Incoming ship transport is delayed, but goods need loading on cargo train for further transport	Operation 2, Event 2.1		X	- Notification of the transport delay - Update the train schedule
Incoming ship transport arrives at the port and needs to load goods onto a cargo train for further transport, but the train transport is unavailable	Operation 2, Event 2.2		X	- Notify the train breakdown - Find alternatives for train transport - Truck substitute train for the outcoming transport
Incoming cargo ship transport arrives at the port and needs to unload cargo using a crane. The crane is broken	Operation 2, Event 2.3		X	- Notify the crane breakdown - Organize the ship queuing to the port - Organize alternative equipment
Incoming trucks arrive late for picking up the outgoing goods transport from Herøya port to Breivik and Larvik ports	Operation 3, Event 3.1		X	- Notify the delays of incoming trucks - Reorganise the internal traffic

3.7 Training sessions to be accomplished

The traffic orchestrators involved in the living lab will need to be trained in the working of the multimodal traffic management system that will be put in place and piloted. The training is therefore

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especially relevant for operational management stakeholders involved in roads, both inside and outside the HIP, as well as in sea traffic. As there is currently no railway connection to Herøya, there are no relevant stakeholders at railway operational centres that could be trained. For road management outside HIP, employees of the NPRA will have the most pivotal role. In particular, operators of the Traffic Management Centre, the owner and users of the HBT will need to be trained. Both for them and for the internal road actors in HIP outlined in section 3.2, a large part of the training will be dedicated to understanding the flow of information across the network (especially between HIP and public roads). Different types of circumstances will be covered for this, notably everyday operations on the one hand, including foreseen changes (with the introduction of the CAV and its role as concierge car), and disruptions or unforeseen changes on the other hand. Here, the consequences across networks/traffic orchestrators as well as the transitions or nodes between the traffic orchestrators will require particular focus. All orchestrators will need to be trained in sharing information and to become familiar with their potentially changing roles during a scenario, as this is crucial for all the use cases defined for the Herøya living lab. As part of this, the orchestrators will be trained in the use of the tools and learn how employ corrective measures to keep the traffic running in the case of a system failure or aid in decision making.

The timing of the training sessions in relation to the other activities in the living labs can be seen above in Figure 3, which shows that the training must be complete prior to the start of the pilot. Setting the training close to the start of the pilot will permit to run the theoretical part of the training during the pilot set up, such that there can also be a round of hands-on practical training before the pilot starts. The data collected during these training sessions will be reported back to WP3, WP4 and WP6 and form part of the evaluation.

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4 Living Lab Milano, Italy

4.1 Overview

Milan Malpensa airport is the second Italian intercontinental and international airport for passenger traffic and the first for cargo volumes. It is located in the western area of the Lombardy region, 48 km from Milan and in the heart of central Europe.

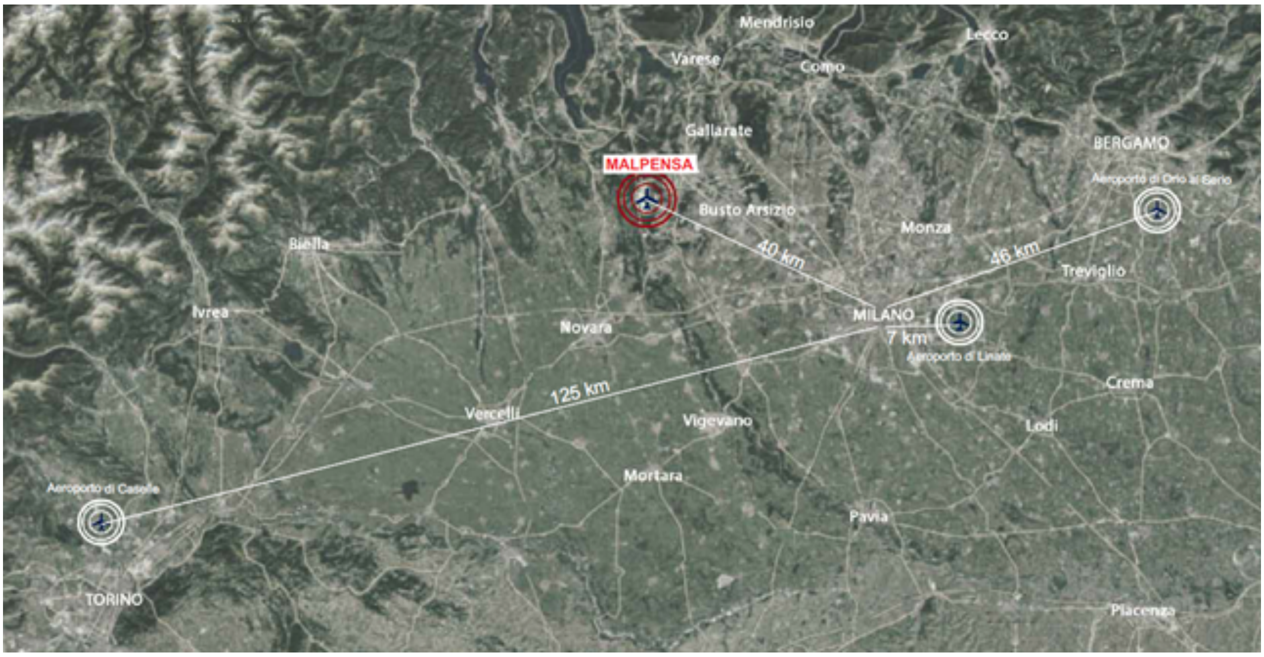

Figure 8: Milan Malpensa airport location. Source: SEA Milan Airports

The airport ground extends for 1'220 hectares on the territories of seven municipalities: Somma Lombardo, Casorate Sempione, Cardano al Campo, Samarate, Ferno, Lonate Pozzolo and Vizzola Ticino. All the airport ground is part of “Parco del Ticino”, the first regional park in Italy, established in 1974.

The airport has two runways, 204 aircraft parking stands and two passenger terminals:

- Terminal 1 (T1), designed for business and leisure customers on national, international and intercontinental routes, with areas assigned to scheduled and charter carriers.
- Terminal 2 (T2), designed for low-cost airlines.

