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Services for Inclusive Rail-based Mobility Demonstration Plan

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1. Executive Summary

This document, deliverable D23.1, is part of Europe's Rail FP1 MOTIONAL project, which is currently (2025 & 2026) in the demonstration phase. It aims to enhance the planning and operational management of rail services and offers, with the overarching goal of ensuring the future European rail system's interoperability, resilience, capacity adaptability, and integration of all involved services. Leveraging digitization opportunities, the project is structured around research and innovation activities organized into various areas, grouping the Technical Enablers (TEs) identified in the Multi Annual Working Plan (MAWP).
The present document addresses TEs 20, 21 and 22 covering capabilities for improving the quality of the travel focusing on the support to Persons with Reduced Mobility (PRM), delivering hands free experience to travellers, and for developing smart solutions for better passenger flow and guidance through platforms.

D23.1 (due at M30) is elaborated during the third phase of the project (demonstration phase) with the objective of setting up and demonstrate the use cases specified during the first phase (specification phase) and developed during the second phase (development phase).
The aim of this deliverable is to provide comprehensive demonstration plans for all tasks included in WP23. It details specific use cases, testing strategies, and timelines for the setup and the execution of demonstrations. Additionally, it outlines the expected outcomes and risk management strategies for each demonstration, ensuring thorough preparation and effective execution.

The demonstrations are organized in four European cities—Madrid, Málaga, Amsterdam, and Berlin—each focusing on specific enablers. These demonstrations validate solutions ranging from Technology Readiness Levels (TRLs) 4 to 8, assessing their integration into existing infrastructure, usability, and effectiveness.

2. Abbreviations and acronyms

Table 1. Acronyms table

Abbreviation / Acronym	Description
ABT	Account Based Ticketing
APP	Application
B2B	Business to Business
FCM	Face Capture Module
FP	Flagship Project
FRS	Face Recognition Server
GA	Grant Agreement
GPS	Global Positioning System
GTFS	General Transit Feed Specification
HFCS	Hands Free Control System
KPI	Key Performance Indicator
MaaS	Mobility as a Service
MAWP	Multi Annual Working Plan
MQTT	Message Queuing Telemetry Transport
PRM	Person with Reduced Mobility
PTO	Public Transport Operator
QR	Quick Response
RTLS	Real Time Location Service
SaaS	Software as a Service
SG	Subgroup
TE	Technical Enabler
TRL	Technology Readiness Level
TSP	Transport Service Provider
UWB	Ultra-Wide Band
WP	Work Package
WS	Work Stream
XML	Extensible Markup Language

3. Background

The present document –D23.1 "Services for Inclusive Rail-based Mobility – Demonstration Plan"– outlines the demonstration plan for WP23 in the framework of the Flagship Project 1 – MOTIONAL.

WP23 builds upon the Technical Enablers (TEs) specified in WP19 and developed in WP22, focusing on inclusive rail mobility services. It covers a series of demonstrations targeting TEs:

- Enabler 20: Services and solutions improving the quality of the travel and dedicated to the support to PRM and passengers with special needs.
- Enabler 21: Delivery of hands-free experience for travellers using rail services and transferring between rail operators and other mobility modes.
- Enabler 22: Smart solutions for better passenger flow and guidance that is based on real-time provided in different channels adapted to the different user's capabilities. Allow data Exchange directly between passengers and platforms that would improve guidance.

These enablers aim to enhance the travel experience for vulnerable users, enable smooth transitions across transport modes, and support the integration of inclusive services into the broader rail system
The goal of WP23 is to setup and validate these innovations in relevant environments, supporting interoperability, accessibility, and seamless multimodal travel.

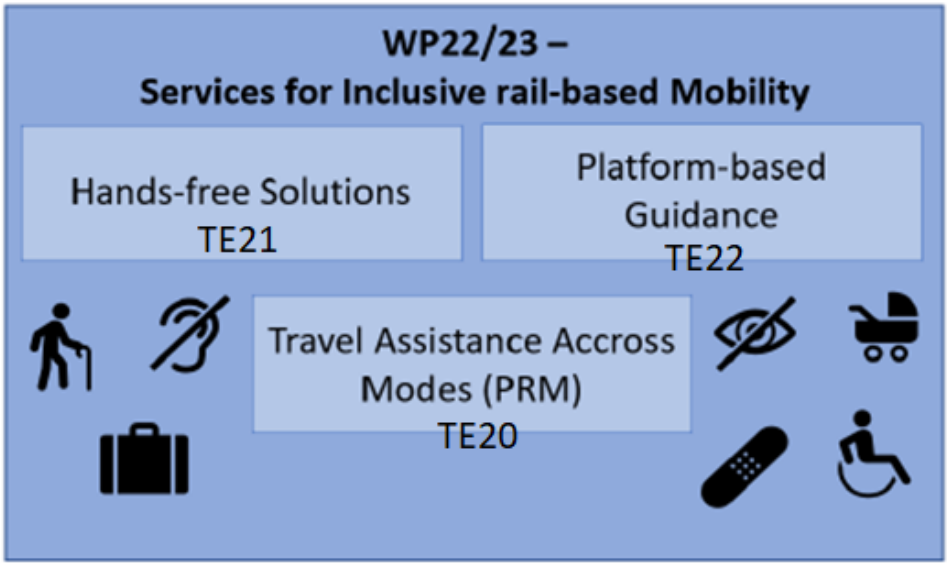


Figure 1. MOTIONAL Workstream 1.3 "Integration of Rail Traffic with Door-to-Door Mobility" – WP22/23 "Services for inclusive rail-based mobility"

4. Objective/Aim

The objective of WP23 is to plan, implement, and evaluate a series of inclusive mobility demonstrations using the enablers developed in WP22. The aim of this deliverable is to provide comprehensive demonstration plans for WP23 demonstrations.
WP23 Demonstrations will occur across several European stations and are intended to:

- Validate solutions at TRLs 5–8 depending on maturity
- Provide relevant feedback on user experience, technical performance, and operational feasibility
- Demonstrate scalable, interoperable services that can be integrated into the European rail system
- Support PRM accessibility, seamless multimodality, and innovative station services

Each demonstration follows a structured approach:

- Preparation Phase: Definition of demonstration site, installation plan, user journey mapping
- Setup and Implementation Phase: Software, hardware and data Integration, setup preparatory meetings, end-users training
- Execution Phase: Installation, dry runs, full operation, validation & communication, data collection
- Evaluation Phase: Assessment of results, impact measurement, and preparation for replication

Within WP23, different levels of maturity are expected depending on the demonstrations. The TRL validation definitions from the project (established by WP2 processes and approved by the partners) can be seen in Table 2 below.

Table 2. TRL Definitions and Validation

TRL	Description	Software Definition	Validation
5	technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)	Alpha version of the software functionalities **tested by outsiders** of the development team	Documented in Deliverable, **testing reports** with screenshots, feedback from outsiders (other partner/ expert within project), Proof of using historical or production data
6	technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)	Beta version of the software functionalities **tested by selected end-user** under a control mode	Documented in Deliverable, **testing Report** with Screenshots, feedback from end-users, Photos of end-user introduction to SW, Proof of using historical or production data
7	system prototype demonstration in operational environment	Beta version of the software functionalities widely **open to end-users**	Documented in Deliverable, **Demonstration Report** with Photos, Survey to end-users and results of survey, Proof of using Production data, Demonstration/ Dissemination Video (optional)
8	system complete and qualified	**Stable version** of the software available for the market	Documented in Deliverable, **Demonstration Report** with Photos, Promotional video for market

4.1 WP23 Demonstrations

All demonstrations in WS1.3 can be seen in Table 3.

Table 3. WP23 Demonstrations

Demo number	Short description	TEs	Related use case	Participants	Infra manager/ location/data provider
23.1	Demonstration in Madrid of PRM assistance and hands-free access (seamless validation)	TE21 TE22	UC-FP1-WP19-19 UC-FP1-WP19-20 UC-FP1-WP19-21	INDRA, MDM	Madrid, Spain
23.2	Demonstration in Malaga station: PRM info sharing and platform guidance systems (Smart platform)	TE20 TE22	UC-FP1-WP19-12 UC-FP1-WP19-13 UC-FP1-WP19-14 UC-FP1-WP19-15 UC-FP1-WP19-16 UC-FP1-WP19-17 UC-FP1-WP19-18	ADIF, INECO, RENFE	Malaga, Spain
23.3	Demonstration in Amsterdam intermodal hub: hands-free solutions and assistive tools	TE20 TE21	UC-FP1-WP19-22 UC-FP1-WP19-23 UC-FP1-WP19-24 UC-FP1-WP19-25 UC-FP1-WP19-26 UC-FP1-WP19-27	GTSD	Amsterdam, Netherlands
23.4	Demonstration in Berlin and Leipzig: Platform-based passenger guidance using smart LED-floor elements (Illuminated Platform Edge)	TE22	UC-FP1-WP19-28 UC-FP1-WP19-29 UC-FP1-WP19-30	DB	Berlin and Leipzig, Germany

5. Methodology

The methodology used to develop the planning of the demonstrations from WP23 is following the guidelines proposed by the WP2 Technical Coordination on the deliverable D2.4 Demonstrations Strategy [2]. On this document each demonstration should have four phases as described in the timeline below.
This document will focus only on the Phase 1 – Demonstration Preparation.



Figure 2. General Timeline for Demonstration Strategy

The methodology used to develop this deliverable is structured to ensure a comprehensive and systematic approach to the demonstration activities outlined in WP23. Each of the demonstrations will follow the same structured approach describing the following steps:

1. **Planning and Coordination**:
    - Initial planning meetings were held to define the scope, objectives, and deliverables of WP23.
    - Coordination with relevant stakeholders and work packages to align goals and ensure integration with other project activities.
2. **Use Case Identification**:
    - Identification and documentation of use cases relevant to the demonstration goals.
3. **Stakeholder and End-User Engagement:**
    - Identification of stakeholders and end-users involved in or affected by the demonstrations.
    - Engagement with these groups to gather input, ensure their needs are addressed, and facilitate their participation.
4. **Test Data Definition**:
    - Specification of the test data required for each demonstration.
    - Collection and preparation of data to ensure it meets the needs of the demonstration tests.
5. **Demonstration Test Design**:
    - Development of detailed test plans, including objectives, procedures, required software/equipment, and personnel.
    - Coordination with technical teams to ensure readiness for the validation events.t

6. **Outcome Definition and Measurement**:
    - Identification of expected demonstration outcomes and development of measurement methods.
    - Preparation of tools and processes to evaluate the outcomes during and after the validation events.
7. **Training Plan Development**:
    - Creation of a comprehensive training plan for end-users and stakeholders.
    - Design of training materials and schedules to ensure effective knowledge transfer and adoption.
8. **Logistics and Installation Planning**:
    - Development of logistics and installation plans for the demonstration setup.
    - Coordination of transportation, installation procedures, and necessary permits/approvals.
9. **Communication Planning**:
    - Creation of a communication plan to disseminate information about the demonstrations.
    - Identification of communication channels, key messages, and timelines for communication activities.
10. **Interaction Management**:
    - Documentation of interactions between demonstrations and other flagship projects.
    - Updating interaction tables and monitoring collaboration with other projects.
11. **Preparatory Meetings**:
    - Scheduling and conducting preparatory meetings to ensure smooth execution of validation events. Those meetings should be addressing any issues and finalizing plans before the demonstrations.
12. **Validation Event**:
    - Detailed planning of validation events, including defining the type, duration, location, and timeline.
    - Development of validation criteria and metrics to assess the success of the demonstrations.
13. **Dissemination event**:
    - Design of dissemination events to share demonstration outcomes with stakeholders and the public.
    - Selection of appropriate dissemination formats (e.g., open/closed, physical/hybrid/online) and coordination with other demonstration events.

14. Demonstration Master Plan (GANTT):

- Development of a master plan/GANTT chart to outline all demonstration activities.
- Regular updates and monitoring to ensure adherence to the timeline.

15. Risk and Opportunity Management:

- Identification and management of risks and opportunities associated with the demonstrations.
- Development of mitigation and action plans to address identified risks and capitalize on opportunities.

This structured methodology ensures that all aspects of the demonstrations are thoroughly planned, executed, and evaluated, leading to successful outcomes and valuable insights for the demonstration implementation, execution and evaluation.

6. Task 23.1 – Demonstration in Madrid

The demonstration in Metro de Madrid aims to showcase the enhanced accessibility and user experience enabled by inclusive mobility services integrated into a Mobility-as-a-Service (MaaS) ecosystem.
By combining hands-free validation, indoor guidance, and account-based ticketing, we will demonstrate how seamless interaction between mobile applications, station infrastructure, and back-office systems can simplify the travel experience, especially for PRM.
This demonstration will highlight the benefits of integrating smart ticket validation and navigation technologies to support barrier-free access and real-time passenger assistance in a real operational environment.

6.1 Use cases

Use case ID	TE's	Name	Description
UC-FP1-WP19-19	TE21 TE22	Frictionless ticket validation	A user is able to validate a ticket without showing any visual ticket to the validation equipment facilitating the access to public transport.
UC-FP1-WP19-20	TE21 TE22	Indoor guidance	The user receives information of the map of the station and is guided to the platform facilitating the access of PRM to public transport.
UC-FP1-WP19-21	TE21 TE22	Account based ticketing	Account-Based Ticketing is a ticketless way of allowing people to travel meaning they tap or scan using a secure token, linked to an account in the back office, to make a journey. The location and number of taps calculates the fare, which is charged to the passenger during or post journey. This means riders no longer need to buy a ticket and can benefit from best fare policies.

6.2 Involved stakeholders and end-users

Stakeholders involved in the demonstration:

- **INDRA:** technology supplier. INDRA is responsible for the development and integration of inclusive mobility services such as frictionless ticket validation, indoor guidance, and account-based ticketing. Its interest lies in demonstrating the usability and effectiveness of these solutions in a real operational environment, particularly for PRM passengers, and validating their integration into a MaaS ecosystem.

- **Metro de Madrid (MdM):** infrastructure and operations partner. MdM provides access to the demonstration site and supports the deployment of the solutions in one of its stations. Its interest is in improving accessibility, passenger experience, and operational efficiency, especially for users with reduced mobility.

End-users:
The main end-users of the demonstrated solutions are passengers of Metro de Madrid, with a particular focus on PRM, who will benefit from improved accessibility, indoor navigation, and seamless station access. Additionally, general public transport users including frequent commuters, occasional riders, and tourists will experience a more intuitive and convenient journey through features like hands-free ticket validation and account-based ticketing. These solutions aim to simplify access, reduce barriers, and enhance the overall travel experience for a wide range of user profiles.

By demonstrating these use cases, the project aims to validate the practical benefits of inclusive mobility services and support their future adoption across European transport networks.

6.3 Define test data

The demonstration will require a limited but essential set of test data to validate the functionality of the inclusive mobility services in a real operational environment. The following data will be used:

- **Ticket Sample:** A digital ticket sample will be used to test the frictionless validation system. This ticket will be linked to a user account and configured to simulate a standard fare scenario, enabling the validation process through the mobile application and Ultra-Wideband (UWB)/Bluetooth Low Energy (BLE) detection.
- **Station Map:** A detailed digital map of the selected Metro de Madrid stations will be used for the indoor guidance functionality. It will include key infrastructure elements such as entrances, platforms, elevators, and accessible routes to support passenger navigation.
- **Fare Information:** Basic fare structure data will be used to support the account-based ticketing (ABT) logic. This includes fare rules and pricing needed to simulate post-journey fare calculation.

These datasets will be integrated into the MaaS platform and mobile application to enable realistic testing of the user journey and system performance.

6.4 Define demonstration tests

The demonstration will include a series of structured tests to validate the functionality, usability, and integration of the inclusive mobility services developed in WP22. These tests will be conducted during the Validation Event at a selected Metro de Madrid station. Below is a detailed outline:

Test Objectives:

- *Validate frictionless ticket validation:* Ensure that users can access the station without presenting a physical ticket, using mobile-based UWB/BLE detection.
- *Verify indoor guidance:* Confirm that the application provides accurate, accessible navigation within the station, especially for PRM users.
- *Test account-based ticketing (ABT):* Check that the system correctly calculates fares and sends post-journey notifications based on user travel behaviour.
- *Assess system integration:* Validate that all components (mobile app, validation equipment, back-office systems) work together seamlessly within the MaaS platform.

Test Procedures:

- *Simulate a full journey:* A user will enter the station, be guided to the platform, and complete a simulated trip using the app.
- *Trigger validation events:* The user will approach the gate with the app active to test automatic detection and access.
- *Activate and follow guidance:* The user will use the app to receive and follow indoor navigation instructions to the platform.
- *Verify fare calculation:* After the simulated trip, the system will calculate the fare and send a notification to the user.

Required Software and Equipment:

- *Mobile app with UWB/BLE:* Used for seamless validation and indoor guidance.
- *Validation equipment:* Gates or sensors configured to detect the mobile device and allow access.
- *Indoor positioning system:* Includes the station map, wireless infrastructure for navigation, such as beacons for favouring connectivity.
- *Back-office systems:* Handle user account management, fare calculation, and MaaS integration.

Personnel Involved:

- *Indra technical staff:* Responsible for system setup, monitoring, and troubleshooting during the tests.
- *Metro de Madrid staff:* Ensure operational coordination, safety, and support within the station.

These tests will help assess the readiness of the solutions for real-world deployment and identify any areas for improvement before scaling.

6.5 Definition of demonstration outcomes and how to measure them

To ensure a meaningful evaluation of the demonstration, a set of expected outcomes has been defined in advance.

Expected Outcomes:

1. **Successful frictionless validation:** Users are able to access the station without presenting a physical ticket, using UWB/BLE detection via the mobile app.
2. **Effective indoor guidance:** Users, especially PRM, are able to navigate the station using the app and reach the platform following the suggested accessible route.
3. **Correct fare calculation through Account-Based Ticketing (ABT):** The system accurately calculates the fare based on the user's journey and sends a post-trip notification.
4. **Positive user experience:** Users report satisfaction with the ease of use, accessibility, and overall functionality of the demonstrated services.
5. **Seamless system integration:** All components (mobile app, validation equipment, indoor positioning, and back-office systems) operate in a coordinated and reliable manner.

