

# MERIDIAN Deliverable D46 – “D5.05 - Report on the implemented appointment system at the Port of La Spezia”

## Document Information

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### Distribution

| Date       | Version  | Dissemination   |
|------------|----------|-----------------|
| 28/11/2025 | 00-00-01 | Internal (AMLO) |
| 23/12/2025 | 00-00-02 | Internal (AMLO) |
| 29/12/2025 | 00-00-03 | Internal (AMLO) |
| 20/01/2026 | 00-00-04 | PAT for review  |
| 27/01/2026 | 00-01-00 | PAT approved    |
| 25/03/2026 | 01-00-00 | SC approved     |

### Abstract

The implementation of the appointment system for trucks at the Port of La Spezia, developed within the framework of the MERIDIAN action and Task T5.05, demonstrates the effectiveness of an integrated ITS-based approach to port access management. The platform successfully addresses long-standing operational challenges related to congestion, fragmented information flows, and limited anticipation capabilities at the port entrance.

The work carried out across the different phases, from ITS architecture design, through integration with existing port IT systems, to pilot implementation and validation, confirms that the chosen federated and interoperable model is well suited to complex port environments. By preserving the roles and responsibilities of existing systems while enabling structured data exchange, the solution achieves tangible operational improvements without requiring disruptive changes to established processes.

A key outcome of the project is the transition from a reactive, presence-based management of truck access to a preventive and data-driven paradigm. The availability of pre-arrival notices and consolidated authorisation procedures allows stakeholders to act in advance, reducing uncertainty and inefficiencies at the gate. The integration with the Gate Operating System (GOS) further ensures traceability between planned missions and actual physical transits, enabling objective performance measurement through Level of Service indicators.

The pilot action has validated the technical robustness and operational reliability of the system in real conditions, enabling progressive scaling and the transition to extensive operational usage. Benefits have been observed across all stakeholder categories, including the Port Authority, road haulage companies, gate operators, and terminals, with positive impacts on efficiency, predictability, and service quality.

The appointment system implemented at the Port of La Spezia represents a mature and replicable solution that aligns with TEN-T objectives, sustainability goals, and the broader digitalisation strategies of European ports. It provides a solid foundation for future enhancements, wider stakeholder onboarding, and potential replication in other port nodes facing similar access and congestion challenges, thereby contributing to more resilient, efficient, and sustainable freight transport systems.



reduced operational efficiency. Vehicles often reach the port area without full certainty regarding the readiness of containers, the completion of customs procedures, or the validity of access permits, leading to unproductive stops and repeated gate interactions. These inefficiencies also have negative externalities, including increased emissions, reduced safety, and impacts on urban and regional traffic conditions.

The MERIDIAN Task T5.05 builds on this background and the outcomes of past digitalization initiatives by addressing the root causes of congestion and inefficiency through the implementation of an appointment system for trucks, integrated with Intelligent Transport Systems (ITS) and the existing Port Community System. The underlying issues are not limited to gate throughput alone, but concern the end-to-end coordination of transport missions, from pre-arrival planning to terminal access and exit. Consequently, the proposed solution targets the early availability of transport mission data, the smoothness of authorisation checks, and the continuous monitoring of vehicle flows as enabling factors for improving the overall performance of the port access process.

In this context, the Port of La Spezia has progressively introduced experimental measures aimed at regulating and monitoring access, including the definition of Level of Service (LoS) based on measurable indicators such as time of permanence in pre-gate and port areas, maximum dwell times, and the balance between incoming trucks and effective port access capacity. While these measures provided a quantitative framework for assessing performance, they also highlighted the structural need for digital tools capable of supporting preventive and data-driven traffic management.

Within this framework, the appointment system is conceived as a neutral and central digital layer that supports harmonisation among stakeholders, enables advance notice of arrivals, and provides the operational foundation for proactive congestion management and measurable improvements in service quality at the port entrance and along the entire container handling chain.

## System overview and functional architecture

The design of the Intelligent Transport Systems (ITS) architecture for the appointment system at the Port of La Spezia has been developed with the objective of enabling a structured, anticipatory, and interoperable management of truck access to the port area. The architecture defined under Milestone MS5.05.1 establishes the technical and functional foundation upon which system integration, piloting, and operational deployment have been subsequently based.

The appointment system implemented at the Port of La Spezia is conceived as part of an integrated and federated digital ecosystem around the local Port Community System (APNet PCS), to support the coordinated management of truck arrivals, port access authorisations, and gate operations. The system complements and interoperates with different existing systems, operated by the Port Authority or by private stakeholders as well.

At a high level, the architecture is designed to support the lifecycle of a truck mission, from pre-arrival to gate-in, terminal operations and gate-out, ensuring continuity of information across all involved actors.

## Design objectives

The ITS architecture was conceived to address a set of clearly identified operational needs, namely:

- enabling the **early availability of transport and mission data** prior to the physical arrival of trucks at the port;
- supporting **advance verification of authorisations** related to port access, terminal operations, customs procedures, and dangerous goods;
- providing a reliable mechanism for **monitoring truck flows and travel times**, both in pre-gate areas and within the port;
- ensuring **interoperability** among heterogeneous systems already operated by the Port Authority, terminals, and private stakeholders.