Cargo activities are gathered in the Cargo City, in the south part of the airport ground.

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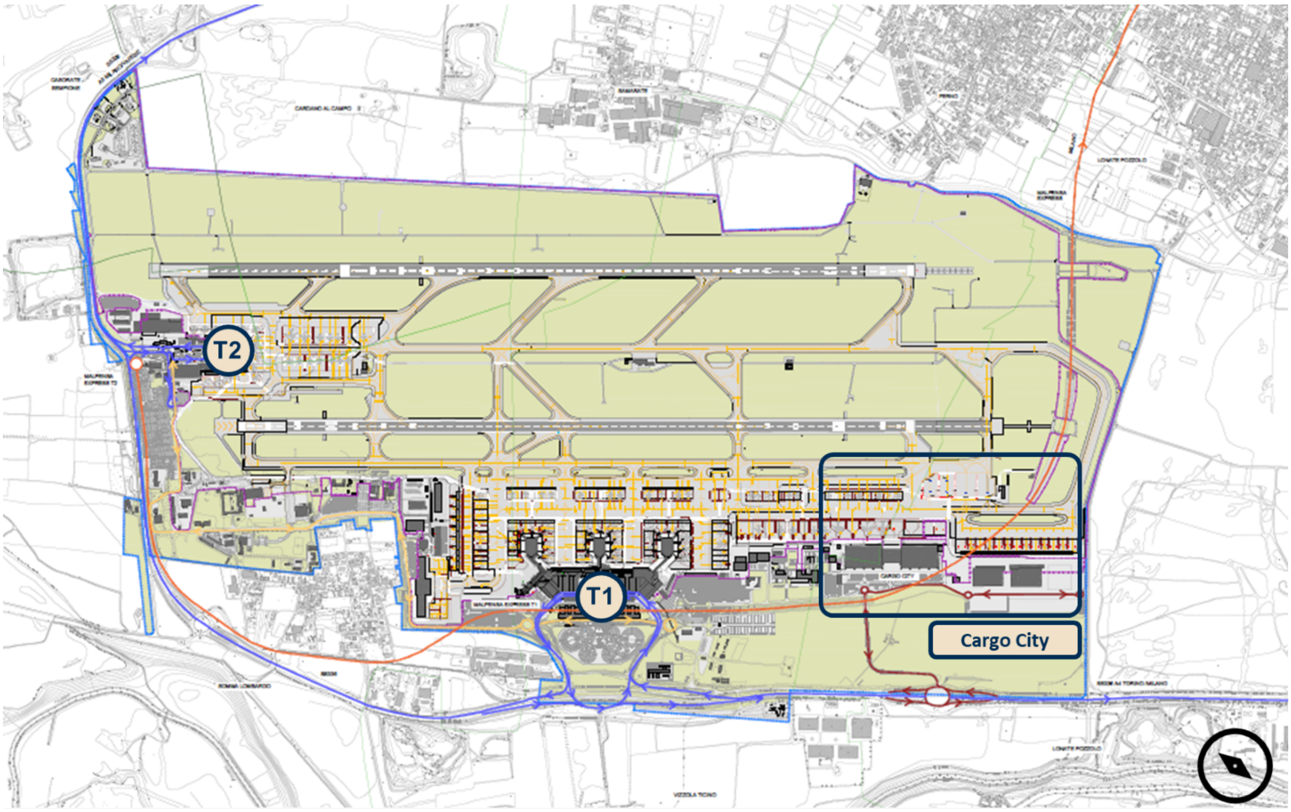

Figure 9: Milan Malpensa airport grounds

Before the Covid-19 pandemic, in 2019, Malpensa handled:

- 28.7 million passengers,
- 225,506 aircrafts movements,
- 545,000 tons of freight.

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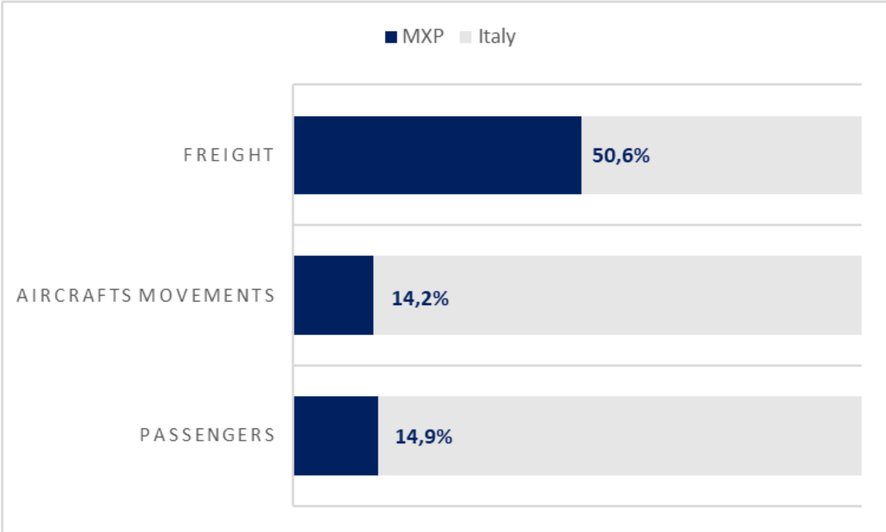

Figure 10: Main traffic information about Milan Malpensa (MXP) in 2019, compared to the whole commercial aviation in Italy

In 2021, the amount of transported freight in Malpensa reached 740,000 tons, with an increase of 36% with respect to 2019. Conversely, passenger traffic has not recovered yet from the pandemic: In 2021 Malpensa handled 9.6 million passengers, which represents -67% compared to 2019. According to the most reliable forecasts, passenger volumes are expected to recover in 2024, reaching the values of 2019.

Within the airport system of Northern Italy, Malpensa has a strategic importance as it boasts the most relevant long-haul destination network, with its 200 direct destinations, more than 80 Countries served and 85 airlines. The medium-long term trends strengthen Malpensa's role as a point-to-point intercontinental airport to which the main international airlines are expected to be attracted, especially for long-haul flights.