Measurement Methods:

- **System logs and backend data:** Used to verify validation events, navigation activations, and fare calculations.
- **User feedback forms:** Short surveys completed by testers after the demonstration to assess usability, accessibility, and satisfaction.
- **FAQ Sheets**: documents addressing common issues and solutions, helping users troubleshoot potential problems.

These outcomes and measurement methods will ensure that the demonstration is not only technically validated but also aligned with user needs and expectations, providing a solid foundation for future deployment.

6.6 Training plan for end-users

To ensure a smooth and effective demonstration, a basic training plan will be provided to familiarize end-users with the functionalities of the demonstrated solutions, particularly focusing on accessibility and ease of use.

Training Objectives:

- Enable users to understand and operate the mobile application for frictionless validation and indoor guidance.
- Introduce the concept of **Account-Based Ticketing (ABT)**, explaining how it works and its benefits (e.g., no need to purchase a ticket in advance, best fare calculation, simplified travel experience). The training will also address user trust aspects related to the digital management of tickets by explaining how journeys are registered, how fares are calculated, how post-journey notifications are provided, and how users can verify their travel information, ensuring transparency and confidence in the ticketless model.

Training Schedule:

- **1 week before the demonstration:** Distribution of digital training materials to participants. If necessary, a short online webinar may be organized to explain the key functionalities.
- **Day of the demonstration:** A brief on-site session will be held to review how to use the app, its main features, and the expected user flow during the test.

Training Materials:

- **Digital user guide:** Will be the primary training material and will include clear, step-by-step explanations supported by screenshots where appropriate. Given the limited scope and pilot nature of the demonstration, no video tutorials or in-app demos will be produced.
- **Quick reference sheet (optional):** A one-page summary of key actions and app features.

Training Methods:

- **Optional workshop:** A short, targeted session may be organized if participants require additional support or clarification.
- **One-on-one support:** Available on-site during the demonstration, especially for PRM users or those unfamiliar with mobile applications.

This lightweight training approach is designed to be efficient and user-friendly, ensuring that all participants can confidently interact with the demonstrated solutions with minimal preparation.

6.7 Logistics, installation plan

A detailed logistics and installation plan has been defined to ensure the successful deployment of the demonstration setup at the selected Metro de Madrid station. The plan includes the transportation, installation, and configuration of both hardware and software components required for the frictionless validation and indoor guidance functionalities.

Installation Components and Procedures:

- **Beacons for Indoor Navigation:**
  - A set of Bluetooth Low Energy (BLE) beacons will be installed throughout the station to enable accurate indoor positioning and guidance.
  - Placement will be optimized to ensure full coverage of key areas such as entrances, corridors, elevators, and platforms.
  - Installation will be coordinated with Metro de Madrid to avoid interference with station operations.
- **Validation Antennas:**
  - Two antennas will be installed per access gate to enable hands-free validation using UWB/BLE.
  - Each antenna will be connected to a PC via a **microUSB-to-USB cable** for power and data transmission.
  - Antennas will be mounted on custom supports (e.g., metal brackets, enclosures, or 3D-printed mounts) to ensure stability and proper alignment.
- **Software Setup:**
  - The mobile application and back-office systems will be pre-configured and tested prior to deployment.
  - On-site configuration will include final calibration of the indoor positioning system and validation equipment.

Logistics and Approvals:

- All equipment will be transported to the station in advance of the installation date.
- Coordination with Metro de Madrid will be required to obtain **installation permits**, ensure access to technical rooms, and schedule installation during low-traffic hours to minimize disruption.
- Safety protocols and installation guidelines provided by the infrastructure operator will be strictly followed.

This plan ensures that all technical components are properly installed and operational ahead of the demonstration, enabling a smooth and effective validation event.

6.8 Communication Plan

To ensure visibility of the demonstration and engage relevant stakeholders, a basic communication plan will be implemented. The goal is to inform the public and project partners about the objectives and outcomes of the demonstration in Metro de Madrid.

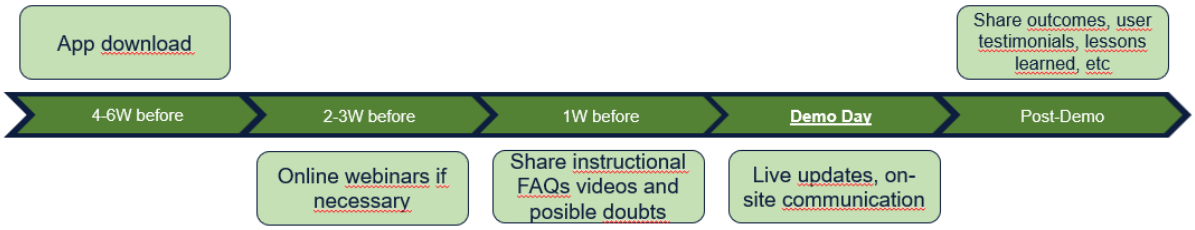
Communication Channels:

- **LinkedIn posts:** One or more posts will be published on Indra's LinkedIn page to share updates about the demonstration, highlight the innovative solutions being tested, and showcase the company's role in advancing inclusive mobility.
- **Internal communication:** Project partners and stakeholders will be informed through internal channels such as email updates and project meetings.
- **Event dissemination:** The developments and the upcoming demonstration were presented at the **16th ITS European Congress in Seville (May 19-21, 2025),** helping to raise awareness among industry professionals and mobility stakeholders.

Key Messages:

- Highlight the demonstration of inclusive mobility services such as frictionless validation, indoor guidance, and account-based ticketing.
- Emphasize the benefits for passengers, especially persons with reduced mobility (PRM).

Timeline:



This simple yet effective communication approach will help raise awareness and support the dissemination of results within the project and to the broader public.

6.9 Interactions between demos (If applicable)

The primary interaction for this demonstration is with Demo 21.2. In this demonstration, the same mobile application will be used, ensuring a consistent user experience and leveraging the app's capabilities for both ticket purchasing and PRM assistance. Beyond this interaction, there are no additional interactions with other demonstrations.

6.10Interaction with other flagships projects (If applicable)

There is no interaction with other FPs.

6.11Setup preparatory meetings

To ensure that the Validation Event runs smoothly, a couple of preparatory meetings will be organized with Metro de Madrid (MdM). These meetings will focus on clarifying the strategy for the demonstration, addressing any last-minute issues, and reviewing the results post-demonstration.
The first meeting will take place approximately one month before the demonstration. This meeting will involve MdM and INDRA. The primary focus will be to discuss and finalize the strategy for the demonstration, including the objectives, roles, and responsibilities of each party. This meeting will ensure that we are aligned and prepared for the event.
A second meeting will be held one week before the demonstration. This meeting will serve as a final check to address any last-minute issues or concerns. Reviewing the setup, confirming the availability of necessary resources, and ensuring that all technical aspects are functioning correctly. This meeting will help mitigate any potential risks and ensure a smooth execution of the demonstration.

6.12Validation Event

To ensure the successful demonstration of the inclusive mobility services developed in WP23, a hands-on validation event will be organized. This event will allow users to experience the functionalities of the mobile application frictionless validation, indoor guidance, and account-based ticketing in a real operational environment. It will also provide stakeholders with the opportunity to gather feedback and validate system performance under realistic conditions.

Type and Location:
The validation event will be a hands-on demonstration exercise where users will access the station using the mobile app, navigate to the platform using indoor guidance, and complete a simulated journey with account-based ticketing. The event will take place at two Metro de Madrid stations, with the specific locations to be confirmed.

Stakeholders:

- **INDRA:** Technology provider responsible for the development and integration of the inclusive mobility solutions.
- **Metro de Madrid (MdM):** Host of the demonstration, providing the venue and operational support.

Duration:
The validation event is expected to last one full day. The morning will be dedicated to setting up the demonstration environment, performing final system checks, and briefing participants. The afternoon will focus on user testing, where selected participants will interact with the app and complete the demonstration journey, followed by feedback collection.

Expected TRL:
The demonstration aims to achieve **Technology Readiness Level (TRL) 6–7**, by validating a system prototype in a relevant environment that closely simulates real-world conditions.

By organizing this validation event, the project aims to showcase the practical benefits of inclusive mobility services, validate their technical performance, and gather valuable insights for future deployment.

6.13 Dissemination event

To effectively share the outcomes and insights from the demonstration, a dissemination event will be organized. This event will provide an opportunity to present the demonstration activities, engage with a broad audience, and discuss the implications of the results.

Type and Location: The dissemination event will be an online event where each partner presents a video showcasing their demonstration activities. This format allows for broad accessibility and the ability to reach a diverse audience.
The demonstration in WP23 will be connected to the WP21 demo, as both will take place on the same day and at the same location. This connection will allow for a comprehensive showcase of both demonstrations, highlighting the integration and collaborative efforts between the two work packages.

Target Audience: The event will be open to the general public, industry professionals, policymakers, transport operators, and other stakeholders interested in the outcomes of the demonstration. This broad target audience ensures that the insights and lessons learned from the demonstration are widely disseminated and can influence various sectors.

Expected Content:

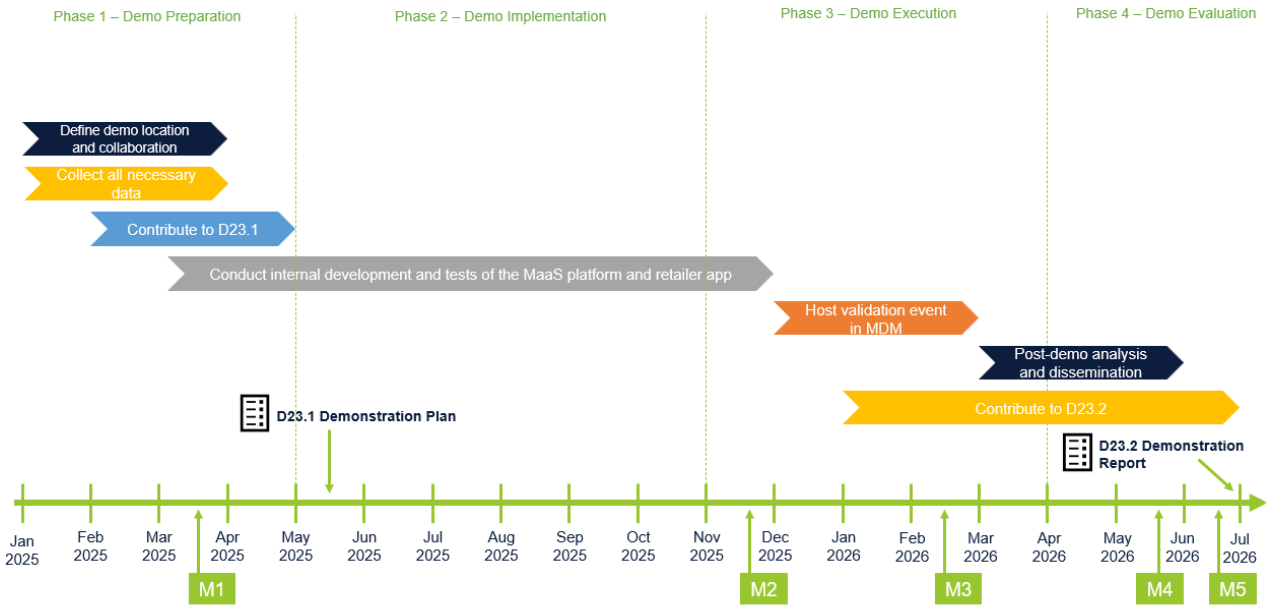
- **Video presentation:** the event will feature a video presentation of the demonstration process and results. This presentation will include highlights of the MaaS platform, the app, B2B intermodal services, and ticketing functionalities such as frictionless validation, indoor navigation and ABT.
- **Discussion of outcomes and lessons learned:** the event will include a discussion segment where the outcomes of the demonstration and the lessons learned are shared with the audience. This segment will provide valuable insights into the effectiveness and impact of the demonstrated solutions.

- **Opportunities for audience interaction:** the event will offer opportunities for audience interaction through Q&A sessions or follow-up discussions. These interactions will allow participants to ask questions, provide feedback, and discuss the implications of the results.

By organizing this dissemination event, we aim to effectively share the achievements and insights from the demonstration, engage with a wide audience, and foster discussions that can drive further innovation and collaboration in the field.

6.14 Demonstration Master plan (GANTT)

The GANTT scheme for all the expected demonstration activities is the following:



6.15 Risk and Opportunity management

Table 4. Risk and Opportunity Management table

Risk/Opp. ID	Risk/Opp Name	Risk/Opp Description	Probability (1-5)	Impact (1-5)	Mitigation / Action Plan
T23.1-R01	Beacon Connectivity Failure	Indoor navigation may fail if BLE beacons are not properly installed or lose connection.	3	4	Conduct pre-demo testing and calibration; have spare beacons and technical staff on-site for support.
T23.1-O02	UWB/BLE Detection Inaccuracy	Frictionless validation may not trigger correctly due to signal interference or device issues.	2	5	Perform multiple validation tests in advance; provide fallback manual validation if needed.

T23.1-O03	Data Exchange Issues Between Components	Inconsistent or delayed communication between the mobile app, validation system, and back-office may affect the user experience or data accuracy.	2	4	Conduct end-to-end integration testing prior to the demo; monitor system logs in real time during the event.

7. Task 23.2 – Demonstration in Malaga

Demonstration in T23.2 is divided into three specific ones:

- Software Demo
- Gobos Demo
- Gap Filler

7.1 SW Demonstration

7.1.1 Use cases

Use case ID	TE's	Name	Description
UC-FP1-WP19-12	TE22	Totem T-Ais: 1 specific spot for people with visual disability	Totem receives information from transportation information sources, offering specific information to people according to their requests.
UC-FP1-WP19-13	TE22	Totem T-Ais: 2 specific spot for people with hearing impairment, PRM, motor disability, cognitive impairment, language misunderstanding and some visual impairments; also can be used by persons with no disabilities	Totem receives information from transportation information sources, offers specific information in text by screen, loudspeaker and magnetic induction loop, to people according to their requests.
UC-FP1-WP19-16	TE22	Accessible Robot	Guiding of people with disabilities inside of the multimodal railway station
UC-FP1-WP19-17	TE22	Guiding Accessible Software	Guiding of people with disabilities inside of the multimodal railway station
UC-FP1-WP19-18	TE22	Guiding Accessible Intelligent Tool with physical complementary signalling in different languages	Guiding of people with disabilities inside of the multimodal railway station

7.1.2 Involved stakeholders and end-users

Several key stakeholders are directly involved in the demonstration. ADIF, as infrastructure manager, is collaborating by granting access to the Málaga María Zambrano station (Cercanías - commuter Spanish public rail services- platforms 10 and 11) and supporting the setup. RENFE, as the operator, is coordinating the test execution, activating the platform lights according to the arriving train composition. Vialia is the concessionaire of the commercial areas of the station, where the demonstration is also taking place.

Station staff and Vialia will play an active role during the demonstration, helping to manage the operation and providing valuable feedback based on their daily experience assisting passengers.

Additionally, end-users with specific needs will be invited to test the Totem T-Ais & the Motional mobile app, and share their feedbacks regarding its usefulness and clarity. In particular, the following end-users are expected to participate:

- People with visual disability
- Hearing impairment
- PRM (wheelchair users)
- Cognitive impairment
- Motor disability (people without fingers and without the ability to press small buttons).

In the market-ready version, this system could benefit a wide range of users, including persons with disabilities, elderly passengers, travelers with pushchairs, and anyone needing clearer guidance on accessible routes through the station.

7.1.3 Define test data

Depending on the target of the test, the following data are required:

Target	Get information
Test data	• Departure time and track of the next train to Madrid (or other destination). • Time and track of arrival of the next train from Granada (or other origin). • Underground frequency at those times.
Target	Obtain information on a ticket by scanning its QR code
Test data	• Ticket with departure within 30 minutes of the test, and if this is not possible, a controlled ticket from which a response will be forced.
Target	Follow accessible routes through the station accompanied by an assistance robot
Test data	• Location of interest within the station (Cafeterias, toilets, platforms, exits, ticket sales points, customer service, etc.)
Target	Follow accessible routes through the station using a mobile guidance system
Test data	• Location of interest within the station (Cafeterias, toilets, platforms, exits, ticket sales points, customer service, etc.)

7.1.4 Define demonstration tests

As detailed in previous sections, the test objectives are as follows:

1. The user can obtain information through the totem T-Ais or through the mobile phone regardless of the disability he/she suffers from.

2. Users can find out which track their train is parked on by scanning their ticket on the totem T-Ais or with their mobile phone.
3. Users can make accessible routes through the station with the accompaniment of an assistance robot.
4. To enable users to make accessible routes through the station using a mobile guidance system (Navilens).
5. Offer users accessible routes in the station by displaying them on a map both on the totem T-Ais and on the Motional mobile app.

During the demonstration Validation Event, tests will be carried out with people with different disabilities (detailed in section 7.1.2) in several work sessions on different days.
It is expected to have at least 2 users/volunteers of a given disability in each work session; one will test the totem T-Ais and the second will test the Motional mobile app.
Therefore, at least 10 users/volunteers (testers) are expected to participate.

The testers will belong to official associations, and will be accompanied at all times by staff from their association, and by project staff who will evaluate the performance of the tests.

Station staff will also be involved in the demonstration Validation Event to facilitate access to the different areas of the station.

The tests will be carried out during normal station opening hours, so while the tests are being carried out there will be passengers in transit as on any other day.

In order to test the Motional system for providing accessible information to people with different disabilities, T-Ais Totem will be used as well as two phones (Android and iOS) to test its associated mobile app, and each phone will have the following applications installed:

- AccessRobot application (related to the assistive robot)
- Navilens application (offers intelligent guidance with the mobile).
- Motional application, that offers the same services as the T-Ais totem, such as providing accessible train and Underground timetable information, calculates accessible routes shown on a map, indicates the track on which a train is parked by scanning the ticket and is integrated with the AccessRobot application and with Navilens.

The tests also require the assistive robots that will accompany users on request, and the technology associated with Navilens (in addition to the mobile application, foot-tracking on the floor and Navilens labels throughout the station).

The test procedure shall consist of reproducing each use case in a test case.

For each type of disability, the effectiveness of the T-Ais totem and the Motional application will be tested to achieve each of the objectives indicated above.