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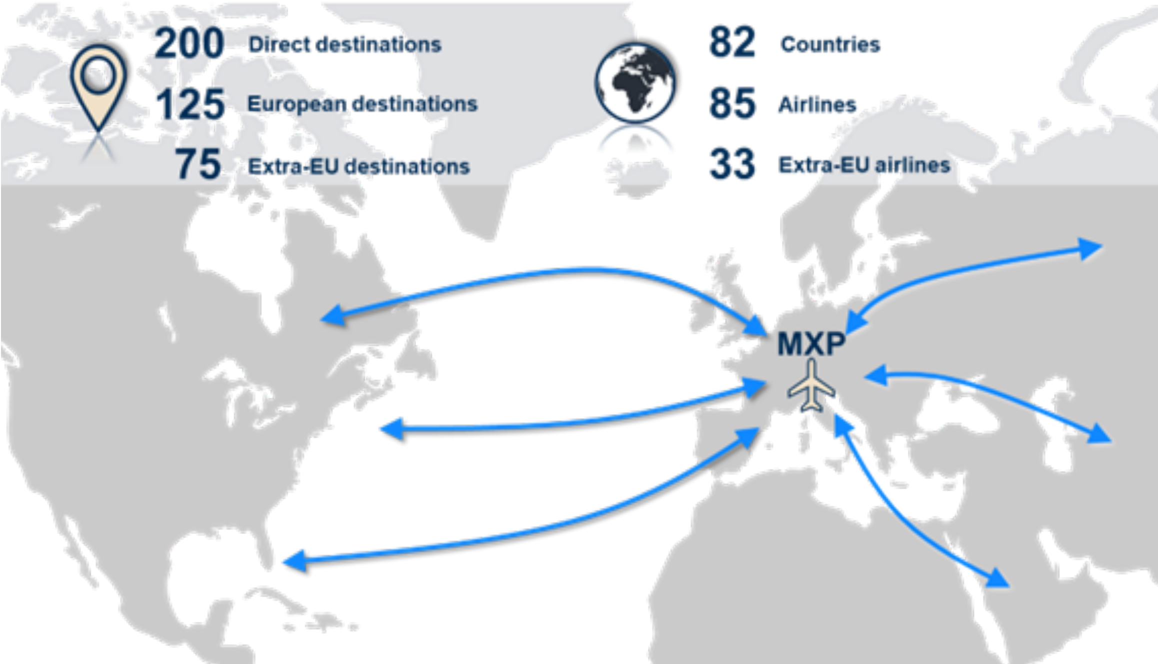

Figure 11: Main figures about Milan Malpensa commercial aviation offer

Malpensa's catchment area mainly includes, in terms of attractiveness, in order: the metropolitan city of Milan, the territory of the Lombardy Region and the regions of the North-West. It also extends - although with a lower capacity in terms of attracted demand - in the regions of the North-East of Italy, in Emilia-Romagna, Tuscany and in the Swiss region of Canton Ticino.

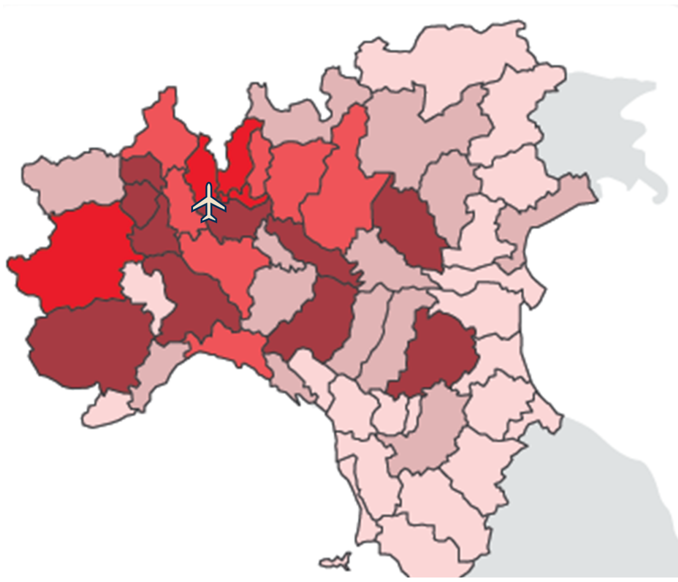

Figure 12: Milan Malpensa catchment area by Provinces. Source: SEA Milan Airports

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Table 6: Distribution of departing passengers by country of origin

Origin of passengers

Italy	95.28%
Switzerland	4.25%
Other EU Countries	0.47%

Table 7: Distribution of departing passengers by region of origin

Origin of passengers departing from Italy

Lombardia	77.01%
Piemonte	13.34%
Emilia-Romagna	3.06%
Liguria	2.26%
Veneto	1.77%
Toscana	1.01%
Others	1.56%

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Table 8: Distribution of departing passengers by provinces of origin

Origin of passengers departing from Italy

Milano	46.07%
Varese	15.03%
Torino	5.56%
Como	4.39%
Novara	3.63%
Monza e della Brianza	3.24%
Brescia	2.06%
Bergamo	1.74%
Genova	1.51%
Pavia	1.42%
Verbano-Cusio-Ossola	1.26%
Lecco	1.17%
Verona	1.00%
Others	11.91%

The graph below shows the modal share of passengers reaching the Malpensa Airport.

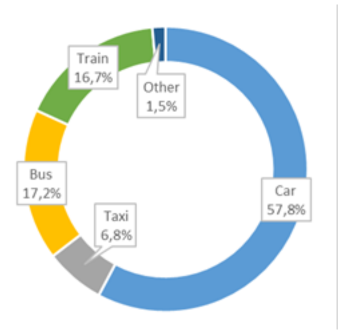

Figure 13: Current passenger modal share

Passengers reach the airport mainly by car (the value accounts for passengers arriving with their own car and for passengers taken to the airport by a third person). Bus and trains follow respectively with 17.2% and 16.7%.

The main access road network to Malpensa consists of the A8 and A4 motorways, which allow private cars, taxis, buses, etc. to access the SS336 state road thus directly reaching the airport.

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The main bus services connecting Malpensa Airport with surrounding cities are summarised in the following table:

Table 9: Bus services connecting Malpensa Airport

Route
Malpensa – Linate
Malpensa - Bergamo/Orio al Serio
Malpensa - Milano Centrale
Malpensa - Torino
Malpensa – Novara
Malpensa – Domodossola
Malpensa - Lago Maggiore
Malpensa – Genova
Malpensa - Gallarate/Castelnovate
Malpensa – other cities (Bologna, Livorno, Roma, Francoforte, Lugano, Zurigo, etc.)

Malpensa is reachable also by the car sharing service offered by "E-VAI", the first ecologic car sharing available in the whole Lombardy and in the main railway stations. At Malpensa Terminal 1, in front of the T1 railway station, E-VAI is available with 4 parking lots and 4 recharging points.

Milan Malpensa airport is accessible also by two direct train services:

- Malpensa Express, that connects the airport to Milan downtown and other minor cities in Lombardy, with a total of 146 round trips per day - 68 from/to Milan Central Station, 48 from/to Milan Cadorna Station - for a total frequency of 4 trains per hour from the two stations, (one train every 15 minutes). The minimum travel time is 37 minutes from Milan Cadorna to Terminal 1 and vice versa;
- Tilo S50, that links Malpensa to Canton Ticino (Switzerland) and other Italian cities located in the northwest of Lombardy (e.g. Varese, Gallarate). The service consists of 38 daily round trips, with one train per hour. The travel time between Biasca and Malpensa is 2 hours and 16 minutes.

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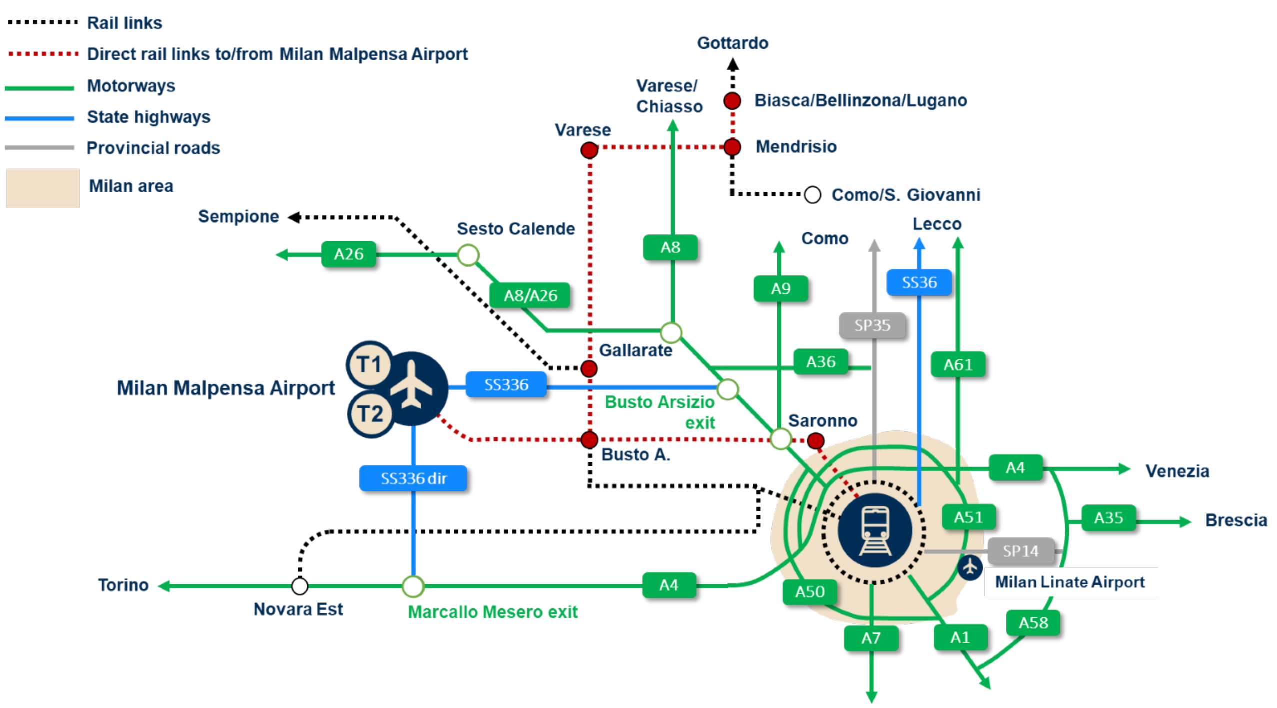

Figure 14: Ground accessibility network to Milan Malpensa Airport

For the scope of ORCHESTRA, activities will be focused on Terminal 1 of Malpensa Airport, as the Terminal 2 has been closed for two years, as a consequence of the decreasing traffic volumes caused by the pandemic.