The structure of each Test Case is as follows:

- Short Description:
  Depends on the objective, the medium used (totem or mobile), and the type of disability of the user taking the test.
- Objective: One of the 5 defined objectives.

- Pre-condition(s):
  - Type of disability of the user.
  - Interface to be used (totem or mobile app).
  - Train ticket to scan its QR code (preferably a real ticket of a train departing close to the time of the test).
  - AccessRobot application, Navilens application and Motional application installed on the test mobile.

- Input Data Description
  - Train ticket
  - Target to be met (the tester is told what information to get from the Motional system, or a location in the station to go to using the assistive robot, Navilens, or the Motional app map.)
- Expected Result: The tester obtains the required information and/or reaches the target station location.
- Sequence:

  The sequence of steps to be carried out by the tester will depend on each test case, depending on the objective, the type of disability of the tester, and the interface to be used (totem or mobile), but in general it will be as follows (e.g. for totem):

  1. The user approaches the totem pole by following the tactile pathways until he/she reaches it.
  2. The user recognizes the elements and shape of the totem (displays, buttons, Braille reliefs, etc.).
  3. The user knows the content of each screen thanks to the touchscreen, screen narrator, loudspeaker, headphone, etc.
  4. The user moves through the screens and selects options using the querty keyboard, touch screen or accessible buttons.
  5. After navigation, the user hears or sees the information requested for the test case (information on timetables, parking lanes after scanning the ticket, etc.).
  6. Depending on the test case, the user will navigate through the different screens of the system to select a location in the station to go to, he/she will request an assistive robot or guided with Navilens, and walk to the location with this help autonomously.
  7. End of the test case.

     When the test case is performed with the Motional mobile application, in step 6 the user will also indicate a meeting point at the station to start the tour with the assistive robot.

7.1.5 Definition of demonstration outcomes and how to measure them

The main outcomes of the demonstration are:

1. Obtain information through the totem T-Ais or through the mobile phone:
   - Expected outcome: Users with disabilities or special needs can get the information and understand it without help, and they find it useful to increase their independence in mobility.

- Measurement: It will be noted as a result of the test whether the user has achieved the information with ease, with difficulty, or even if it has not been achieved.

In addition, feedback will be collected through short informal interviews or questionnaires on-site, assessing clarity, visibility, and perceived value.

2. Find out which track a train is parked on by scanning a ticket:
    - Expected outcome: Users with disabilities or special needs are able to scan their ticket and obtain and understand on which track the train is parked without help, and they find it useful to increase their independence in mobility.
    - Measurement: It will be noted as a result of the test whether the user has achieved understand the track where the train is parked with ease, with difficulty, or even if it has not been achieved.

In addition, feedback will be collected through short informal interviews or questionnaires on-site, assessing clarity, visibility, and perceived value.

3. Walk accessible routes through the station with the accompaniment of an assistance robot:
    - Expected outcome: Users with disabilities or special needs are able to request an assistive robot and follow the instructions to reach a station location accompanied by the robot without help of other person, and they find it useful to increase their independence in mobility.
    - Measurement: It will be noted as a result of the test whether the user has achieved to reach the indicated location with ease, with difficulty, or even if it has not been achieved.

In addition, feedback will be collected through short informal interviews or questionnaires on-site, assessing clarity, visibility, and perceived value.

4. Walk accessible routes through the station with Guiding Accessible Intelligent Tool (Navilens):
    - Expected outcome: Users with visual disability are able to navigate to an accessible path to the location of the test case and can traverse this path using Navilens without help of other person, and they find it useful to increase their independence in mobility.
    - Measurement: It will be noted as a result of the test whether the user has achieved to reach the indicated location with ease, with difficulty, or even if it has not been achieved.

In addition, feedback will be collected through short informal interviews or questionnaires on-site, assessing clarity, visibility, and perceived value.

5. Know the accessible route to a station location thanks to the map displayed on the totem pole or in the Motional application:
    - Expected outcome: Users with disabilities other than visual or cognitive impairment are able to navigate to know the accessible route to a station location without help of other person, thanks to the map displayed on the totem pole or in the Motional application, and they find it useful to increase their independence in mobility.
    - Because the station is large and complex, and because the Motional system only shows the accessible path, but does not position the user when moving and therefore does not show the relative position of the user with respect to the path shown, it is not

intended that the user can reach the location by looking at such a map (it is not easy to find one's way around by looking at a map).

- Measurement: It will be noted as a result of the test whether the user is able to know in an approximate way how to get to the indicated location with ease, with difficulty, or even if it has not been achieved.

In addition, feedback will be collected through short informal interviews or questionnaires on-site, assessing clarity, visibility, and perceived value.

7.1.6 Training plan for end-users

A concise yet inclusive training plan will be implemented to ensure all participants are properly prepared for the validation event. The training will target:

- End-users with different abilities
- Representatives of accessibility organisations
- Station staff (Vialia, ADIF and RENFE)
- Technical and support personnel involved in the test

Training Objectives:

- To explain the purpose and scope of the validation test
- To ensure participants understand the objectives of the validation, the capabilities of the T-Ais totem, the Motional application, and the integrations made with AccessRobot and Navilens.
- To clarify how to interact with the T-Ais totem and the Motional application.
- To prepare station staff for their operational role during the Validation Event.

Training Methods and Format:

- On-site Workshop (60 min):
  A short pre-demonstration session will be held at the station with all involved parties. It will include a live explanation of the test setup, a demonstration of how the system will be activated, and space for questions.
  A short pre-demonstration session will be held at the station with all parties involved. It will include a live explanation of the test set-up, how the Motional system works, the need to use mobile phones that are on the Renfe intranet during the tests (users will not be able to use their own mobile phones), and space for questions.
- One-on-One Briefings (as needed):
  For the staff of the different user/volunteer associations involved, individual instructions will be provided if they cannot attend the main workshop, ensuring consistent understanding of the process.

Schedule:

- Training is scheduled to take place on 24 April 2025.
- Quick refreshers may be given on-site before each session.

This lightweight but targeted training approach ensures smooth participation, a shared understanding of the demonstration goals, and effective data collection from all involved.

7.1.7 Logistics, installation plan

The demonstration is scheduled to take place between 1 and 11 July 2025, and the planned duration is three days (still to be decided). In order to ensure that everything runs smoothly on the Validation Event, the following logistical plan has been put in place:

For T-Ais totem:

The installation and removal of the T-Ais totem will be carried out by a subcontracted company specialized. This company will be responsible for the several transportation, installation and dismantling of the equipment used in the validation event.

- Last week of April: The manufacturer of the T-Ais totem, will send to the offices of Ineco (Motional software developer), all the devices that make up the totem (screens, accessible buttons, qwerty keyboards, speakers, etc.). Not the outer casing.
- 1 to 15 May: Ineco will conduct technical tests at its offices to ensure that all totem components are functioning correctly and that the Motional software is behaving as intended with these interfaces.
- 16 to 23 May: The totem manufacturer will collect from the Ineco offices the totem components and assemble the complete totem at the María Zambrano station in Málaga. Including outer casing.
- 26 to 20 May: Staff from Ineco, AccessRobot, and Navilens will perform technical tests in Malaga station to ensure that all systems and components are functioning correctly at the validation site.
- Between September and October: The manufacturer will dismantle the totem and transport it to a point in the country indicated by Renfe (yet to be determined).

For Motional system:

- Before May 26th: Android and iOS SIM cards with access to the Renfe intranet will be sent from Renfe to Ineco to provide tests phones with access to the intranet.
  The entire Motional system will have been deployed on Renfe's servers.

For AccessRobot:

- Before May 19th: 15 Wi-Fi repeaters will be acquired by RENFE.
- Before May 26th: Wi-Fi repeaters will be deployed by Vialia throughout the station to ensure the robot's proper functioning and communication.
- Between September and October: Vialia will dismantle Wi-Fi repeaters.
- The company that owns the assistance robot will transport it to Malaga for the date of technical testing and will collect it at the end of the Validation Event.

For Guiding Accessible Intelligent Tool (Navilens):

The Navilens guidance system relies on podotactile pathways installed on the ground, as well as in physical codes (similar to QR codes), placed on the floor or vertical walls.

- The podotactile pathways was already installed by a subcontracted company between February and March, and the physical codes will be installed between April and May.
- Between September and October: The subcontracted company will dismantle the podotactile pathways and physical codes.

Logistical Coordination and Safety:

- 9 to 20 June: Preliminary tests will be conducted with the users/volunteers who will be participating in the Validation Event.
  Since these individuals have various disabilities, for good coordination, it was deemed appropriate to conduct these tests to determine their reaction times, behavior, needs, the time the Validation Event will take, etc.

- All activities will be carried out under the supervision of ADIF and Vialia staff, who will be present on site during installation and removal to ensure full compliance with infrastructure safety protocols.
- ADIF personnel will provide guidance on risk management, validate installation zones, and ensure that operations do not interfere with passenger flow or train service.

Permissions and Approvals:

- The necessary approvals for access to the station, works, and power connections have been or will be requested through the standard ADIF infrastructure intervention procedures.
- Subcontractor will be responsible for meeting any additional requirements regarding equipment certifications or temporary installation guidelines.

No permanent modifications to the infrastructure are planned, and the installation will be fully reversible after the demonstration.

7.1.8 Communication Plan

Adif, Ineco, and Renfe are jointly implementing communication and dissemination actions to highlight the impact of the accessibility demonstrators developed under the SG3 work packages. These demonstrations will be tested at specific locations within the General Interest Railway Network. All related actions, along with additional complementary initiatives, are outlined in the Communication and Dissemination Plan (D32.1) and the Results Exploitation Plan (D32.2).

7.1.9 Interactions between demos (If applicable)

N/A

7.1.10 Interaction with other flagships projects (If applicable)

N/A

7.1.11 Setup preparatory meetings

Several preparatory meetings will be scheduled in the weeks leading up to the Validation Event to ensure smooth coordination among all parties.

These will include technical coordination with subcontractors, on-site logistics planning with ADIF, and briefing sessions with station staff and accessibility representatives. A final coordination meeting will be held one week before the event to confirm roles, timings, and safety protocols.

7.1.12 Validation Event

Broadly speaking, the demonstration will consist of train users, specifically users with different types of disabilities, using the T-Ais Totem and the Motional mobile application developed in the project, being able to autonomously perform the following tasks in a station:

- Obtain information about train schedules, delays, cancellations, etc.
- Obtain information about Underground frequency.
- Find out which track his train is parked on by scanning his ticket.
- Find out the accessible route to a station location of their interest.
- Follow the accessible route to a station location accompanied by an assistance robot.
- Follow the accessible route to a station location using a mobile guidance system.

The demonstration will be carried out in a real environment with controlled users (TRL 6). The validation will take place at the María Zambrano railway station in the city of Málaga.

There will be users with different disabilities, in particular we are working to involve users with visual impairment, hearing impairment, motor disability, cognitive disability and motor disability, although the participation of all of them is not guaranteed.

The demonstration is scheduled to take place between 1 and 11 July, and the planned duration is three days (still to be decided), each day there will be two sessions, one in the morning and one in the afternoon. Each session will work exclusively with one type of disability.

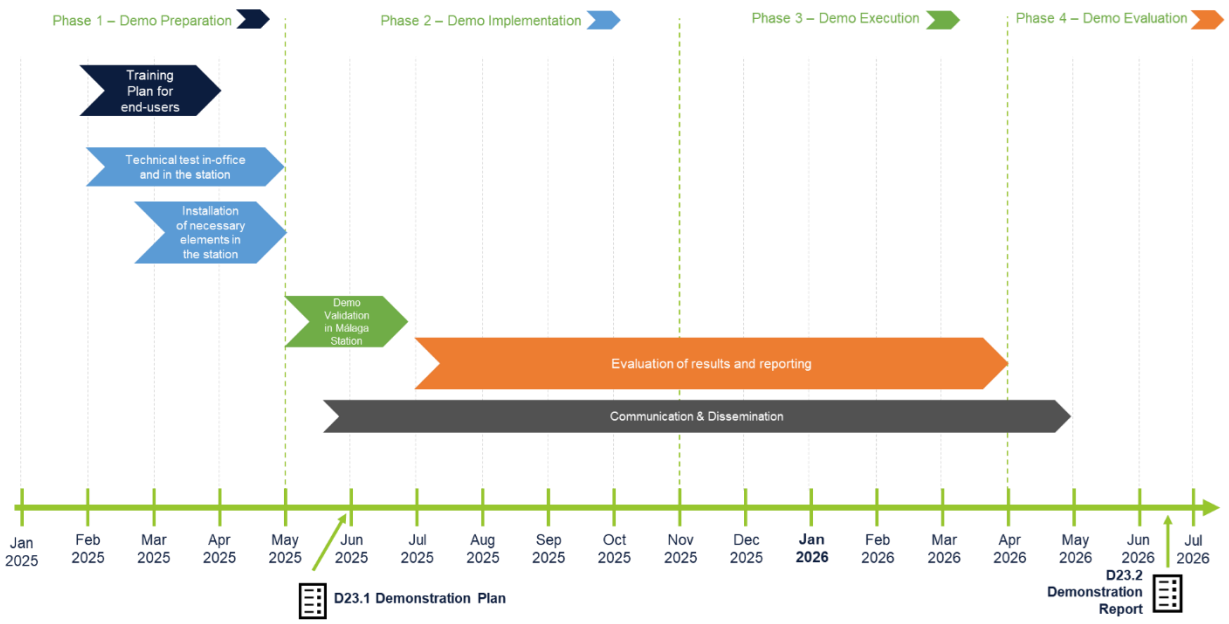
The general timeline for the event is:

Day	1		2		3	
Session	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
Disability/ Volunteer 1	Visual/ Totem	Hearing/ Totem	PMR/ Totem	Cognitive/ Totem	Motor/ Totem	Free
Disability/ Volunteer 2	Visual/ Mobile	Hearing/ Mobile	PMR/ Mobile	Cognitive/ Mobile	Motor/ Mobile	Free

7.1.13 Dissemination event

The dissemination of this validation will be closed and physical, focused on internal stakeholders and project partners. Given the scale and purpose of the test (TRL 6), the dissemination activities will include a short-recorded video and photographic documentation of the demonstration to showcase the setup and user interactions.

7.1.14 Demonstration Master plan (GANTT)



A more detailed technical plan can be found below:

	2025								
Guiding Accessible Software - Actions	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Training plan for end-users									
T-Ais totem									
Send devices to Ineco office									
Technical tests at Ineco's offices									
T-Ais installed at the Malaga station									
Technical tests at Malaga Station									
Tests with end-users									
Validation Event									
T-Ais totem is dismantled									
Motional System									
Send SIM cards to Ineco									
System deployed on Renfe's servers.									
AccessRobot									
Acquisition of Wi-Fi repeaters									
Installation of Wi-Fi repeaters									
Transporting the robot to Malaga									
Technical tests at Malaga Station									
Tests with end-users									
Validation Event									
Robot collection									
Wi-Fi repeaters are dismantled									
Guiding Accessible Intelligent Tool (Navilens)									
Physical codes installation									

Technical tests at Malaga Station									
Tests with end-users									
Validation Event									
Podotactile pathways are dismantled									

7.1.15 Risk and Opportunity management

Table 5 – Risk and Opportunity Management table

Risk ID	Risk Name	Risk Description	Probability (1-5)	Impact (1-5)	Mitigation
T23.2.1 -R01	Delayed Installation	Bureaucratic or access-related delays prevent on-time installation	3	4	Ensure early coordination with different actors, confirm all permits well in advance
T23.2.1 -R02	Low User Engagement	Not enough participation or feedback from users with specific needs	1	5	Invite users in advance via associations and schedule specific time slots
T23.2.1 -R03	Slow validation	Need for more time for validation due to poor estimation of the execution speed of people with disabilities.	4	1	Extend the validation period for another week.
T23.2.1 -R04	Test tickets	Real tickets are not available for departure within 30 minutes of validation.	4	1	Prepare the software to assign a train parking lane to several old tickets used to validation.

7.2 Gobos Demonstration

7.2.1 Use cases

Use case ID	TE's	Name	Description
UC-FP1-WP19-15 GOBO	TE22	Gobos useful information lights for the traveller with or without disabilities	Gobos indicates on the floor useful indicative information

7.2.2 Involved stakeholders and end-users

Several key stakeholders are directly involved in the demonstration. ADIF, as infrastructure manager, is collaborating by granting access to the Málaga María Zambrano station (Cercanías - commuter Spanish public rail services- platforms 10 and 11) and supporting the setup. RENFE, as the operator, is coordinating the test execution, activating the platform lights according to the arriving train composition. Ineco acts as expert consultant in the project.

Station staff will play an active role during the demonstration, helping to manage the operation and providing valuable feedback based on their daily experience assisting passengers. Additionally, end-users with special needs, including people with reduced mobility, will be invited to test and to share their impressions regarding its usefulness and clarity.

The solution aims to support better self-positioning at accessible car doors, increasing autonomy and improving boarding efficiency. Although currently limited to a standard wheelchair symbol and a single train type (with varying compositions), the long-term vision is to connect the system with operational data, allowing dynamic automated detection of train types and a better enriched visual guidance.

In the market-ready version, this system could benefit a wide range of users, including persons with disabilities, elderly passengers, travellers with strollers or bikes, and anyone needing clearer guidance on accessible boarding zones.

7.2.3 Define test data

The following data sets are required for the validation test:

- Train composition data: Information on the type of rolling stock and its possible configurations (standard or reversed), specifically to determine the position of the accessible door relative to the platform.
- Platform layout and stopping points: On-site measurements to identify where the accessible door typically stops and to define the optimal location for the projection.
- Lighting system specifications: Selection of the most suitable projector type, light angle and intensity, considering the station's ambient lighting conditions and indoor constraints.
- Infrastructure conditions: Identification of installation points for the equipment and power supply availability, ensuring both technical feasibility and passenger safety.
- User-related parameters: Types of end-users involved (e.g. people with reduced mobility), their feedback, and interaction with the visual cue during the test.

- Environmental and operational considerations: Platform traffic during different time segments (peak and off-peak), as well as any physical obstructions that might interfere with visibility.

This data has allowed for a controlled and meaningful test setup. Future iterations may include real-time integration with train composition data to automate and enrich the projection logic.