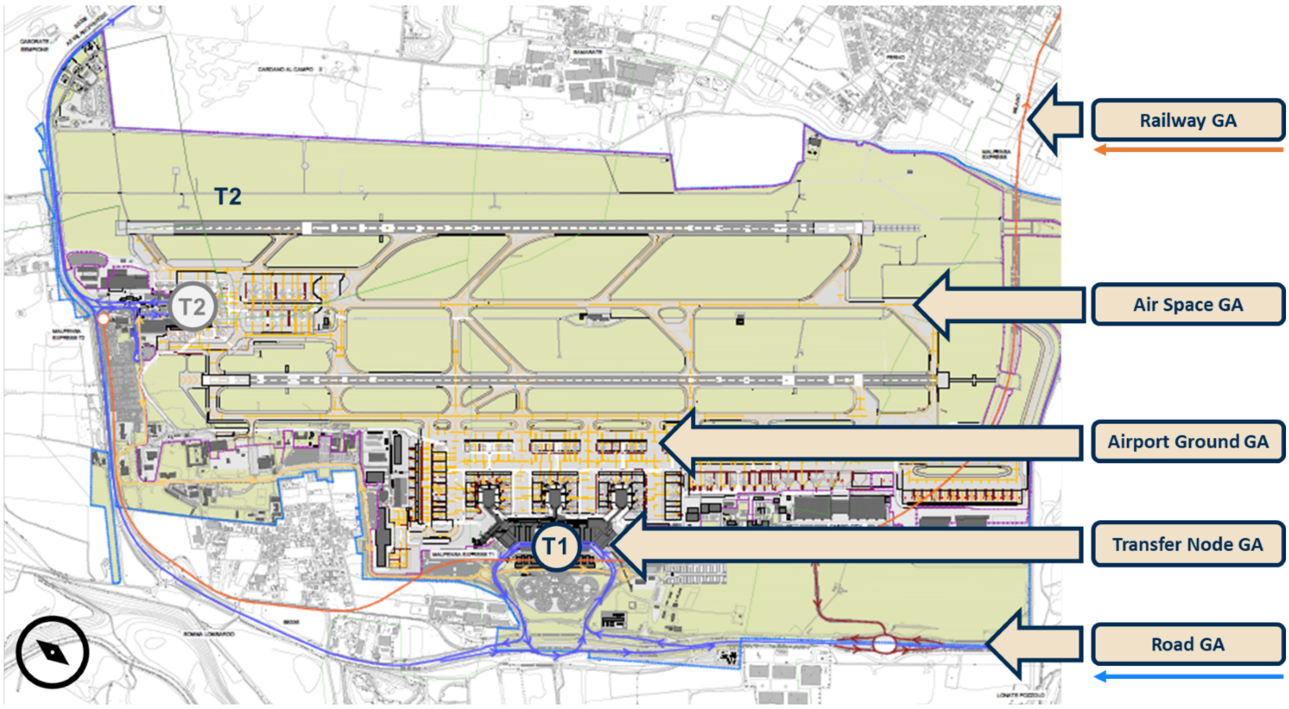

Figure 15: Malpensa governance areas - map view

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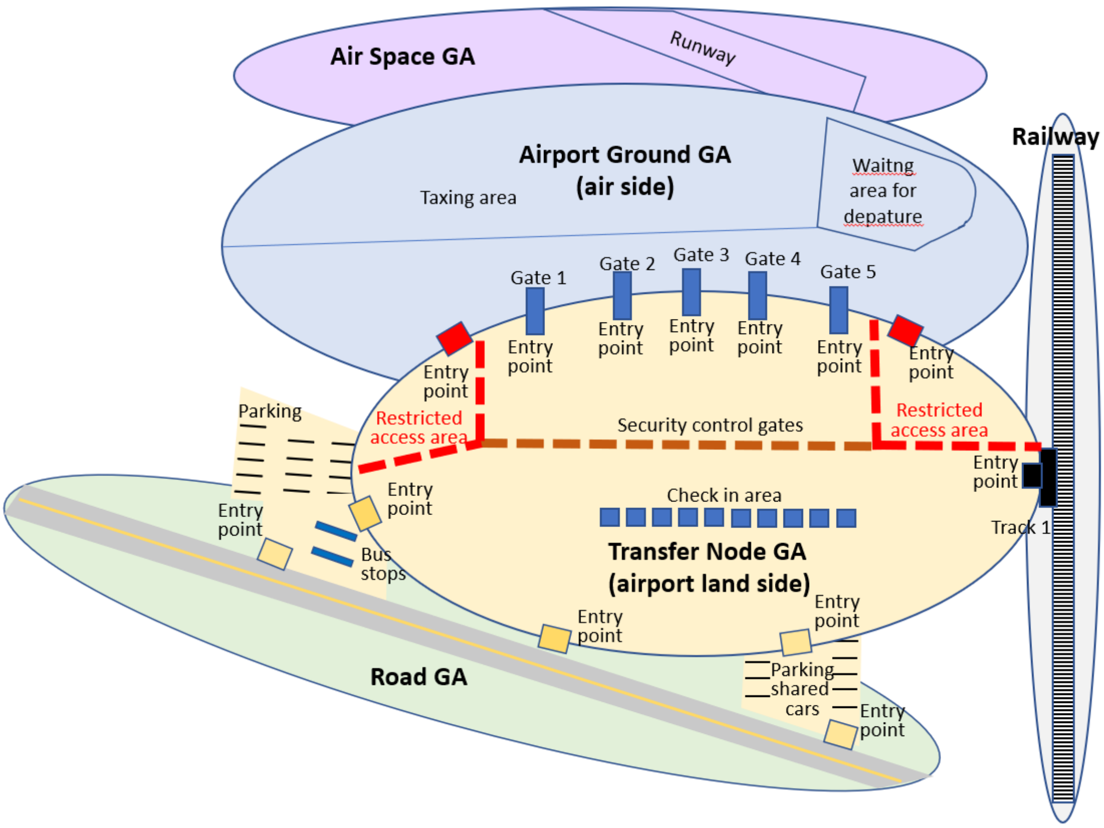

Figure 16: Malpensa governance areas - schematic view

At Milan Malpensa Airport, five main Governance Areas (GA) can be identified:

- The Road GA includes all infrastructure that allow the surface access to the airport by road vehicles. For Malpensa Airport this corresponds to SS336 road. Road junctions connect the SS336 to the airport curbside area, to car parking areas and to bus stops.
- The Railway GA is the railway system that connects Milan and other stations in the Lombardy region to the airport. The railway station located inside the passenger terminal 1 building directly links the rail platform to the airport terminal.
- The Transfer Node GA includes:
  - The curbside area, i.e. the road system adjacent to terminal building where ground transportation vehicles are authorized to stop, drop-off and pick-up passengers,
  - car parking areas (private and shared cars),
  - bus stop area,
  - passenger terminal 1 building, where passengers are processed before and after their flight, passing through the following main areas:

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- the check-in area, where customers receive their boarding pass and drop their luggage,
- the security check area, where passengers undergo security controls before accessing the "sterile" area of the terminal,
- gates through which passengers board the airplanes.