7.2.4 Define demonstration tests

The demonstration will be conducted manually to simulate the activation logic of the future system. Two team members will be positioned at platforms 10 and 11 of the Cercanías area in Málaga María Zambrano station. Each one of them will be responsible for activating the correct light projector according to the incoming train composition. A third team member will coordinate the process by informing them in real time about the type of train approaching and its orientation (normal or reversed), so the appropriate light can be triggered.

Additional observers and participants—including persons with disabilities and station users—will be present to interact with the projection and provide feedback on its visibility, usefulness, and impact on their boarding experience. This hands-on approach allows for a controlled test environment while collecting valuable qualitative data.

The manual process will serve as a first step toward evaluating the concept's viability. In future iterations, this logic could be automated through integration with real-time train data systems, enabling dynamic and intelligent projection based on train characteristics.

7.2.5 Definition of demonstration outcomes and how to measure them

The main outcomes of the demonstration are:

1. User understanding and usefulness:
   - Expected outcome: Users (especially those with disabilities or special needs) understand the meaning of the projected symbol and find it helpful for positioning near the accessible door.
   - Measurement: Feedback will be collected through short informal interviews on-site assessing clarity, visibility and perceived value.

2. Operational feasibility for staff:
   - Expected outcome: Station staff (RENFE/ADIF) find the solution easy to understand and implement manually in its current form.
   - Measurement: Observations and short feedback sessions with staff will be conducted to gather insights on effort, clarity, and usability.

3. Technical viability of the projection system:
   - Expected outcome: The projection is visible and correctly positioned under real lighting and platform conditions.
   - Measurement: Visual inspection during the test, photos/videos for documentation, and user feedback on visibility.

4. Platform behavior analysis across time slots:
    - Expected outcome: The projection remains effective and noticeable during different time segments (peak/off-peak).
    - Measurement: Observational notes and comparison of user interaction across the four predefined time segments.

These outcomes will help assess both the user impact and the technical/operational feasibility of the solution in a real environment. The qualitative insights gathered will serve as the basis for refining the system and defining requirements for future, more automated versions.

7.2.6 Training plan for end-users

Training Plan for Final Users and Stakeholders:
A concise yet inclusive training plan will be implemented to ensure all participants are properly prepared for the validation event. The training will target:

- End-users with different abilities
- Representatives of accessibility organisations
- Station staff (ADIF and RENFE)
- Technical and support personnel involved in the test

Training Objectives:

- To explain the purpose and scope of the validation test
- To ensure participants understand how the projection works and what it represents
- To clarify how to interact with the projected cue and provide useful feedback
- To prepare station staff for their operational role in the manual activation process

Training Methods and Format:

- On-site Workshop (30 min):
  A short pre-demonstration session will be held at the station with all involved parties. It will include a live explanation of the test setup, a demonstration of how the system will be activated, and space for questions.
- One-on-One Briefings (as needed):
  For station staff and technical personnel, individual instructions will be provided if they cannot attend the main workshop, ensuring consistent understanding of the process.

Schedule:

- Training will take place 1-2 weeks before the start of the test, to keep the information fresh and relevant.
- Materials will be shared in advance when possible, and quick refreshers may be given on-site before each session.

This lightweight but targeted training approach ensures smooth participation, a shared understanding of the demonstration goals, and effective data collection from all involved.

7.2.7 Logistics, installation plan

The installation and removal of the demonstration setup will be carried out by a subcontracted company specialized in light projection systems. This company will be responsible for the transportation, installation, calibration, and dismantling of the equipment used in the validation event.

Installation Scope Includes:

- Delivery and mounting of light projectors at platforms 10 and 11 of the Cercanías area in Málaga María Zambrano station
- Positioning and adjustment of the projectors to ensure proper visibility and alignment with the designated boarding areas
- Temporary wiring and secure integration with power sources, following all safety standards
- Removal of all equipment at the end of the demonstration period
  Logistical Coordination and Safety:

All activities will be carried out under the supervision of ADIF staff, who will be present on site during installation and removal to ensure full compliance with infrastructure safety protocols.

ADIF personnel will provide guidance on risk management, validate installation zones, and ensure that operations do not interfere with passenger flow or train service.

Permissions and Approvals:

- The necessary approvals for access to the station, work on platforms, and power connections have been or will be requested through the standard ADIF infrastructure intervention procedures.
- The subcontractor will be responsible for meeting any additional requirements regarding equipment certifications or temporary installation guidelines.

No permanent modifications to the infrastructure are planned, and the installation will be fully reversible after the demonstration.

7.2.8 Communication Plan

Adif, Ineco, and Renfe are carrying out planned communication and dissemination actions aimed at the impact of the accessibility demonstrators planned in the SG3 work packages, whose tests will be carried out at specific points on the General Interest Railway Network. All these actions and other complementary actions can be found in the context of the Communication and Distribution Plan (D32.1) and the Results Exploitation Plan (D32.2).

7.2.9 Interactions between demos (If applicable)

N/A

7.2.10 Interaction with other flagships projects (If applicable)

N/A

7.2.11 Setup preparatory meetings

Several preparatory meetings will be scheduled in the weeks leading up to the validation event to ensure smooth coordination among all parties.

These will include technical coordination with the subcontractor, on-site logistics planning with ADIF, and briefing sessions with station staff and accessibility representatives. A final coordination meeting will be held one week before the event to confirm roles, timings, and safety protocols.

7.2.12 Validation Event

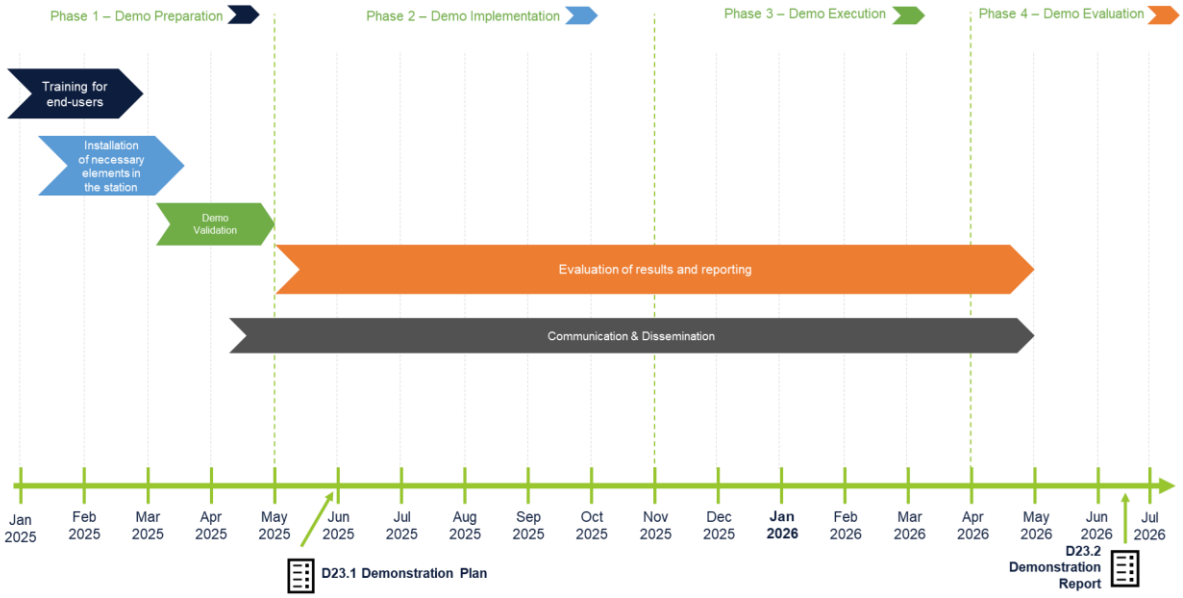
A one-day validation and dissemination event will take place at Málaga María Zambrano train station, specifically on platforms 10 and 11 of the Cercanías (commuter rail) area. The event will be done in one day in two periods, peak and off-peak hours.

During the event, a wheelchair will be virtually projected onto the platforms to help pre-emptively locate the accessible door position, allowing users to align themselves in advance. Representatives with various disabilities, as well as station staff, will be invited to experience the setup and provide feedback regarding usability and impact. This input will help evaluate the effectiveness and real-life value of the proposed solution.

7.2.13 Dissemination event

The dissemination of this demo will focus on relevant stakeholders and project partners. Given the scale and purpose of the test (TRL 6), the dissemination activities will include a short recorded video and photographic documentation of the demonstration to showcase the setup and user interactions.

7.2.14 Demonstration Master plan (GANTT)



7.2.15 Risk and Opportunity management

Table 6 – Risk and Opportunity Management table

Risk/Opp. ID	Risk/Opp Name	Risk/Opp Description	Probability (1-5)	Impact (1-5)	Mitigation / Action Plan
T23.2.2-R01	Delayed Installation	Bureaucratic or access-related delays prevent on-time installation	3	4	Ensure early coordination with different actors, confirm all permits well in advance
T23.2.2-R02	Composition Info Not Available	Difficulty identifying train composition in real time	2	4	Assign a dedicated person to verify incoming trains manually during test
T23.2.2-R03	Platform Overcrowding	Excessive passenger traffic disrupts the test during peak hours	4	3	Schedule testing in both peak and off-peak hours; use signage and staff
T23.2.2-R04	Gobo Technical Failure	Projection system fails to operate properly during demonstration	1	5	Perform full pre-check and have backup equipment or support available
T23.2.2-R05	Low User Engagement	Not enough participation or feedback from users with specific needs	1	5	Invite users in advance via associations and schedule specific time slots, incentivization can be internally discussed
T23.2.2-R06	Visual Interference	Lighting or infrastructure conditions reduce projection visibility	1	4	Calibrate projectors in advance and test visibility under different light

7.3 Gap Filler Demonstration

This solution aims to improve travellers' safety during the transition between platforms and rolling stock. It is more critical in platforms with curvature as this makes the gap wider and increases the risks of getting trapped in between.

The solution consists in Physical element that will minimize the distance between platform and rolling stock by filling the gap between them following the current safety standards.

It consists of a durable and robust rubber profile that is mounted along the edge of the train platform to reduce the gap between the platform and the entrance doors of a passenger train regardless of train cars combinations or where the doors are located. The proposed rubber profile can support up to 300 kg.

Gap Filler solution should improve passenger safety, reduce potential liability risks and enhance access for people with reduced mobility. If safety and accessibility are improved, an expected consequence could be to reduce passenger boarding times which could imply minimizing train delays.

7.3.1 Use cases

Use case ID	TE's	Name	Description
UC-FP1-WP19-14	TE22	Gap filler for the gap between platform and rail stock	Piece to close the gap between platform and train

7.3.2 Involved stakeholders and end-users

The directly involved stakeholders include:

- ADIF, as infrastructure manager, is collaborating by providing information about stations and giving support.
- RENFE, as the operator, is coordinating the test execution and providing information about rail stock.
- INECO, as consulting company, is supporting on the design on the gap filler and it´s adequacy to the specific train station.
  End-users, travellers with or without disabilities that will be able to use the gap filler while installed.

Both Adif and Renfe are interested in this demonstration as it could provide a future easily scalable solution for dangerous gaps in train stations.

7.3.3 Define test data

For the correct execution of this demonstration, the following data and elements are needed beforehand:

- Topographic data of the station
- Rolling stock gauges
- Track detailed description
- Analysis of platforms

- Technical standards
- Information about rail stock using the platform
- Development phase output report: detailed description of the gap filler and location.
- Gap filler fabricated and physically available in the station.
- Staff for installing the element.

With all these elements in place, during the demonstration the necessary data will be the measure reductions of horizontal gap for each type of train that uses the platform.

7.3.4 Define demonstration tests

The demonstration will be conducted manually. The gap between rail stock and platform will be measured by an appointed technician while the trains stop in the station. The objective is to have a series of measurements during selected day along the platform to achieve an average gap reduction.
The simple process will constitute a first step toward evaluating the concept's viability and its installation in other stations.

7.3.5 Definition of demonstration outcomes and how to measure them

Outcomes that will help assess the impact of this demonstration:

- Usefulness: the gap is effectively reduced between rail stock and platform. It will be physically measured.
- Installation viability: no problems are found during the installation of the element or if they are, they are overcome and reported as lessons learnt by the installation company.
- Technical viability: the gap filler element is correctly installed.

7.3.6 Training plan for end-users

A concise training plan will be implemented to ensure all relevant stakeholders are properly prepared for the validation event. The training will target:

- Station staff (ADIF and RENFE)
- Technical and support personnel involved in the test

Training Objectives:

- Explain the purpose and scope of the validation test
- Ensure participants understand how the element works
- Clarify how to interact with the gap filler
- Prepare station staff for their operational role in the measuring process

Training Methods and Format:

- Workshop: A short pre-demonstration session will be held either physically or online. It will include an explanation of the test objectives, its setup, a demonstration of how the measures will be obtained and space for questions.
- One-on-One Briefings (if needed): For station staff and technical personnel, individual instructions will be provided if necessary to ensure consistent understanding of the process.

Schedule:
Training session will be held in the weeks before the day of the test to keep the information fresh and relevant.
Materials will be shared in advance when possible, and quick refreshers may be given on-site before the event.

7.3.7 Logistics, installation plan

Installation and removal of the demonstration setup will be carried out by a subcontracted company specialized in similar works. This company will be responsible for the transportation, installation and dismantling of the equipment used in the demonstration events.

Installation scope includes:

- Delivery and mounting of a test gap filler and removal when adequacy of the dimensions of the element is proved.
- Delivery and mounting of the final complete gap filler.
- Removal of all equipment at the end of the demonstration period

Logistical coordination and safety:

- All activities will be carried out under the supervision of ADIF staff, who will be present on-site during installation and removal to ensure full compliance with infrastructure safety protocols.
- ADIF personnel will provide guidance on risk management, validate installation zones, and ensure that operations do not interfere with passenger flow or train service.

Permissions and Approvals:

- The necessary approvals for access to the station and work on platforms will be requested through the standard ADIF infrastructure intervention procedures.
- The subcontractor will be responsible for meeting any additional requirements regarding equipment certifications or temporary installation guidelines.

No permanent modifications to the infrastructure are planned, and the installation will be fully reversible after the demonstration.

7.3.8 Communication Plan

Adif, Ineco and Renfe are carrying out planned communication and dissemination actions aimed at the impact of the accessibility demonstrators planned in the SG3 work packages, whose tests will be carried out at specific points on the General Interest Railway Network. All these actions and other complementary actions can be found in the context of the Communication and Distribution Plan (D32.1) and the Results Exploitation Plan (D32.2).

7.3.9 Interactions between demos (If applicable)

N/A

7.3.10 Interaction with other flagships projects (If applicable)

N/A

7.3.11 Setup preparatory meetings

Several preparatory meetings will be scheduled in the weeks leading up to the validation event to ensure smooth coordination among all parties. These will include technical coordination with the subcontractor, on-site logistics planning with ADIF and briefing sessions with station staff. A final coordination meeting will be held before the event to confirm roles, timings, and safety protocols.

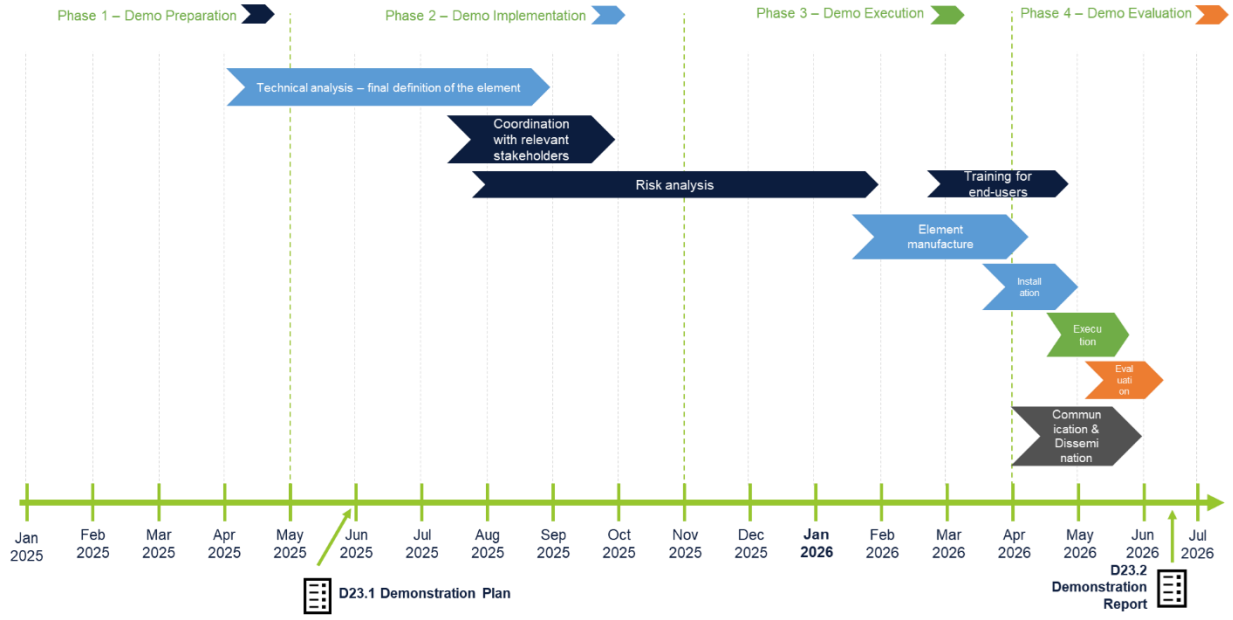
7.3.12 Validation Event

A validation event day will take place in a selected station in Asturias. During this specific day (the gap filler will be in place and in use for a longer period), the reduction of gap between rail stock and platform will be measured in different points along the platform and with different circulating trains to ensure the effectiveness of this element.

7.3.13 Dissemination event

The dissemination actions of this demonstration will focus on internal stakeholders, project partners and selected interested entities. Given the scale and purpose of the test (TRL 6), the dissemination activities will include a short video and photographic documentation of the demonstration to showcase the results and how passengers of the trains interact with the gap filler.