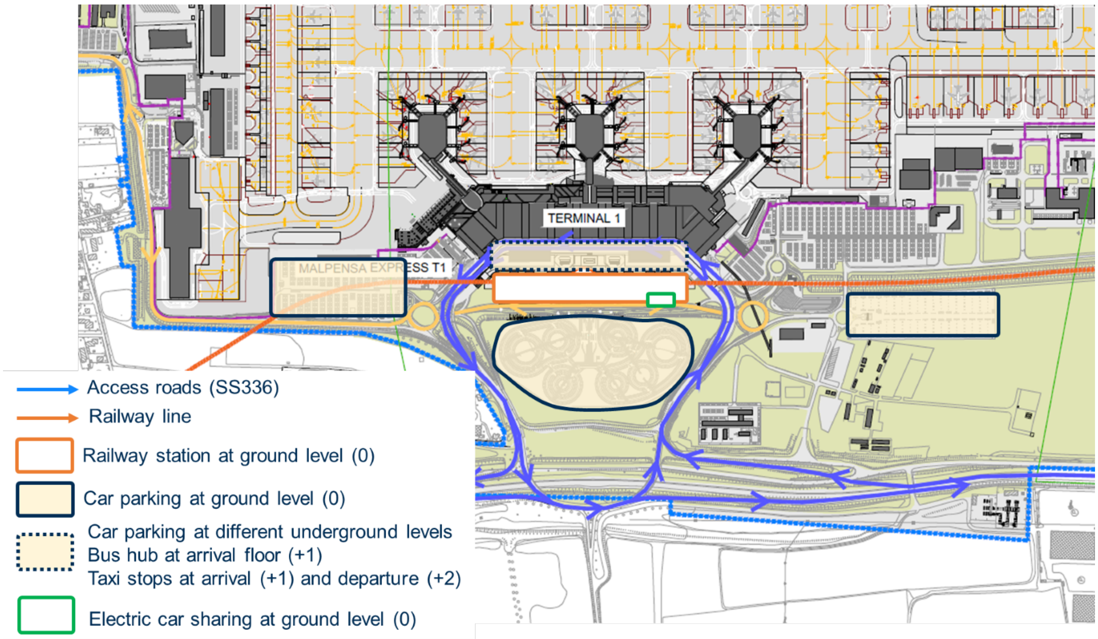

Figure 17: Transfer Node governance area

- The Airport Ground GA includes the apron where aircrafts stand and transit before and after flight operations, as to the handling of flights (e.g., fuelling, catering, passengers boarding, baggage loading/unloading, etc.).
- The Air Space GA includes:
  - the runway for take-off and landing operations,
  - the taxiway system where aircrafts move as to enter and exit the runway,
  - the Air Control Tower,
  - the system of routes and corridors in the air space where aircrafts fly.

4.2 Actors

The main actors involved are described as follows:

- Travelers are people moving on the surface network and using the available transport services to access the airport. They can be distinguished in:

  - Network users: people who use/move through the network. They are passengers driving on roads, passengers moving within the airport, train drivers and airplane pilots.
  - Transport users: people who use transport services to access the airport. They are passengers on trains, on buses, on e-VAI cars, on airplanes.

- SEA is the managing company of Milan Malpensa Airport and is the Traffic Orchestrator for both the Transfer Node Government Area and the Airport Ground Government Area, as to monitor flows of passengers inside the airport and ground operations.
- ANAS is the Italian authority for roads and highways of national interest, in charge of building, managing, monitoring and doing maintenance works on the network. SS336 - that allows the road accessibility to Malpensa - is managed by ANAS. ANAS is both Traffic Orchestrator and Network Manager, as it is in charge of constantly monitoring the infrastructure status and the vehicle flows on the network.
- ENAV is the national air navigation service provider responsible for the provision of air traffic services and other air navigation services. It is responsible for the provision of air traffic control services, flight information services, aeronautical information services and for issuing weather forecasts for the airports and the airspace under its responsibility. ENAV is both Network Manager and Traffic Orchestrator, as it establishes routes and corridors for airplanes and monitors air traffic.
- Ferrovienord is the company that manages the network of regional railway concessions owned by the FNM Group in Lombardy, with 331 kilometres and 124 railway stations in total. It is in charge of managing the infrastructure and of train circulation, thus representing both a Network Manager and a Traffic Orchestrator.
- Trenord is the company that operates the rail public transport in Lombardy, including the Malpensa Express service that links several cities in Lombardy to Milan Malpensa airport (as well as the city of Milan), thus representing a Transport Service Provider and a Fleet Operator (as it owns and manages different categories of train in its fleet).
- The shared car operator present in Malpensa is a 100% electric sustainable car sharing, present with 4 parking lots and 4 recharging points in front of the Malpensa Terminal 1 railway station. It is both a Transport Service Provider, as it offers a mobility service to people, and a Fleet Operator, as it owns and manages the electric car fleet.
- Bus operators are the several Transport Service Providers that operate the connections between Malpensa Airport and different cities. Because they own and/or manage their fleet they are considered also Fleet Operators.
- FST (FS Technology) is the company that provides technological solutions and services supporting travellers during the connection from Milan Central Station to Malpensa Airport via train.~~;~~ FST will have a role in the communication process between travellers and the Transport Service Provider in case of normal situations or disruptions of any kind regarding railway.