7.3.14 Demonstration Master plan (GANTT)



7.3.15 Risk and Opportunity management

Table 7 – Risk and Opportunity Management table

Risk/Opp. ID	Risk/Opp Name	Risk/Opp Description	Probability (1-5)	Impact (1-5)	Mitigation / Action Plan
T23.2.3-R01	Delayed Installation	Bureaucratic or access-related delays	3	4	Ensure early coordination with

		prevent on-time installation			different actors, confirm all permits well in advance
T23.2.3-R02	Platform Overcrowding	Excessive passenger traffic disrupts the measurements for the test during peak hours	4	3	Schedule testing in both peak and off-peak hours
T23.2.3-R03	Gap Filler Technical Failure	The element fails during demonstration	1	5	Perform a test with a specific gap filler element before the full demonstration.

8. Task 23.3 – Demonstration in Amsterdam

The demonstration in Amsterdam, led by GTSD under WP23 Task 23.3, will take place within an intermodal hub in close collaboration with GVB, the Public Transport Company of Amsterdam. Its primary objective is to demonstrate how inclusive mobility services can enhance accessibility and improve the overall user experience in public transport environments.

This pilot will showcase the seamless interaction between travellers' media (UWB wearable tags), station infrastructure, and back-office systems through the integration of hands-free validation and account-based ticketing. It aims to highlight how smart, seamless access can reduce both physical and cognitive barriers for all users, enabling a more intuitive and frictionless travel experience.
The key objectives of this demonstration are to:

- Validate the effectiveness of a hands-free ticketing system based on UWB technology.
- Demonstrate fully contactless access, allowing passengers to pass through access points without any physical validation gesture (e.g., tapping a card or device).
- Evaluate the integration of the new technology with existing infrastructure from both the operator's and the traveller's perspective.
- Assess the impact on passenger flows, particularly in high-traffic areas.
- Highlight the benefits for connection management and service coordination.
- Measure the overall traveller experience and perceived ease of use.

The demonstration will primarily leverage Enabler 21 – Hands-Free Solution for Travelers, targeting a Technology Readiness Level (TRL) of at least 7. In addition, Enabler 20 – Travel Assistance Across Modes (especially for PRM) will be partially integrated to reinforce inclusiveness and support passengers with specific mobility needs.

By deploying this solution in a relevant mobility hub serving both train and metro services, the demonstration will validate the operational impact of these innovations and pave the way for broader adoption across multimodal transport networks.

8.1 Use cases

Use case ID	TEs	Name	Description
UC-FP1-WP19-22	TE20 TE21	Hands Free. UWB Walk-in	Passengers will be able to check-in and access the closed area of the mobility hub using their UWB wearable tag, without any physical validation gesture (e.g., tapping a contactless card or device at a gate or validator).
UC-FP1-WP19-23	TE20 TE21	Hands Free. UWB Walk-out	This use case is the continuation of UC-FP1-WP19-22 (walk-out, following the walk-in). Passengers will check-out and exit the closed area using the same UWB wearable tag, again without requiring any validation gesture.
UC-FP1-WP19-24	TE20 TE21	Hands Free. UWB Intermodal transfer	Use of UWB technology to support seamless transfers between different mobility modes. After exiting the train platform via an automated gate, passengers receive contextual guidance for the next travel leg.
UC-FP1-WP19-25	TE20 TE21	Hands Free. UWB in station assistance	Focused on enhancing accessibility for passengers with reduced mobility (PRM), this use case features automatic detection of passenger arrival via UWB, triggering notifications to station staff to provide appropriate support.
UC-FP1-WP19-26	TE20 TE21	Hands Free. Face Recognition Walk-in	Passengers enter the closed area of the mobility hub via facial recognition. A dedicated terminal captures the face signature, verifies access rights with the back-office, and grants check-in access.
UC-FP1-WP19-27	TE20 TE21	Hands Free. Face Recognition Walk-out	This use case is the continuation of UC-FP1-WP19-26 (walk-out, following the walk-in). Passengers exit the closed area using facial recognition. Their face is captured at the gate, validated, and check-out is granted with no manual interaction required.

Note: Face ID is a biometric authentication technology based on 3D facial recognition.
It does not store photos or videos of a passenger's face. Instead, facial features are converted into a mathematical biometric template.

- The biometric template is securely stored, not as an image,
- Facial data is used only to verify travel rights, not for identification or tracking,
- No raw facial images are retained after enrolment.

Passenger registration is performed dynamically as part of the test's preliminary steps through a dedicated prototype mobile application (not distributed via public app stores).
During account creation, a privacy notice is displayed to inform users about:

- The purpose of data processing (travel rights validation),

- The type of data processed,
- How data is stored and protected.

A link to the full privacy policy is provided, ensuring transparency and informed consent, in line with GDPR requirements.
Facial data is converted into a biometric template and used solely for authentication within the scope of the test.
Data processing is limited, controlled, and time-bound, following privacy by design principles.

8.2 Involved stakeholders and end-users

Stakeholders involved in the demonstration are:

- **GTSD:** Technology supplier.
  GTSD is responsible for the development and integration of inclusive mobility services, including frictionless validation and account-based ticketing. Their interest lies in demonstrating the usability and effectiveness of these innovative solutions in a relevant operational environment, particularly focusing on passengers with reduced mobility (PRM), and validating their integration within a multimodal transport ecosystem.

- **GVB:** Transport operator and infrastructure provider.
  GVB manages the intermodal mobility hub in Amsterdam where the demonstration takes place. They provide access to the infrastructure and support the deployment of the solutions across train and metro services. GVB's interests focus on improving accessibility, enhancing the passenger experience, and increasing operational efficiency, especially for users with specific mobility needs.

- **End-users:**
  The primary end-users of the demonstrated solutions are regular passengers using the Amsterdam public transport network, including daily commuters, occasional riders, and tourists. A special focus is placed on passengers with reduced mobility (PRM), who will benefit from improved accessibility, seamless station access, and tailored assistance services.

8.3 Define test data

To conduct the demonstration effectively in Amsterdam, the following data are required:

- **Data Types:**
  - **Fare Structures:** Comprehensive fare rules and tables governing ticketing conditions, pricing, and validations.
  - **Station Map and Positioning Data:** Accurate definitions of station zones (detection zones, entry points, paid/unpaid areas) required for precise access control and passenger tracking.

- **Data Sources:**
  - **GVB:** Primary data provider responsible for supplying fare structures, station layouts, and operational data.
  - **GTSD:** Responsible for data configuration, including setup and calibration of UWB systems and integration with fare and back-office platforms.

- **Data Configuration:**
  - **UWB Anchors Positions:** Accurate location data for each UWB anchor to enable reliable real-time positioning and detection.
    Deployment and configuration of UWB anchors in the designated test area within the intermodal mobility hub.
  - **Station Paid and Unpaid Areas:** Definition and mapping of access-controlled zones within the station, including paid (restricted) and unpaid (open) areas.
  - **Detection Zone and Entry Zone:** Definition and mapping of detection zones and entry zones for seamless hands-free validation and access control.
  - **Configuration of UWB Tags at the Back-Office:** Setup of wearable UWB tags in the back-office systems to ensure correct identification and validation of passengers.
  - **Back-Office Systems:** Integration of two key components:
    - Real Time Location Server (RTLS) for continuous tracking of UWB tags.
    - Hands-Free Control System (HFCS) for processing validation and access management.
  - **Fare Data:** Detailed fare structures from GVB defining fare products, pricing, rules, and conditions relevant to the demonstration scenarios.

This data is essential to validate the hands-free ticketing and seamless mobility use cases during the demonstration, ensuring the system's performance and integration within the existing operational context.

8.4 Define demonstration tests

The demonstration in Amsterdam will consist of a series of structured test scenarios conducted in a relevant operational environment.
The main focus during the Validation Event will be to test the identified use cases. Ideally, each use case will correspond to a dedicated test scenario, although more complex use cases may be broken down into multiple test scenarios for thorough assessment.

These scenarios aim to verify the seamless functionality of the new hands-free validation technologies and assess their integration with existing infrastructure.
Specifically, the tests will evaluate the effectiveness, reliability, and user experience of the UWB-based hands-free validation system, as well as the integration of assistive services for PRM.

To do so, several preliminary test sets have been identified to integrate, verify, validate, and qualify each test scenario. Each test set consists of various types of tests:

- **Integration and Verification Tests**:
  The objective of these tests is to **integrate** key demonstration components—such as the UWB anchors and wearable tags, the configuration of detection and entry zones within the station, and the associated fare structures—into the back-office systems, including the Real-Time Location Server (RTLS) and the Hands-Free Control System (HFCS).
  These tests aim to **verify** the end-to-end interaction between the wearable tags, station infrastructure, and backend systems. They ensure that the entire system operates as expected, with accurate detection, proper triggering of validation events, and seamless data exchange across all components of the hands-free solution.

- **Validation End-to-End Tests:**
  The objective of these tests is to **validate** each identified use case through corresponding test scenarios. Each scenario will be executed either manually by the testing team, composed of GTSD, GVB staff, and selected end-users.

  Below is the list of validation end-to-end test scenarios that will be conducted during the demonstration Validation Event:

  - **UC-FP1-WP19-22:**

Name	**Hands Free: UWB Walk-in**
ID (UC_ID/TC_ID)	UC-FP1-WP19-22/TC01
TRL	7
Short Description	Test of the usage of UWB (Ultra-Wide Band) technology as hands-free interaction solution with automated gates for entering a mobility hub.
Responsible	Edouard CARPENTIER DE CHANGY (GTSD)
Pre-condition(s)	The Passenger is wearing a UWB tag registered in the system.
Input Data Description	The test configuration includes the following: • Installation of UWB Anchors in the test area. • Configuration of in-door positioning areas: Detection zone, Entry zone.

	• Configuration of UWB tags at the back-office. The back-office includes two parts, the Real Time Location Server (RTLS) and the processing part, Hands Free Control System (HFCS)
Testing Environment	The test environment includes: • Ultra-wideband anchors installed around the fare gate • Ultra-wideband tags held by passengers • The hands-free control system • The required telecommunication network
Expected Result	The automatic gate grants access to the mobility hub
Sequence	The walk-in sequence is made of several phases: 1. Passenger enters the detection zone; anchors receive signals from the UWB tag and exchange data with the RTLS. 2. The RTLS calculates continuously the position of the tag and updates the HFCS. 3. The HFCS validates that the UWB tag is registered and if this is the case, engages the monitoring of the Passenger position. 4. When the Passenger approaches the gate entry zone, the HFCS sends a signal to the gate to grant entry. 5. The gate opens the door and the Passenger walks in.
Notes	In case the Passenger tag is not registered, the gate does not open.

- **UC-FP1-WP19-23:**

Name	**Hands Free: UWB Walk-out**
ID (UC_ID/TC_ID)	UC-FP1-WP19-23/TC01
TRL	7
Short Description	Test of the usage of UWB (Ultra-Wide Band) technology as hands-free interaction solution with automated gates for leaving a closed area in a mobility hub. This is the continuation of UC-FP1-WP19-22/TC01 (walk-out, following the walk-in).
Responsible	Edouard CARPENTIER DE CHANGY (GTSD)
Pre-condition(s)	The Passenger is wearing a UWB tag registered in the system. Test case UC-FP1-WP19-22/TC01 (walk-in) has been performed
Input Data Description	The same as UC-FP1-WP19-22/TC01
Testing Environment	The same as UC-FP1-WP19-22/TC01
Expected Result	The automatic gate grants exit.
Sequence	The walk-out sequence is made of several phases 1. Passenger enters the detection zone on the exit side, UWB anchors receive the signal from the tag and exchange data with the RTLS.

	2. The RTLS calculates continuously the position and updates the HFCS. 3. The HFCS validates that the UWB tag is registered and valid of exit and if this is the case, engages the monitoring of the Passenger position. 4. When the Passenger enters the gate exit zone, the HFCS sends a signal to the gate to grant exit. 5. The gate opens the door and the Passenger walks out.
Notes	In case the Passenger tag is not registered or not valid for exit the gate does not open.

- **UC-FP1-WP19-24:**

Name	**Hands Free: UWB Intermodal Transfer**
ID (UC_ID/TC_ID)	UC-FP1-WP19-24/TC01
TRL	7
Short Description	Test of the usage of UWB (Ultra-Wide Band) technology as hands-free interaction solution in case of a transfer from train to another mobility mode. The passenger goes through an automatic gate (leaving the train platform) and gets an indication of the next travel segment.
Responsible	Edouard CARPENTIER DE CHANGY (GTSD)
Pre-condition(s)	The passenger is wearing a UWB tag registered in the system. The passenger has purchased a fare ticket requiring a transfer.
Input Data Description	The test configuration is like the one of previous UWB tests, Walk-in and Walk-out (UWB anchors, positioning zones definition) with in addition the configuration of the transfer area.
Testing Environment	The same as UC-FP1-WP19-22/TC01
Expected Result	The automatic gate grants the exit and then an indication of the transfer is given to the Passenger.
Sequence	The sequence is made of several phases 1. Execution of the walk-out sequence (refer to UC-FP1-WP19-23/TC01) 2. Following the exit, an indication of transfer is given via a digital signboard.
Notes	In case the Passenger tag is not registered for transfer, there is no indication.

- **UC-FP1-WP19-25:**

Name	**Hands Free: UWB In Station Assistance**
ID (UC_ID/TC_ID)	UC-FP1-WP19-25/TC01
TRL	7
Short Description	Test of the usage of UWB technology as hands-free interaction solution in the perspective of delivering in station assistance to people with disabilities. The targeted scenario consists in having an automatic detection of the arrival of the Passenger combined with the information of station staff via text message.
Responsible	Edouard CARPENTIER DE CHANGY (GTSD)
Pre-condition(s)	The Passenger is wearing a UWB tag registered in the system and associated with a disabled profile.
Input Data Description	The test configuration is like the one of previous UWB tests, with a detection zone where the arrival of the Passenger triggers the notification
Testing Environment	The test configuration is like the one of UC-FP1-WP19-22/TC01. Additionally, a cloud-based SMS service is deployed to send SMS notifications.
Expected Result	Notification received by the station staff.
Sequence	The sequence is made up of the following steps. 1. Passenger wearing an UWB tag associated with a disabled profile is entering the detection zone 2. The RTLS detects the tag and updates the HFCS. 3. The HFCS validates that the tag is associated with a disabled profile and sends a text message to the station supervisor. 4. The station supervisor receives text messages on their mobile.
Notes	-

- **UC-FP1-WP19-26:**

Name	**Hands Free: Face Recognition Walk-in**
ID (UC_ID/TC_ID)	UC-FP1-WP19-26/TC01
TRL	7
Short Description	Test of the usage of Face Recognition for entering a closed area in a mobility hub. The Passenger approaches an automatic gate that captures the face signature using a dedicated terminal, checks the validity with the back-office and grants access.
Responsible	Edouard CARPENTIER DE CHANGY (GTSD)
Pre-condition(s)	The Passenger is registered for the Face recognition service

Input Data Description	The key configuration consists in Passenger registration. This is done dynamically and part of preliminary steps of the test through a dedicated App which is a is a prototype App and not available at public stores. Registration steps are as follows. • Creation of an Account with the App. • Face registration. The Passenger selects the option called 'Face ID'. The App proposes to upload a picture from the gallery or to take a picture with the camera. The App saves the picture and requests the creation of a new Face ID at the back-office. In order to ensure compliance with data protection regulations and increase transparency, a privacy notice will be displayed during the account creation process. This visual notification informs users of how their data will be used, stored, and protected, and provides a link to the full privacy policy. This feature enhances user awareness and consent, aligning with GDPR and related standards Remaining pre-requisites are associated with the deployment of the system • Automatic Gate equipped with dedicated terminals (Face Capture Module) and connected to communication network. • Back-office (Face Recognition Server), deployed.
Testing Environment	The test environment includes • A fare gate fitted with Face Capture Modules on both sides. • The back-office • The mobile app • The required telecommunication network
Expected Result	The automatic gate grants access to the mobility hub following the processing of the Passenger face image.
Sequence	Preliminary steps consist in the registration of the Passenger (if not registered yet) a. Passenger starts the App. b. Passenger creates an Account. c. Passenger adds a Face ID taking a picture with the camera. d. Passenger validates and the Face ID is successfully created at the back-office. The walk-in sequence is as follows 1. Passenger approaches the gate. 2. Passenger's face is scanned. 3. The FCM captures the face for further processing. 4. The FCM does liveness check. 5. The FCM submits the captured face signature to the back-office.

	6. The back-office matches the face signature and retrieves the Face ID. 5. The gate grants the passage to the Mobility Hub
Notes	In case the Passenger is not registered or has no registered Face ID, access is denied

- **UC-FP1-WP19-27:**

Name	**Hands Free: Face Recognition Walk-out**
ID (UC_ID/TC_ID)	UC-FP1-WP19-27/TC01
TRL	7
Short Description	Test of the usage of Face Recognition for leaving a closed area in a mobility hub. This is the continuation of UC-FP1-WP19-26/TC01 (walk-out, following the walk-in). Exit is granted based on face signature capture.
Responsible	Edouard CARPENTIER DE CHANGY (GTSD)
Pre-condition(s)	The Passenger is registered for the Face recognition service Test case UC-FP1-WP19-26/TC01 (walk-in) has been performed
Input Data Description	Passenger registration is carried out within the context of UC-FP1-WP19-26/TC01
Testing Environment	The test environment is similar to the one of UC-FP1-WP19-26/TC01
Expected Result	The automatic gate grants exit
Sequence	The walk-out sequence is as follows 1. Passenger approaches the gate on the exit side. 2. Passenger's face is scanned. 3. The FCM captures the face for further processing. 4. The FCM does liveness check. 5. The FCM submits the captured face signature to the back-office. 6. The back-office matches the face signature and retrieves the Face ID. 7. The gate grants the exit
Notes	-

- **Performance and Qualification Tests:**

The objective of these tests is to:

- Measure the efficiency and responsivity of the Hands-Free solution under expected load by evaluating its response time and precision.
- Identify the Hands-Free solution limits by pushing it beyond its normal capacity and evaluates how it behaves under extreme load (multiple passage, short-distance passage…).
- Assess how resilient the ASP MaaS platform is when faced unexpected conditions and evaluate its stability under faulty or unexpected scenarios.

The procedure involves conducting performance, stress and robustness tests by performing multiples passage/ticket validation with short distance and near distance, measuring and analysing the response times and the performance.

8.4.1.1 Test Objectives

- Validate the seamless operation of UWB-based hands-free ticketing for walk-in and walk-out access.
- Confirm accurate real-time location tracking and zone detection via UWB infrastructure.
- Verify back-office processing (Real-Time Location Server and Hands-Free Control System).
- Evaluate the system's behavior during intermodal transfer and assistive scenarios.
- Collect feedback from test users (including PRM where applicable) on usability and satisfaction.
- Ensure proper synchronization with fare rules and passenger rights validation via account-based systems.

8.4.1.2 Test Procedures

Test Case	Description	Objective
TC-1: UWB Walk-in	Test passenger entry using UWB tag without any manual action	Validate hands-free access to paid area
TC-2: UWB Walk-out	Test passenger exit using UWB tag	Confirm accurate check-out and proper journey closure
TC-3: Intermodal transfer	Simulate a transfer from train to metro (or vice versa)	Verify continuity and seamless interaction across modes
TC-4: Assistance scenario	Simulate arrival of a PRM passenger triggering staff notification	Validate automatic detection and alert mechanisms
TC-5: Back-office processing	Monitor data processing in RTLS and HFCS	Ensure system stability, data integrity, and correct tagging
TC-6: Fare product validation	Link user tag to correct fare product during test trips	Ensure proper application of fare rules and entitlements

8.4.1.3 Required Software & Equipment

- **UWB Anchors**: Installed in paid and unpaid zones
- **UWB Wearable Tags**: Pre-configured for each test user
- **RTLS (Real-Time Location Server)**: Manages position data
- **HFCS (Hands-Free Control System)**: Processes access events and validates entitlements
- **GVB fare system interface**: Provides fare rules and test product validation
- **Monitoring dashboard**: Real-time system monitoring during tests
- **Test devices and terminals**: For fallback and control validations

8.4.1.4 Personnel Involved

- **GTSD**: Test coordination, system setup, data collection and analysis

- **GVB**: On-site operations, access control, infrastructure support
- **Test Users**: A mix of regular travelers and selected PRM volunteers (target ~10–15 users)
- **Support Staff**: GTSD engineers, GVB station personnel, technical observers (~5–7 staff)

8.5 Definition of demonstration outcomes and how to measure them

The demonstration will showcase several Hands-Free travel scenarios, featuring multiple functionalities (be-in/be-out, transfer, PRM support…).

- **Outcomes:**
  - Successful frictionless validation: Users are able to access/exit the station without presenting a physical ticket, using UWB and Face Recognition technologies.
  - Positive user experience: Users report satisfaction with the ease of use, accessibility, and overall functionality of the demonstrated services.
  - Seamless system integration: All components operate in a coordinated and reliable manner.

- **Measurements:**
  - System logs and backend data: Used to verify validation events, transfer detection, PRM notifications and fare calculations.
  - User feedback forms: Short surveys completed by testers after the demonstration to assess usability, accessibility, and satisfaction.
  - FAQ Sheets: documents addressing common issues and solutions, helping users troubleshoot potential problems.

Thanks to the defined outcomes and measurements, as well as the test scenarios detailed on the previous section, we aim to ensure that the demonstration effectively showcases the capabilities of the Hands-Free solution, providing valuable insights for future improvements and deployments.

8.6 Training plan for end-users

To foster smooth adoption and effective use of the demonstrated solution, a training plan has been defined for the involved end-users and stakeholders. This plan outlines training objectives, schedule, materials and methods, all tailored to ensure a successful showcase of the implemented capabilities.

- **Training Objectives:**

The main objective of the training plan is to ensure end-users understand how to use:

- The Hands-Free solution (RTLS and HFCS) and configure station mapping and the positions of the validation devices.
- Ticketing Back-Office and configure the test Data identified for each demonstration test scenario (fare product, transfer, traveller profile…).

- **Training Schedule:**

Two sessions are foreseen between January 2026 and March 2026, with continuous use of the Hands-Free solution and related tools during this period.

- Briefing Session (January 2025): This session is intended to align stakeholders on the demo objectives, roles & responsibilities and key activities/actions required for the demonstration. It will serve as a foundation to ensure smooth coordination.
- Pre-demonstration Session (approximately 2 weeks before the validation event): This session serves to finalize preparations ahead of the demonstration. It will cover last-minute checks, coordination of roles and alignment on the demonstration flow including demo dry runs to ensure a smooth and successful execution.

- **Training Materials and Methods:**

To ensure that the training is comprehensive and accessible, a variety of materials and methods will be employed. These resources will be designed to cater to different learning preferences and provide end-users with the necessary tools and knowledge to effectively use the app.

- **Presentation:** Material to share demo objectives, roles & responsibilities and key activities/actions required for the demonstration.
- **User Manual**: Material that provide detailed instructions on using the solution and related tools.
- **Hands-on demonstration dry runs:** Pre-demonstration event sessions during which the overall demo scenarios are executed.

By following this training plan, we will ensure that all end-users and stakeholders are fully prepared to engage with the demonstration, resulting in a smooth and successful validation event.

8.7 Logistics, installation plan

The purpose of this plan is to ensure a smooth and efficient setup of the demonstration environment, considering the following details:

- **Demonstration Environment:**
  - Solutions/Products: The ticketing Back-Office is already existing and used for the existing operational ticketing solution.
  - The validation devices (Gates) are already installed and operational on the station.
  - The RTLS and the HFCS will be installed on-premises in the station server rooms.
  - The UWB anchors will be installed on the station area where the demonstration will be performed.
  - Demonstration Environment: The demonstration will be executed in an operational environment with real operational conditions.
- **Installation and Setup:**
  - Preparation:
    - Verify integration, communication and access existing infrastructure (Back-Office, Gates…) and the new one (RTLS, HFCS, UWB Beacons, UWB Wearable…) prior to the demonstration.
    - Ensure all tools are correctly configured and ready for use.
  - Connectivity Check:
    - Test network connections to ensure stable and secure access during the demonstration.

- **Permits and Approvals:**
  - New infrastructure components will be transported to the station in advance of the installation date.
  - Installation, tests and demonstration permits was agreed and will be issued with GVB all activities will be scheduled during low-traffic hours to minimize disruption.
  - Safety protocols and installation guidelines provided by GVB will be strictly followed.

- **Contingency Plan:**
  - Support available for quick troubleshooting (if needed).
  - Technical assistance available throughout the demonstration if any issues arise.

8.8 Communication Plan

To ensure the successful dissemination of the demonstration to stakeholders, end-users, and the public, a communication plan has been defined with an emphasis on engaging stakeholders at various events, expanding market outreach, and utilizing multiple communication channels.

- **Objectives:**
  - Showcase Demonstration Results: Demonstrate the results at key mobility and railway events and fairs to engage with relevant audiences.

- Engage Potential Customers and Partners: Highlight the demonstrated solution value to potential customers, partners, and markets, emphasizing the benefits of revenue apportionment and settlement.
- Strengthen Internal Communication: Keep internal teams informed about progress, success, and key achievements within Hitachi Rail (RCS-FR).
- Global Market Outreach: Broaden communication efforts to reach international markets, ensuring global visibility of the demonstration outcomes.

- **Key Messages:**
  - Contactless access - Product validation and access grant seamlessly:
    - Highlight the demonstration of inclusive mobility services such as frictionless validation.
    - Emphasize the benefits for passengers, especially persons with reduced mobility (PRM).
  - Enhanced security: Enhance the security of transactions and access, authenticating users more reliably than previous technologies.

- **Communication Channels:**
  - Demonstrations at Events and Fairs:
    - Target Audience: Industry professionals, potential customers, partners, and market influencers.
    - Method: Live demos at mobility and railway events, fairs, and exhibitions.
    - Content: Demonstration of the solution.
  - Engaging Potential Customers, Partners, and Markets:
    - Target Audience: Transport service providers, financial partners, and international market representatives.
    - Method: Private demos, webinars, and interactive presentations showcasing the technology's impact.
    - Content: Presentations and case studies focusing on how demonstration capabilities can optimize operations.
  - Internal Communication:
    - Target Audience: Hitachi Rail internal teams (RCS-FR).
    - Method: Regular internal newsletters, updates via internal marketing channels, and quarterly meetings.
    - Content: Updates on demonstration milestones, successes, and how it enhances the company's offerings.
  - Global Market Outreach:
    - Target Audience: Global transport and mobility stakeholders.
    - Method: Digital marketing campaigns, global press releases, social media outreach, and targeted advertisements.
    - Content: Highlight the potential impact on the transportation systems.

This communication plan ensures effective dissemination of demonstration results across multiple channels, targeting relevant audiences to generate interest, build partnerships, and increase visibility in both local and global markets.

8.9 Interactions between demos (If applicable)

N/A: No interaction identified with other demos.

8.10 Interaction with other flagships projects (If applicable)

N/A: No interaction identified with other FPs.

8.11 Setup preparatory meetings

To ensure that the Validation Event runs smoothly, and all participants are aligned, the following preparatory meetings are planned:

- **Validation Event Kick-off Meeting:**
  - Timing: January 2026 (this meeting will be integrated with the briefing session of the training plan).
  - Purpose:
    - Align on objectives, roles & responsibilities, and expectations.
    - Review the demonstration scope, timeline, and key deliverables.
    - Identify responsible teams and assign tasks.
  - Participants: Project lead, technical team, communication team, demo stakeholders.

- **Coordination Meeting:**
  - Timing: Approximately 8 to 6 weeks before the validation event (February 2026).
  - Purpose:
    - Final alignment on the demonstration flow.
    - Review any remaining actions and responsibilities.
  - Participants: All involved teams (technical, operational, communication).

- **Technical Readiness Review:**
  - Timing: Approximately 4 weeks before the validation event (March 2026).
  - Purpose:
    - Verify the readiness of the test environment (access, tool configuration).
    - Confirm that all components are functional.
    - Address any technical dependencies or risks.
  - Participants: Project lead, technical lead, developers and test managers.

- **Validation Event Dry Runs / Rehearsal Sessions:**
  - Timing: Approximately 2 weeks before the validation event (this meeting will be integrated with the pre-demonstration session of the training plan).
  - Purpose:
    - Perform a full run-through of the demonstration.
    - Identify and correct potential issues in the execution.
    - Validate that all tools, data flows, and user scenarios perform as expected.
  - Participants: Full demo team, including technical support and demo stakeholders.

These meetings are designed to reduce uncertainty, prevent last-minute issues, and ensure that

the Validation Event is delivered smoothly and successfully.

8.12 Validation Event

The Validation Event will take the form of a **live scenario-based demonstration** executed in an operational environment with real operational conditions. The purpose is to validate the implemented solution under real operations, in line with a **Technology Readiness Level (TRL) 7** evaluation.

- **Event Format:**
  - **Type:** Live, hands-on demonstration of system functionalities based on predefined test scenarios.
  - **Environment**: Executed in a **controlled operational environment**.

- **Duration:**
  - The Validation Event is planned to take place over one full day.
  - Additional time may be allocated before or after the event for setup, testing, and follow-up discussions if needed.

- **Location:**
  - Amsterdam Central station operated by GVB.
  - Participants: demo stakeholders, technical teams, observers... Additional participants are able to join remotely from their respective locations via secure internet access.

- **Candidate Agenda:**

Time	Activity
09:30 – 10:00	Welcome and introduction
10:00 – 11:00	Overview of scenarios and roles
11:00 – 12:30	Execution of demonstration scenarios (Part 1)
12:30 – 14:00	Break
14:00 – 15:30	Execution of demonstration scenarios (Part 2)
15:30 – 16:30	Review of results and observations
16:30 – 17:00	Wrap-up and next steps

ⓘ *Note: This Agenda may be updated closer to the event date based on final coordination with all participants.*

This structure ensures a focused, interactive, and well-organized validation process, aligned with TRL 7 requirements and the remote/cloud-based nature of the solution.

8.13 Dissemination event

In order to effectively communicate the outcomes and key insights of the demonstration, a dedicated dissemination event will be organized. This event will provide an opportunity to present the demonstration activities, engage a diverse audience, and explore the broader implications of the results.

To maximize visibility and impact, the event could be coordinated at the WS1.3 level, bringing

together related demonstrations from other work packages within the same stream. This joint approach would enable a more comprehensive presentation of results, promote synergies across activities, and ensure efficient use of resources by emphasizing the interconnections between the different demonstrations.

- **Event Format:**

The event could be a **closed hybrid event**:

- **Closed** to invited participants (stakeholders, technical partners, EU-Rail JU members…).
- **Hybrid** to allow both **in-person participation (location to be confirmed)** and **remote attendance** via secure online access.
- A **recorded version** of the event, including key presentations and outcomes, will be made available for further dissemination through official project channels.

A **promotional video** will accompany the dissemination materials, summarizing the demonstration preparation, execution, and key findings.

- **Target Audience:**

The event will be open to a general public and aim to engage a wide range of stakeholders:

- **EU-Rail community,**
- **Transport Operators and Authorities,**
- **Mobility a non-mobility Service Providers,**
- **Retailers and Distribution Channels,**
- **Academia and Research Centers,**
- **Industry partners and market influencers,**
- Other stakeholders interested in the outcomes of the demonstration.

This broad target audience ensures that the insights and lessons learned from the demonstration are widely disseminated and can influence various sectors.

- **Expected Content and Agenda Highlights:**
  - Presentation and/or video of demo(s) background and objectives including an overview of demo(s) preparation steps (e.g., platform setup, test data), process, and results.
  - End-user feedback and performance observations.
  - Outcomes, lessons learned, and conclusions: discussion segment where the outcomes of the demonstration and the lessons learned are shared with the audience. This segment will provide valuable insights into the effectiveness and impact of the demonstrated solutions.
  - Open Q&A session: the event will offer opportunities for audience interaction through Q&A sessions or follow-up discussions. These interactions will allow participants to ask questions, provide feedback, and discuss the implications of the results.

By organizing this dissemination event, we aim to effectively share the achievements and insights from the demonstration, engage with a wide audience, and foster discussions that can drive further innovation and collaboration in the field.

8.14 Demonstration Master plan (GANTT)

The following Gantt chart outlines the Demonstration Master Plan:

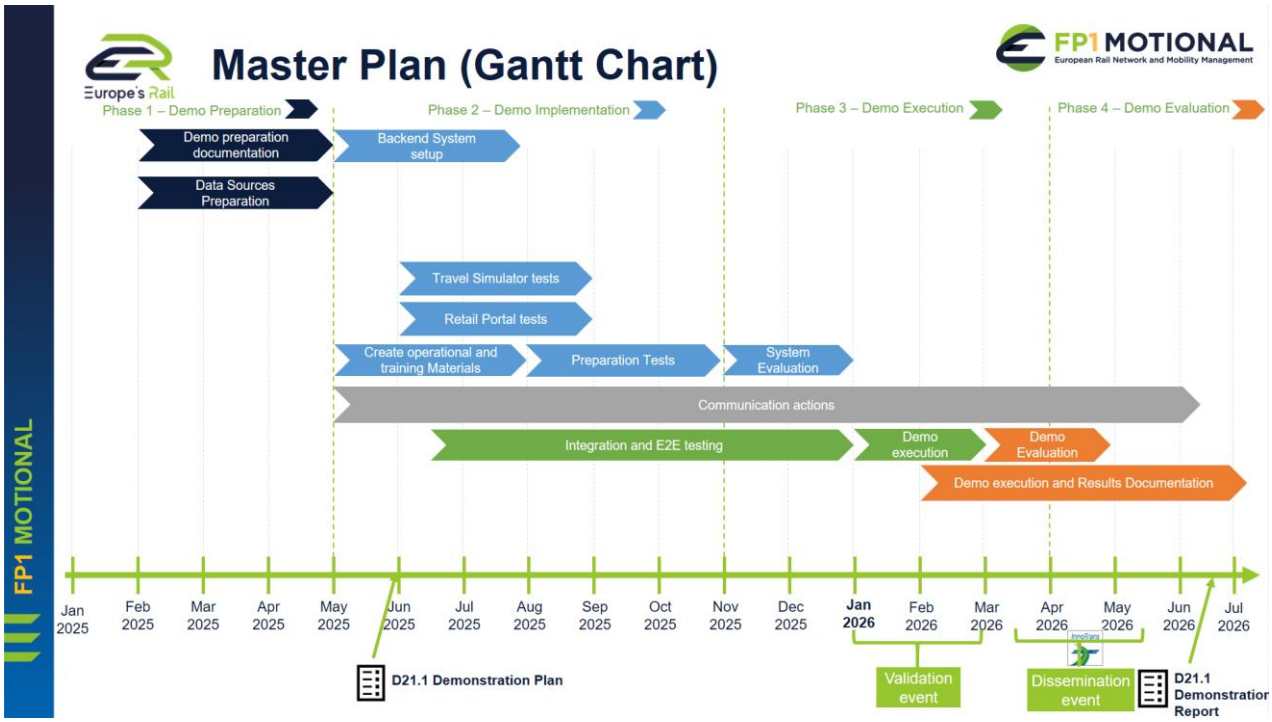


Figure 3 – Demonstration in Amsterdam Gantt chart

8.15 Risk and Opportunity management

Table 8 – Risk and Opportunity Management table

Risk/Opp. ID	Risk/Opp Name	Risk/Opp Description	Probability (1-5)	Impact (1-5)	Mitigation / Action Plan
T23.3-R01	Low engagement of end-users	If only a few end-users participate in the validation event, the feedback on the demonstration may be biased.	2	4	Request additional feedback from participants involved in WP23 or WS1.3
T23.3-R02	Technical Failure	Possible infrastructure failure/not working as expected.	1	5	Perform full pre-check and ensure the appropriate technical support during the demo validation event.

9. Task 23.4 – Demonstration in Berlin and Leipzig

The aim of the demonstrator is to test the illuminated platform edge system with regard to

- Improve stopping times and punctuality,
- Improve capacity utilization,
- Increase attention and the perception of safety and
- Increase customer satisfaction

At the same time, it is important to test the reliability of the system and the suitability of the operating processes. The central component is the display concept, which should effectively guide passengers on the platform. To measure the effectiveness of the defined use cases, a market research institute was commissioned to conduct customer surveys and customer observations in several stages. Two demonstrators (Berlin and Leipzig) with different conditions are used for the validation.