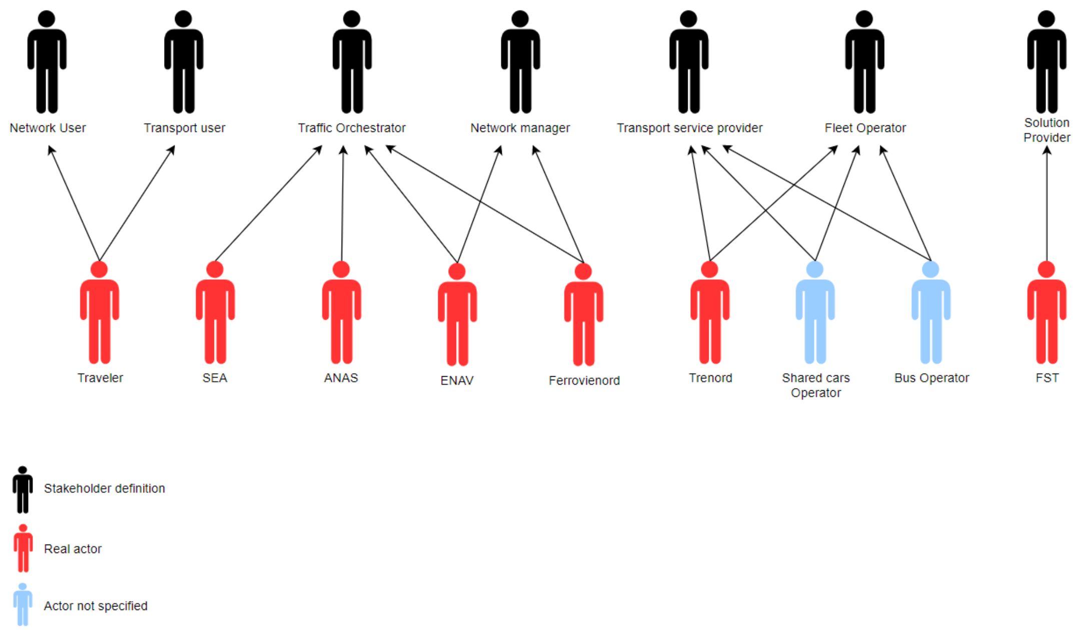

Figure 18: Actors-Stakeholders definition in Milano

Table 10: Description of actors in Milano

Actor	**Related Stakeholder**	**Description**
Traveller	Network User, Transport User	People moving on the surface network and using the available transport services to access the airport
SEA	Traffic orchestrator	Airport managing company that monitors flows of passengers inside the airport and ground operations
ANAS	Traffic orchestrator, Network Manager	Italian authority for roads and highways of national interest, in charge of building, managing, monitoring the network
ENAV	Traffic orchestrator, Network Manager	Air navigation service provider responsible for the provision of air traffic control service, flight information service, weather forecasts for the airports
Ferrovienord	Traffic orchestrator, Network Manager	Railway network manager in Lombardy region
Trenord	Transport Service Provider, Fleet Operator	Rail transport provider that operates the rail public transport in Lombardy, including the Malpensa Express service
Shared Cars Operator	Transport Service Provider, Fleet Operator	Car sharing operator that offers a shared mobility service
Bus Operator	Transport Service Provider, Fleet Operator	Providers that operate the connections between Malpensa Airport and different cities
FST	Solution Provider	FST is the owner of the travel planner solution that is not yet available. As Solution Provider, FST will have a role in the communication process between passenger and the Transport Service Provider.

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4.3 Tools to be used

Different tools to enable the simulated and piloted use-cases of Milano Living Lab will be developed. As in 3.3 a brief overview is provided here, but full details on all the tools' functionalities, prototypes and specific usage during the simulation and pilots, can be found in D4.1.

All data generated in the Milano Living Lab is shared between the tools and relevant stakeholders via a **data sharing infrastructure tool**, based on a distributed ledger. Additionally, data sharing between passengers and transport services provider will be enabled, mainly in the case of a disruption when a passenger re-direction will be deemed necessary. In such cases, a **transport credential system** shall be used in order to issue transport credentials for the disrupted passenger. Transport credentials based on IOTA distributed ledger can be used by the passenger for seamless travel with an alternative mode as verification of their validity does not require direct point-to-point integration between ticketing systems and reduces complexity while guaranteeing flexibility in the transport orchestration.

As disruptions shape significantly the Milano Living Lab, a good representation of the environment will be needed to apply transport demand management**. Network representations for use-cases** are used to simulate the status of the network under graph settings and aim to inform the traffic orchestrator about current or future possible problems at the network. Predictive assignment, i.e., the way the system is expected to evolve, will be part of the functionalities provided from this tool.

Under a disruptive situation the main goal is to apply capacity balancing and guidance for both disrupted and future users. To help users that are already *enroute*, **dynamic guidance for disrupted agent** will be provided, using information directly derived from the network status. Similarly, future users, i.e., users that have not yet started the trip to/from the airport will be provided **multimodal travel information guidance**, mainly regarding modal choice, to steer the system towards optimality. However, compliance of proposed routes will never be assumed. This tool takes available traffic information into account.

Finally, arbitration between passengers, in cases where supply exceeds demand may be needed. Since electric car sharing is already part of the fleet available for commuters to/from the airport, an algorithm for **matching of electric car-sharing passengers** will be developed, to maximize occupancy of the fleet, in a way that customer satisfaction is maintained.

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Table 11: Milano tools

Tool	Application ("why")	Functioning ("how")	Ownership
Data Sharing Infrastructure	Secure data sharing and optimisation of traffic	REST APIs for using IOTA Identities and Distributed Ledger	IOTA Foundation
Transport credential system	Collection of transport credentials when a passenger is redirected	REST APIs for using IOTA Identities and Distributed Ledger	IOTA Foundation
Network Representations for Use-Cases	Monitor traffic conditions and network's level of service	Open-source Python libraries, mainly OSMNX	TU Delft
Dynamic guidance for disrupted agents	Handle deviations for *enroute* passengers affected, by a disruption	Algorithm taking input from Network Representations tool	TU Delft
Multimodal travel information guidance	Provide travel information for passengers before trip starts	Algorithm taking input from Network Representations tool	TU Delft
Matching of electric car-sharing passengers	Arbitration between passengers to maximize occupancy of electric cars	Mixed-Integer Linear Programming model in Gurobi	TU Delft

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4.4 Systems to be integrated

4.4.1 Simulation

Since Milano Malpensa is a huge area with a dense traffic flow, the pilot will mainly be supported by the simulation. It will be necessary to develop a simulation that can provide data to the actors and evolve based on actor decisions. The idea is to have a simulation that will emulate the traffic in the area, so actors can observe the traffic evolution and take the appropriate decision to overcome the current issues.

4.4.2 Passenger emulator

The passenger emulator will be used to emulate the travel request of people that aim to travel from and to Malpensa. It is clear that the pilot cannot involve all the people that can potentially travel in the Milano Malpensa area. For this reason, we need a tool that can emulate their travel requests. The tool shall consider that people will have their own preferences such as shortest path, green path, etc. This system will not be a travel planner, nor a substitute of the ORCHESTRA's enabling tools, it will play the role of a request generator. The request will then be injected into the simulation.

4.5 Living labs operations

4.5.1 Operation 1 – People travelling from home to a foreign destination

Description of Scenario:

Passengers directed to Paris Charles De Gaulle with a direct flight departing from Milan Malpensa chose to reach the airport by Malpensa Express train. They plan their trip from Milan Cadorna, the downtown railway station, to reach the airport in less than 40 minutes [37 min].