9.1 Use cases

Use case ID	TEs	Name	Description
UC-FP1-WP19-28	TE22	Illuminated Platform Edge "Attention"	The LED bricks on the platform surface flash red to indicate the arrival and departure of the train. This is intended to increase customer awareness at the edge of the platform.
UC-FP1-WP19-29	TE22	Illuminated Platform Edge "Orientation"	The boarding area of the train (train stop position) is indicated by a white running light that runs dynamically towards the train stop position. The aim is to make it easier for customers to find their way around the platform.
UC-FP1-WP19-30	TE22	Illuminated Platform Edge "Capacity"	By displaying the traffic light colors, red, green and yellow, the capacity of the arriving train is displayed in the stopping area. This should help customers to spread out better on the platform and find a free seat more quickly. At the same time, the handling of the train should be optimized.

9.2 Involved stakeholders and end-users

Stakeholders:

- Station operator (> Increase customer satisfaction and capacity of the station, better safety and fewer incidents)
- Train operator (improvement of punctuality and train handling)
- Manufacturer of the illuminated platform edge (sales and further development of the product)
- Station management staff (operational safety and smooth processes, particularly for inspection, maintenance and servicing)
- Supervisory authorities (safe operation and compliance with all recognized rules of technology)
- Management Board (improvement of important KPIs and the passenger offering)

The end user group is the passengers on the platform. The illuminated platform edge system provides them with better guidance on the platform and increases their attention and orientation. Passengers with reduced mobility in particular benefit from this system.

9.3 Define test data

- Incoming Train Data

- Train architecture (train type, train length, number of compartments)
- Arrival time (specific dataset via html)
- Utilization of train compartments (specific dataset via html)

- Platform-specific data

- Number of train positions on the platform (static data in “m”)
- Train stop detection (specific dataset via cable)
- Train departure detection (specific dataset via cable)
- Position of the LED elements along the platform (static data in “m”)

- Operational data of the system

- Functionality of all LED elements
- Functionality of all power & data boxes
- Availability of server (keep alive signal)
- Availability of lighting control software (keep alive signal)
- Availability of utilization sensor (keep alive signal)
- Availability of train stop sensor (keep alive signal)
- Pre-programmed display system
- Availability of remote access

IT-Architecture:

Internet access was established for communication with the system (control computer). The connection between the control computer and the components (P&D boxes, train stop sensor) was designed via LAN. Communication between the utilization sensor with the control computer was also realized via the Internet, with the upstream data processing was carried out on a server at DB Systel in the DB WLAN, which then sent the data via Internet. MS Windows 10 Pro was installed on a control computer in order to run the lighting control software without errors. The middleware ran in an Ubuntu Linux container. The middleware could be accessed via SSH key Authentication. Accesses were logged. The middleware is the software that receives the data from the sources, validates processes and sends corresponding commands to Sympholight, the lighting control software. The middleware is also able to monitor the system. All incoming interfaces to the middleware were protected via token authentication and were constantly monitored. The Sympholight lighting software was controlled via REST interface, which was authenticated via Bearer. Every incoming data record to the middleware was logged, as was the subsequent signal sent. The middleware was written in Typescript and is based on an Express JS-server. The picture below shows the system architecture (interaction of all components).

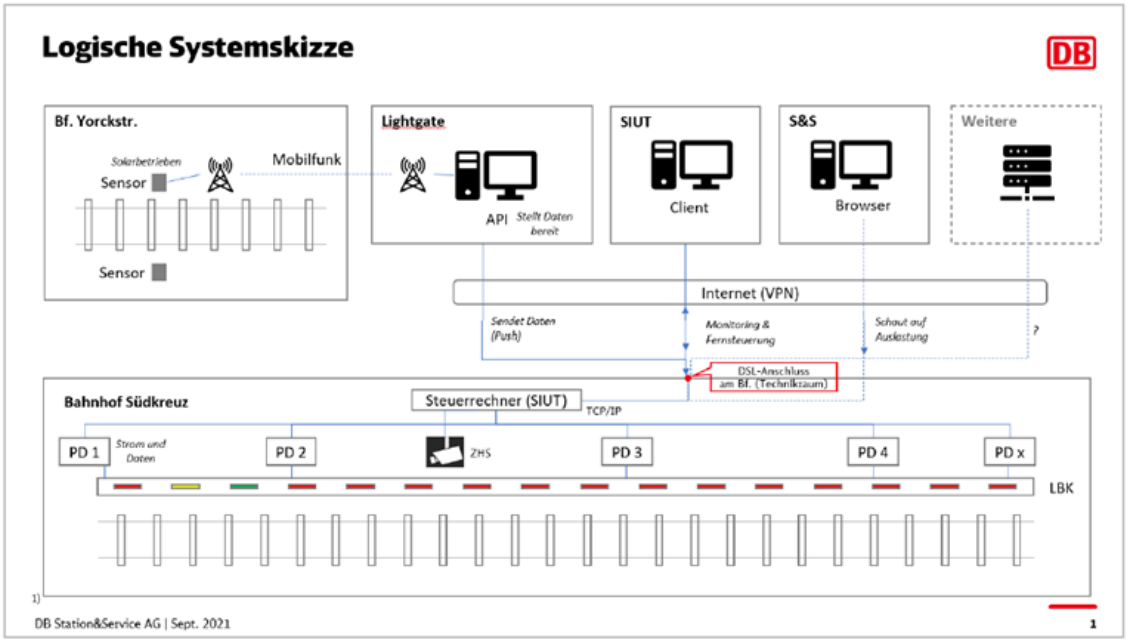


Figure 4 – Demonstration in Berlin and Leipzig – System Architecture

9.4 Define demonstration tests

The demonstration will include a series of structured tests to validate the functionality, usability and integration of the illuminated platform developed in WP22. The product's operational testing and trials will be conducted at two pilot locations (Berlin and Leipzig), each with different frameworks (location, construction site, train operation, capacity e.g.) and display patterns for the customers. Each test phase is scheduled to last approximately one year. During this test phase, validations of the use cases will be conducted through customer surveys and observations at three different intervals (approximately every three months). Conceptual considerations and detailed planning were made in advance for the tests. The tests in Berlin Südkreuz were already done in

2024, in Q4 2025, there will be further tests at the second demonstrator/station in Leipzig "Hauptbahnhof Tief". A detailed overview is marked below:

Test Objectives:

a) Validation of the functionality of the IT components

b) Validation of the functionality of the sensors

c) Validation of the functionality of the hardware

d) Validation of the "Attention" use case

e) Validation of the "Orientation" use case

f) Validation of the "Capacity" use case

Test procedures:

a) Check and ensure that the server is online, the control computer is accessible, the lighting control software can be started, and all LED elements are online and displayed in the system.

b) Check and ensure that the utilization sensor is online and sending data. Check and ensure that the train stop sensor is online and sending data.

c) Check and ensure that all LED blocks can be activated and that the LED chains are illuminated. Check that the entire RGB color spectrum can be displayed by the LEDs. Check that all LED blocks and their chains and p&D-Boxes are activated in the correct sequence. Adjust if necessary.

d) Check that the "red flashing" display pattern is displayed correctly over the platform length (color, frequency, intensity, uniformity). Adjust if necessary.

e) Check that the "white running light" display pattern is displayed correctly in the area of the train stop position (color, frequency, intensity, start and end of the running light, timing). Make adjustments if necessary.

Required software and equipment:
- Lighting control software
- Internet access and access via the station-specific firewalls
- Remote access via laptop
- Sensors (utilization sensor, train stop sensor)
- Access to video surveillance
- Mobile cameras.

Personnel involved:
- DB InfraGO project team and technical staff: responsible for system setup, monitoring and troubleshooting during testing.
- DB InfraGO station management staff: Ensuring operational coordination, security and support within the station.
- Developer and supplier team: Responsible for system setup, monitoring and troubleshooting during testing.
- Metro train drivers for the test runs

These tests help assess the readiness of the solutions for real-world use and identify opportunities for improvement before scaling.

9.5 Definition of demonstration outcomes and how to measure them

The central component for determining the benefits of the system is the display concept which guides the passengers on the platform. The concept was developed in several iteration loops and tested with all project participants. In detail the display patterns, luminosities, color schemes, sequences and glare. To validate the concept under real conditions, there is a series of test runs with SBahn-Berlin GmbH on site at Südkreuz Station and the Metro in Leipzig station in order to test the effect of the display patterns on rail operations, more specifically on train drivers and passengers (customer guidance, color spectrum, brightness, glare, irritation, etc.). The tests are based on the following sequences and display concept (1 = warning track, 2 = train stopping position and capacity, 3 = warning train arriving, 4 = bording, 5 = train departure; 6 = warning track):

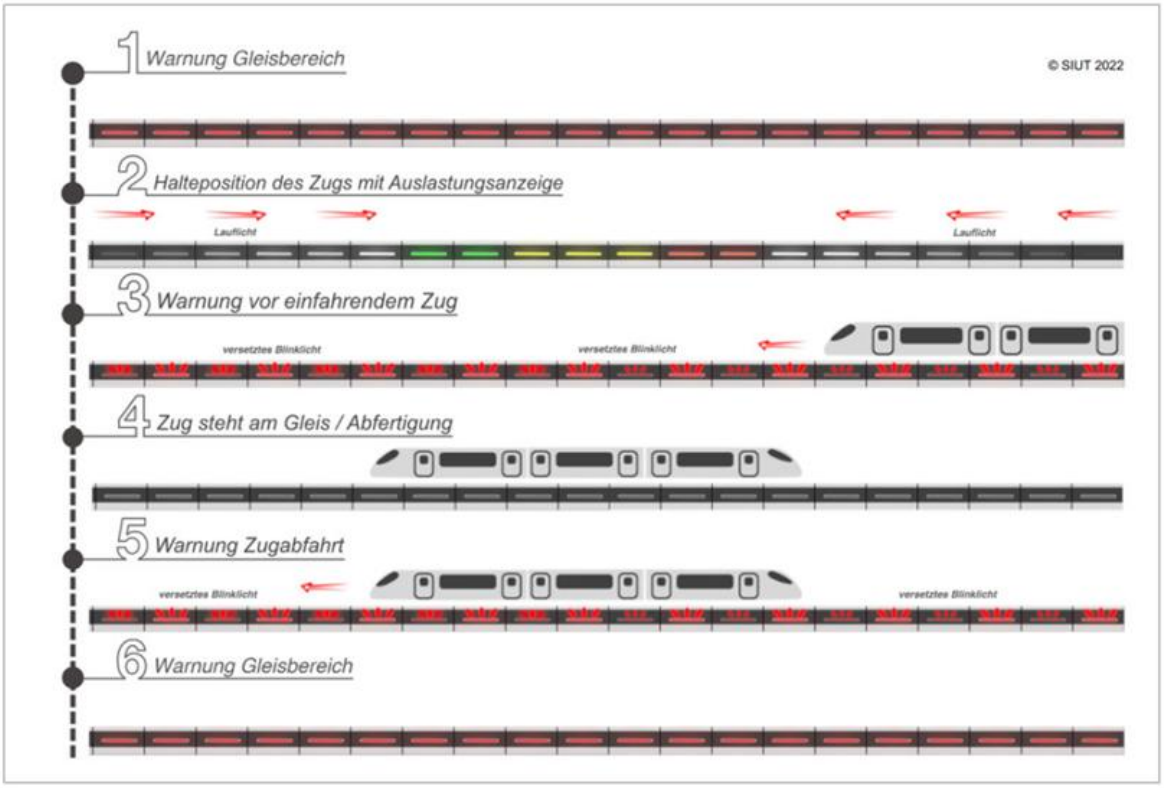


Figure 5 – Demonstration in Berlin and Leipzig – Tests Sequences and Concept

The colour samples are based on the data obtained from the sensors used and transmitted in real time. The sensor on the track detects train length and utilization. The sensor at the station detects train stops and departures.

For each pilot period, four customer surveys including observations (one zero measurement and three impact measurements) by a market research institute are planned. The aim is to measure the effects on travellers' behavior on the lighting pattern. The validation concept also provides a retrograde evaluation of the data in the SQF database (SQF = Steuerungssystem Qualität

Fahrbetrieb), where all data on the stopping times of the trains are locked. By evaluating the data and a comparison with the previous year's values, a change in stopping time compliance can be read off.

9.6 Training plan for end-users

As the end user is the passenger within the general public there will be no training. The system will be self-explanatory for the users. In addition, the system is explained on publicly accessible DB-websites. An explanatory video of how the illuminated platform edge works and what it means for the passengers was also produced with an external agency. In addition to a website, wall posters and floor stickers with costumer information were attached to the platform superstructures and along the track/edge. To validate the effect on the movement of travelers and on the defined goals (improve stopping times and punctuality, improve capacity utilization, increase attention and the perception of safety and increase customer satisfaction) several customer surveys are planned during the duration of operation.

9.7 Logistics, installation plan

On the S-Bahn platform, the illuminated platform edge was planned with a laying length of approx. 150 – 200 m. The LED concrete slabs run parallel to the guidance system for blind passengers and must be laid in the zone near the track. Within the platform length, different power connection points are required via “P&D-boxes" which were installed in the regular platform shafts. This was based on an exemplary planned sub-distribution, which was commissioned by the manufacturer at DB E&C and can be used as a sample distribution board for other projects. The number and installation location of the P&D boxes depends on the existing structure and must be planned individually. The platform is made of prefabricated concrete components with abounded construction of the floor covering. The floor slabs are laid in a grid dimension of 60 cm x 60 cm in an anthracite/grey finish. The necessary construction and electrical planning could be carried out on the basis of the documents from the manufacture company (SIUT) and the existing documents from the construction project.

For the further development of the individual components of the LED control system the project carried out a requirement analysis and involved various technical experts from DB InfraGO AG in order to obtain the certification of the system:

- Construction
- Electric (50Hz)
- Information- and telecommunications technology (ITK)
- Fire Protection
- Maintenance
- Station management
- Railway operation management

Based on the requirements analysis, a specification sheet was drawn up, which formed the basis for granting temporary user approval. The certification process ensured that the LED guidance system met all DB-specific requirements in terms of load-bearing capacity, traffic safety, durability,

fire protection, electrical engineering, accessibility for persons with reduced mobility and operation (inspection, vandalism, cleaning, etc.).

9.8 Communication Plan

The project is supported and communicated internally and externally through various communication measures. Internally, the current status was regularly communicated to interested and participating project partners every 4 weeks (project dialog) and weekly in a project management jour fix. In addition, presentations with the project status were held irregularly in various rounds.

In addition to the measures on site, the project/system is explained on publicly accessible DB-websites. An explanatory video of how the illuminated platform edge works and what it means for the passengers was also produced with an external agency. In addition, film recordings are being made in the Berlin Metro locomotive cab during train entry and exit and integrated into the communication measures.

In addition to the website, targeted customer information measures include wall posters with costumer information were designed by an agency and attached to the platform superstructures (e.g. in the picture below). Also floor stickers of various sizes in the stairway areas and along the edge were used to create attention to the system and explain the display patterns. These floor stickers were renewed at regular intervals.



Figure 6 – Demonstration in Berlin and Leipzig – Dissemination Sticker

9.9 Interactions between demos (If applicable)

No interactions with other demos

9.10 Interaction with other flagships projects (If applicable)

No interactions with other flagship projects

9.11 Setup preparatory meetings

There are regular project meetings (weekly) in which the event is discussed. If necessary, extra meetings are arranged with affected stakeholders. Preliminary meetings are also held to prepare for the validation event. An on-site meeting with the station management will be held one week prior to the test event.

9.12 Validation Event

The demonstration will include a series of structured tests to validate the functionality, usability and integration of the illuminated platform. The product's operational testing and trials will be conducted at two pilot locations (Berlin and Leipzig), each with different frameworks (location, construction site, train operation, capacity e.g.) and display patterns for the customers. Each test phase is scheduled to last approximately one year. During this test phase, validations of the use cases will be conducted through customer surveys and observations at three different intervals (approximately every three months).

Berlin Südkreuz: A zero measurement and three operational tests have already taken place in 2024 (Q1, Q2 and Q3 2024).

Leipzig Hauptbahnhof: The construction site is fully integrated, and a first half-day validation period (on-site tests) is planned for the end of August 2025 (after approval of German railway authority EBA) in order to enable regular operation afterwards. A second half-day test in planned end of October. After on-site tests were successful the system will be cleared for regular operation (commissioning in accordance with German railway authority EBA). Duration of operation is planned for one year.

9.13 Dissemination event

Various updates on the project status and interim results were provided in internal project meetings and every four months in a board meeting. The results of both pilots, which only together lead to project success, will be prepared and presented internally and externally at the end of the second pilot in Leipzig approx. June 2026 (via a presentation with photos, a video and a final report).

9.14Demonstration Master plan (GANTT)

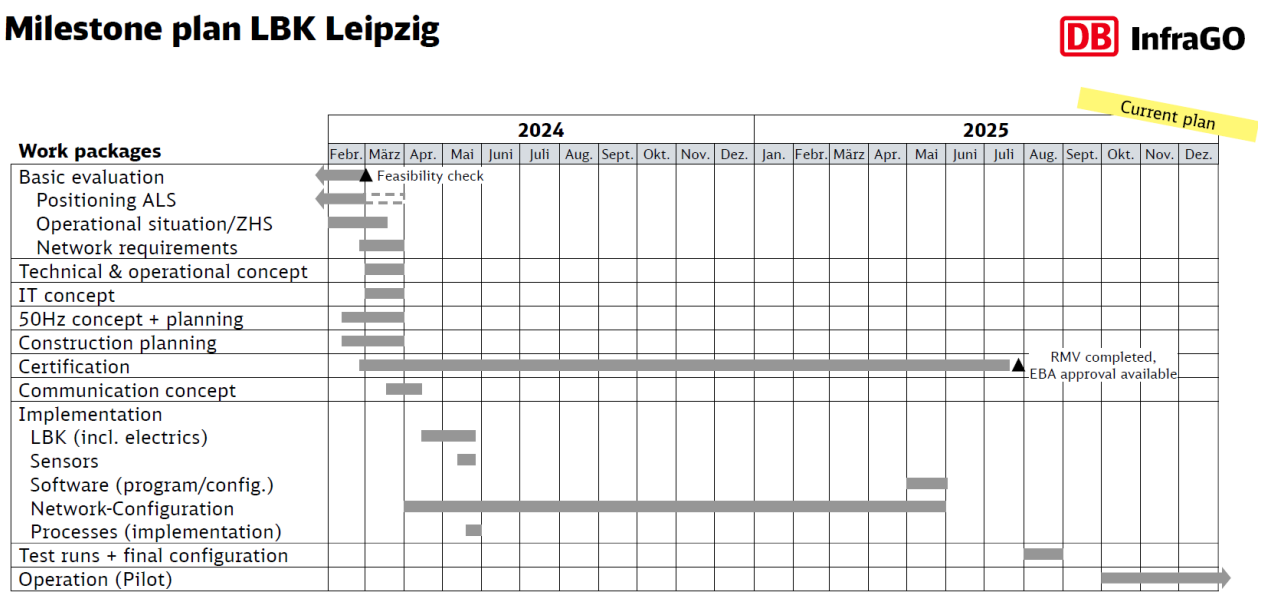


Figure 7 – Demonstration in Berlin and Leipzig – Master Plan

9.15 Risk and Opportunity management

For the illuminated platform edge project, the necessary risk management procedure (RMV) in the form of the European Common-Safety-Method (CSM RA) was carried out for the risks to rail operations and to control them. For this purpose, the relevant departments such as station management, the S-Bahn Berlin (including train drivers), relevant technical experts from the above-mentioned areas and the railroad operations management were involved.