Purpose and Goal:

Coordinate the flow of passengers that are moving from their homes to Milano Malpensa. This coordination shall take into account needs of the passengers and the overall traffic situation.

4.5.1.1 Event 1.1 – Happy flow

People are able to plan their rail travel with Trenord using a travel planner application (App). People take the planned train and arrive at Malpensa at the planned time. They will then follow the on-site instruction and proceed with boarding the plane. The flight departs at the planned time.

4.5.1.2 Event 1.2 – A railway network planned maintenance decreases the train traffic flow

Trenord informs people through the travel planner App that a planned maintenance on railway network at Milano Centrale station is slowing down the railway system on the track reserved for the airport-bound line: the foreseen time for the maintenance is 2 hours. This means that the route towards the Malpensa Airport is temporary blocked; trains will arrive minimum 2 hours late at their final destination and people who need to catch a flight at Milano Malpensa Airport may miss the flight. Therefore, Trenord will contact the Shared Car Operator and the Bus Operator to find alternative solutions for the involved passengers that are waiting at Milano Centrale station for the first available train to reach the airport in a fast way. Trenord will also contact SEA in order to communicate that most of people are reaching the airport at a different arrival point than the train station, and assistance to reach the correct checking point is needed. People are then invited or to leave the station and take

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the Shared Car Operator or alternative Bus, or to wait for the first available train. People who need to catch a flight soon are likely to follow the invitation for the alternative means of transportation and finally reach the airport on time to catch their flight.

4.5.1.3 Event 1.3 – Train breakdown

People are able to plan its rail travel with Trenord using the planner App. People take the train in time but at a sudden time, the train has a technical failure and must stop at Saronno rail station. Trenord shall inform the passengers, SEA and ANAS about the unexpected event. Trenord will contact the Shared Car Operator and the Bus Operator to find solutions for the involved passengers. All the passengers that risk missing their flight will be prioritized for faster alternatives solutions. Once the passengers choose their new travel, Trenord will contact the involved Fleet Operators and SEA. SEA will optimize the flight access to the passengers that will be in a hurry due to the unexpected event.

4.5.2 Operation 2 – People coming home from a foreign destination

Description of Scenario:

Passenger arrived at Milano Malpensa with a direct flight from Paris Charles De Gaulle. They choose to reach their home by Malpensa Express train. They plan their trips from Malpensa to Milano Cadorna.

Purpose and Goal:

Coordinate the flow of passengers that are coming by air and that want to travel to home.

4.5.2.1 Event 2.1 - Happy flow

Passengers are able to plan their travel from the airport to home, using the travel planner application. The flight lands in time and the passengers are able to catch the planned train. They arrive at home at the planned time.

4.5.2.2 Event 2.2 – A flight delay causes the airplane to land later in the evening and no more public transport is available

The airplane lands at the airport with a three-hour delay. It is 2.30 AM and public transport is not available anymore to passengers who want to reach their destination. ENAV, which is in charge of arrival flights management, transfers the information to SEA; SEA will alert the Shared Car and Bus Operator to make their service available for arriving passengers. Passengers are then able to check in the travel planner application which solution is proposed: taking a Shared Car or alternatively a Bus. Passengers choose their solution and are able to arrive at home.

4.6 Use Cases to be piloted

This section describes the scenarios which will be addressed in the simulation and the piloting part of the project. Scenarios are built by combining the proposed operations and events. A scenario is composed by several use cases. The use cases proposed in this table are not binding and can be modified during the living lab development.

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Table 12: Use cases to be piloted/simulated in Milano

Scenario to be addressed	Reference	Piloted	Simulated	Use cases
Travel from home to Charles de Gaulle, without any issue	Operation 1, Event 1.1	X	X	- Plan the travel - Travel
Travel from home to Charles de Gaulle with a maintenance on the railway network.	Operation 1, Event 1.2	X	X	- Notify the maintenance - Plan the travel - Plan alternatives - Overcome the maintenance issue
Travel from home to Charles de Gaulle, but a train breakdown occurs	Operation 1, Event 1.3		X	- Plan the travel - Disruption happens - Monitor flows - Cope with the disruption
Travel from Charles de Gaulle to home, without any issue	Operation 2, Event 2.1	X	X	- Plan the travel - Travel
Travel from Charles de Gaulle to home in the evening, but the aircraft land with a delay.	Operation 2, Event 2.2		X	- Notify the delay - Plan alternatives - Plan a new travel - Travel

4.7 Training sessions to be accomplished

The training sessions will have the objective to train the traffic orchestrators in the Living Lab. They will play a main role in the pilot and it is important that they have already experienced concepts and tools that they need to use. For this reason, it is planned to have a training session before the piloting part. The training session will comprise a theoretical part where the actors receive all the information necessary to work in the environment. Afterwards, there will be a practical part to allow people to understand how the tools have to be used. The stakeholders that will play a main role in the training sessions will be the rail, road, airport land and airport air traffic orchestrators. So, the main actor that will be involved are: Trenord, ANAS, SEA and ENAV. Trenord and ANAS are not ORCHESTRA project partners, for this reason their training will be probably emulated.

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5 Conclusions

The presented plan for the living labs contributes to the ORCHESTRA project in two main ways:

- The outline of the different scenarios to be piloted or simulated is important input for D5.1 (Simulation Architecture) and D5.2 (Simulator), which gain a clearer overview over the requirements of the living labs.
- Describing the operations also allows to gain insights into possibilities for data collection, which is crucial for supporting the evaluations done in WP6 (Evaluation and lessons learned).

With regards to the overall objectives of the ORCHESTRA project, this deliverable supports the validation and calibration of the MTME (objective 4) by defining and outlining relevant use cases that are to be piloted in the living labs, covering both person and freight transport.

It is clear from the current document that more work is to be done in detailing the descriptions of the living labs, especially with respect to the operations and events. It is expected that final details will emerge as the pilots and simulations are starting to be implemented, such that a complete description can be provided in D5.4 (Final Living Labs). In D5.4, the lessons learned from the living labs can then also be presented. In the Final Living Labs document, it will be of particular interest to note which aspects of the traffic orchestration as tested in the living labs went smoothly and which parts did not, in order to provide recommendations for future work.

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