The RMV was continuously updated during the project and adapted to new or changing framework conditions. Among other things, all operating scenarios that could rise as a result of changes to the Metro timetable (e.g. construction work) and corresponding display patterns were programmed. Examples include track-switching operations, reverse entry or dense train sequences.

Another case that was evaluated in more detail as part of the RMV project, was phase 3 with the capacity utilization display in green, yellow and orange. The German railway supervisory authority (EBA) had expressed safety concerns here, in particular regarding the display of the color green in the immediate vicinity of the area to be kept clear. The RMV includes various risk-mitigating measures for this, which the project team had to review separately by an independent expert (here the Vice President Technical University Berlin). The professor also concluded, like the RMV experts involved, that the risk-controlling measures are suitable for limiting the risk to an acceptable level and that there is no uncontrolled danger. The German railway authority EBA continues to have concerns regarding this RMV, so the procedure had to be expanded and submitted to an independent assessment body in Switzerland (the results are currently being prepared). The following table, as part of the RMV, shows the identified and controlled risks of the system:

Table 9 – Risk and Opportunity Management table

Nr	Risk Name	Risk Description	**Risk Control** The resulting hazardous situations are remedied or prevented in accordance with DB guidelines and technical regulations. (specified here in German)
1		**Person falls on the platform and injures themselves.**	
1.1.	security of location	Insufficient positional stability of the LED guide stone in the overall assembly	- Fixed bonding of the LED panels in the mortar bed. Due to an additional tongue-and-groove system with intermediate elements, no movement in the longitudinal or transverse direction is possible (cf. requirement specification C6). - Operational testing (robustness test > 2 years) successfully completed. - Project-specific operation and inspection concept with stored troubleshooting measures during the piloting phase according to Appendix X. - Carry out LP-04-01 technical asset management. - Guideline 813.0201 – Design and dimension platforms and user approval (type approval) of DB InfraGO AG.
1.2.	winter service	Winter service/snow removal cannot be carried out adequately on the LED guide stone (between the light outlets).	- Guideline 513.2101 – Prepare winter service. - Guideline 513.2102 – Perform winter service. - Winter service suitability additionally tested on a test setup with the relevant user group (here: station management Berlin). Leipzig deep-level station, however, without frost effects (upVa).
1.3.	slip resistance	The surface does not provide sufficient slip resistance.	See B10 requirement specification
1.4.	Unevenness	Unevenness between the LED guide blocks, the integrated glass element, and the adjoining floor covering can cause tripping hazards.	- Guideline 813.0201 – Design and dimension platforms and user approval (type approval) of DB InfraGO AG. - Requirement specification No. A3 (DIN EN 1338). - Project-specific inspection concept with stored troubleshooting measures during the piloting phase.
2		**A person accidentally or prematurely enters the area that must be kept clear and is injured by the arriving train.**	

2.1.	programming (light patterns)	An incorrectly programmed display causes confusion among passengers and unwanted crowding in certain areas (display of incorrect stopping position, etc.).	General: Effectiveness and risk control through general platform safety measures according to EBO §13 (3) and §16 (5) and Guideline 513.2010 and 513.2011, such as safety elements (lines, hatching, notices, signs, and warning announcements), confirmed by an external expert report (Appendix X) by EBP Switzerland (company specializing in risk analyses and the definition of acceptance criteria in railway operations). Project specific - Preparation of a display concept by a specialist team as the basis for programming (Appendix X). - Ensuring expert knowledge within the core team through integration of experts from relevant disciplines, particularly construction engineering, passenger information/IT, and operations. - Programming according to the specifications of the specialist concept and approval by the core team. - Execution of software-based simulation of display patterns including operational relationships and approval by the specialist team. - Functional tests of the programmed display patterns on a test setup in the RINN Idea Garden. - Functional tests of the programmed display patterns at the deployment site, Leipzig station. - Execution of technical acceptance before commissioning.
2.2.	sensor technology	Due to a malfunction/failure of the sensor system, no data or incomplete data is sent to the illuminated platform edge, and the scheduled display sequence is disrupted.	- Preparation of an IT specialist concept (Appendix X). - Successful operational and robustness tests of the sensor systems at the Südkreuz station pilot. - Passive monitoring (remote control) and alerting system according to the IT and troubleshooting concept for detection and initiation of countermeasures (Appendix X). - Automated fallback levels through pre-programmed lighting patterns according to the display concept (Appendix X). -Operation and troubleshooting concept (Appendix X)
2.3.	Deviations from the regular timetable or special operational situations	Deviations from the timetable or special operational situations that were not taken into account in the display concept result in incorrect displays of the illuminated platform edge, causing confusion among passengers or directing them to the wrong areas.	<u>General:</u> Effectiveness and risk control through general platform safety measures according to EBO §13 (3) and §16 (5) and Guideline 513.2010 and 513.2011, such as safety elements (lines, hatching, notices, signs, and warning announcements), confirmed by an external expert report (Appendix X) by EBP Switzerland. <u>Project Specific:</u> - Preparation of a display concept by a specialist team as a programming basis (Appendix X).

			- Analysis of all operational standard and special situations or timetable deviations based on the available sensor technology and the operational track situation at and around Leipzig Central Station, including risk assessment and hazard mitigation through pre-programmed lighting patterns. - Documentation of the aforementioned risk analysis and programming in Appendix X. - Ensuring the quality of the risk analysis through integration of relevant experts.
2.4.	Misinterpretation Display	Travelers could misinterpret the selected color/display patterns of the LED guide stones, leading to unwanted crowding in certain areas of the platform.	<u>General:</u> Effectiveness and risk control through the general platform safety measures according to EBO §13 (3) and §16 (5) and Guideline 513.2010 and 513.2011 (lines, hatching, notices, signs, warning announcements), confirmed by an external expert report by EBP Switzerland. **Project-specific** - Preparation of the display concept by the specialist team (Appendix X), including findings from 1.5 years of operational testing at Südkreuz station. - Time-staggered, two-stage implementation of display patterns during the operational testing phase to “train” customers and avoid irritation according to the display concept (Appendix X). - Pre-programmed “warning level” through red flashing before train arrival and departure. - Continuous customer information measures and accompaniment during operational testing, including floor posters for each display stage and further information (QR code, website, video), considering the experience gained from 1.5 years of operational testing at Südkreuz station. - External expert report/evaluation of the general display concept by Prof. Stephan Völker, Vice President TU Berlin, Chair of Lighting Engineering (Faculty IV); International Lighting Consultant (Appendix X). - Demand-oriented control capability or modification of lighting pattern programming according to the display concept by the specialist team (roles and access rights defined in the IT risk analysis according to Guideline 114.0210).

2.4.1.	Misinterpretation PRM Traveler Groups Here: Visually Impaired	The display of different colors (including red and yellow) may lead to misinterpretation of the platform edge lights as traffic signals, especially by groups of passengers with impaired vision (visually impaired).	- Hazard control measures as listed under 2.4. Additionally: - On-site tests and approvals at the Südkreuz pilot with the contact group and the head of the joint technical committee for Environment and Transport (GFUV) of the German Federation of the Blind and Partially Sighted (DBSV). - Professional statement from the Blind and Visually Impaired Association (BSVH), Appendix X. - External expert report/evaluation of the display concept by Prof. Stephan Völker (TU Berlin), Appendix X. - Findings from 1.5 years of operational testing without incidents regarding hazard 2.2.1.
2.4.2.	Misinterpretation PRM Traveler Groups Children here	The display of different colors (including red and yellow) may lead to misinterpretation of the platform edge lights as traffic signals, especially by groups of passengers with impaired vision (visually impaired).	- Hazard control measures as listed under 2.4. Additionally: - External expert report/evaluation of the display concept by Prof. Stephan Völker (TU Berlin), Appendix X. - Legal duty of parental supervision. - Customer communication measures according to the communication concept to increase parental awareness. - Findings from 1.5 years of operational testing without incidents regarding hazard 2.2.2.
2.5.	hatching	Installing the LED stone in the area that must be kept clear impairs the effectiveness of the “hatching” safety feature.	• Assessment and approval of system coexistence within the clearance area by the guideline owner of Guideline 513.2001A01 (confirmation in Appendix X). • Limitation of installation width to 15 cm directly adjacent to the tactile guidance system for the blind.
3		**Person's vision is impaired**	
3.1.	glare effect	The person is blinded by the LED elements and their field of vision/vision is impaired.	- General: Temporary user approval by the approval authority of DB InfraGo AG (Appendix X). - Photobiological safety of lamps and lamp systems (IEC 62471:2006, modified); German version EN 62471:2008 (see requirement specification E5). - Expert report by OUT e.V. regarding light intensity and glare according to DIN EN 12464-1 Lighting and illumination (Appendix X). - System continuously dimmable. - System pre-tested on test setups at various times of day with relevant user groups. - No point visibility of the LEDs due to light diffusion through the roughened glass elements of the light strip.
4		**Person injured by electric shock**	

4.1.	short circuit	Malfunction/short circuit of the electronics due to water ingress, for example, leads to electric shock.	- General: Temporary user approval by DB InfraGo AG (Appendix X). - Guideline 954.0107 – Protection against electric shock, principles of low-voltage switchgear – Part 1: General provisions. The LED guidance system is operated with protective extra-low voltage (low voltage <50V according to IEC 60449). - Enclosure protection rating of electrical equipment: IP68 (protection against contact, dust, and water) according to DIN EN 60529 (see requirement specification E3). - Device protection class II according to DIN EN 61140 (see requirement specification E4). - Safety of electronic components according to EN 62368-1 “Audio/video, information and communication technology equipment – Safety requirements”. - Device connection must be executed according to DIN VDE 100 “Installation of low-voltage systems”.
4.2.	electric shock	Electric shock from touching	- General: Temporary user approval by DB InfraGo AG (Appendix X). - Guideline 954.0107 – Protection against electric shock, principles of low-voltage switchgear – Part 1: General provisions. The LED guidance system is operated with protective extra-low voltage (low voltage <50V according to IEC 60449). - Enclosure protection rating of electrical equipment: IP68 (protection against contact, dust, and water) according to DIN EN 60529 (see requirement specification E3). - Device protection class II according to DIN EN 61140 (see requirement specification E4). - Safety of electronic components according to EN 62368-1 “Audio/video, information and communication technology equipment – Safety requirements”. - Device connection must be executed according to DIN VDE 100 “Installation of low-voltage systems”.
5		**Person injured by fire or smoke**	
5.1.	fire development	Malfunction/short circuit of the electronics, for example due to water ingress, leads to fire development.	- Housing protection class IP68 according to DIN EN 60529. - LED guidance system in the platform edge operated with protective extra-low voltage (<50 V according to IEC 60449). - Fire safety approval of the entire system by fire protection experts (material classification, fire behavior, fire load; see requirement specification D1).

5.2.	fire acceleration	Fire development in the transport station is accelerated by LED guidance system	Applicable standards: - DIN 4102 – Fire behavior of building materials and components. - DIN EN 13501-1 – Classification of construction products and building elements according to fire behavior. - Fire protection review and approval of the entire system by the system type responsible person (including conformity with fire prevention requirements at the defined location)
6		**Person injured by broken glass**	
6.1.	broken glass	Breakage of the integrated glass element leads to a risk of injury	Applicable standards: - DIN EN 356 – Glass in construction – Security glazing – Test methods and classification of resistance against manual attack. - DIN EN 12150-1 – Thermally toughened safety glass (fracture behavior and physical/mechanical properties). - Compressive strength test of the LED guide plates including the glass element according to DIN EN 206-1 and Guideline 813.0201 (> 5 kN/m²; see requirement specification A4).
7		**Blind and/or visually impaired people become confused or misguided and are thus injured.**	
7.1.	misinterpretation	see 2.2.1	See 2.4.1
7.2.	contrast	The sufficient contrast according to TSI PRM, especially in the area adjacent to the area to be kept clear, is no longer maintained or is impaired by the luminous effect.	- Contrast requirements according to TSI PRM or Guideline 813.0202 for floor slab coverings are fulfilled (see requirement specification C5). - Testing on a test area and approval by the relevant user group (visually impaired persons) by the German Federation of the Blind and Partially Sighted (DBSV). - Guideline 813.0205 “Equipment of passenger stations with tactile guidance systems for the blind and visually impaired”.
7.3.	surface finish	Surface texture of LED panels (especially glass elements) causes tactile irritation/misinterpretation by blind and visually impaired people	- Testing on a test area and approval by the relevant user group (visually impaired persons) by the German Federation of the Blind and Partially Sighted (DBSV).
8		**Endangerment of railway operations**	
8.1.	signaling technology	Train drivers may confuse the colored light symbols with those used in signaling technology, or be blinded or	-Preliminary test runs with the Leipzig S-Bahn to evaluate lighting patterns and light intensities (at different times of day) by train drivers. - Findings considered in the configuration of the display

		distracted.	concept (results: no confusion with signalling technology; light intensity 70% during the day, 10% at night). Note: the system is continuously dimmable and adjustable across the entire RGB color spectrum. - confirmation of results by the operations manager (EBL) of the Leipzig S-Bahn prior to commissioning. - No risk of confusion with signalling technology according to external expert evaluation by Prof. Stephan Völker,
8.2.	train dispatch	The verification of train dispatch (e.g., via video system in the driver's cab) may be obscured or impaired by the illuminated symbols (crossfading).	- Conducting preliminary test runs with the Leipzig S-Bahn to evaluate the light patterns and light intensities (at different times of day). - Evaluation by S-Bahn train drivers. - Consideration of the findings when configuring the display concept (light intensity: 70% during the day, 10% at night). Note: the system's brightness is continuously dimmable and adjustable across the entire RGB color spectrum. - Confirmation of the results by the operations manager (EBL) of the Leipzig S-Bahn prior to commissioning.
8.3.	Electromagnetic compatibility	Unwanted electrical or electromagnetic effects interfere with other technical devices in the railway environment.	The following standards must be complied with and demonstrated (see requirement specification F3): - EN 61000-3-3 – Electromagnetic compatibility (EMC) – Limits for voltage changes, fluctuations, and flicker in public low-voltage supply networks. - EN 61000-6-4 – EMC emission standard for industrial environments. Limits. Limitation of the emission of harmonic currents in low-voltage supply networks for equipment and devices with rated currents above 16 A.
8.4.	radio interference	The device may emit radio interference that could interfere with legally designated frequencies (e.g., Federal Network Agency).	Radio interference suppression standards must be complied with (see requirement specification F4): - EN 55022 – Information technology equipment – Radio disturbance characteristics – Limits and measurement methods. - EN 55024 – Information technology equipment – Immunity characteristics – Limits and test methods.
8.5.	IT security	The IT security of the system is not guaranteed, and unauthorized or unsuitable persons/roles can access the system and play unwanted light patterns that mislead/irritate travelers.	- Guideline 114 (IT risk management), particularly implementation of an IT risk analysis including residual risk declaration and determination of protection requirements. - Preparation of an IT concept (Appendix X). - Temporary user approval by DB InfraGo AG (Appendix X).
8.6.	cyberattack	Unauthorized external access to data (cyberattack) manipulates the control system and may lead to	- Requirements of relevant sections of the IT security guideline (RIL 114) must be fulfilled. - DB InfraGo AG cyber security processes MP02-01-03 (IT security management) are implemented, including

		misdirection/confusion among passengers.	penetration testing.
8.7.	environmental sustainability	Use of environmentally harmful materials	Use of materials according to the RoHS Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment must be confirmed by a declaration of conformity according to DIN 50581 (technical documentation for assessing electrical and electronic equipment with regard to the restriction of hazardous substances).

10. Conclusions

The FP1 MOTIONAL WP23 demonstration plan represents a significant step forward in the preparation of demonstrations to achieve seamless integration between rail and other transport modes. Through carefully planned demonstrations across multiple locations, this initiative has established a robust framework for advancing multimodal transportation solutions.
The demonstrations are expected to successfully address several critical aspects:

- Technical Integration and Standards
- Stakeholder Benefits
    - Transport Operators and Mobility Services Providers (MSPs) benefit from enhanced market outreach and new service areas
    - Passengers gain access to improved journey planning and seamless travel experiences

The next step on WP23 is to continue with the setup of the planned demonstrations, monitoring if all the activities go as planned on this deliverable.

The demonstration results to be presented in deliverable D23.2 (June 2026) will validate the technical feasibility and practical value of integrated transport solutions, establishing a strong foundation for future expansion of cross-border mobility services. Through comprehensive testing and validation events involving key stakeholders, the project will show that improved rail integration with other transport modes is not just possible but practical and beneficial for all participants.
This initiative sets the stage for transforming local transport ecosystems and enhancing connectivity across different modes of transportation, ultimately contributing to more efficient and user-friendly mobility solutions for the future.

The implementation, execution and evaluation of the WP23 demonstrations will be reported in 2026 on the D23.2 Integrate Rail with other transport modes – Demonstration Report.

11. Referenced Documents

Table 10. Referenced documents

Reference Number	Document
[R1]	D19.1 – Specification Report of Enablers 18-27
[R2]	D2.4 – Demonstration Strategy
[R3]	D2.5 – Use Cases for project demonstrations
[R4]	D22.1 – Services for Inclusive Rail-based Mobility – Development Report