These objectives required an architecture capable of combining real-time data acquisition with asynchronous information exchange, while remaining scalable and neutral with respect to technology providers.

## Federated and modular architecture

The design follows a federated and modular approach, in which each participating system retains responsibility for its own data and functions, while standardised interfaces enable coordinated interaction. Rather than centralising all information in a single platform, the architecture relies on a set of interconnected modules, each addressing a specific functional domain.

This approach ensures that:

- existing Port Authority systems are reused and enhanced rather than replaced;
- road haulage companies can participate using different IT and telematics solutions;
- future extensions and additional services may be integrated without disrupting core functionalities.

At the centre of this architecture lies the Port Hauler Module, which acts as the logical hub for the exchange of transport-related information.

## Integration with flow detection and monitoring systems

The overall architecture relies on the physical flow detection systems deployed at the port access points, in particular at the Varco Stagnoni. Data collected through OBU detection buoys (roadside detection units), OCR cameras, and other sensors enrich the digital representation of available truck information regarding port access.

This alignment ensures continuity between the digital layer and the physical execution layer, allowing each gate event to be associated with a known mission and enabling the accurate measurement of performance indicators such as travel times, dwell times, and Level of Service.

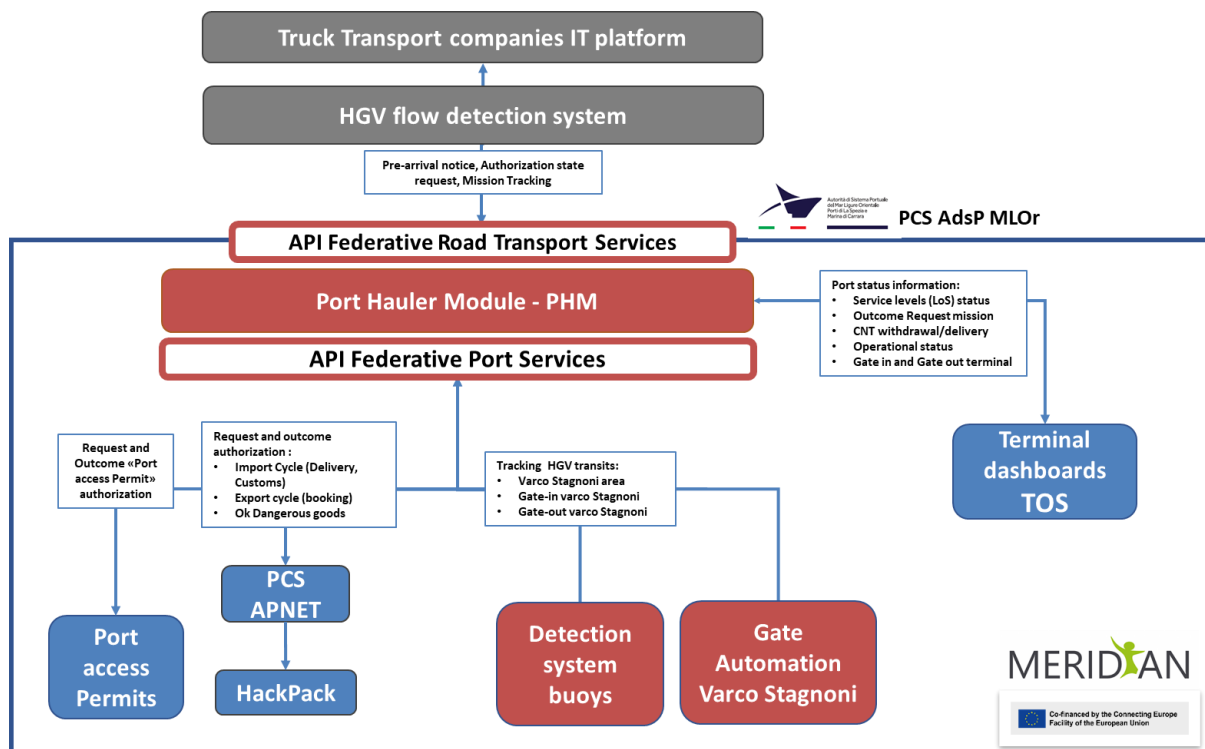


Figure 2 Overall architecture of the PCS-integrated MERIDIAN platform – in red the IT systems upgraded thanks to MERIDIAN

## Main system components

The appointment system is based on the following functional components:

- **Port Hauler Module (PHM)**

The PHM represents the core federative component of the architecture. It collects pre-arrival notices and mission data and orchestrates interactions with port-related IT systems. The PHM is responsible for:

- distributing advance information to the Port Authority and gate operators;
- sharing authorisation checks on federated systems;
- consolidating outcomes and making them available to stakeholders.

| Missione        | Stato   | Trasportatore                | Autista              | Veicolo                       | Stato autorizzazione | Eta | Annullato                | Orario ingresso | Orario uscita | Durata (minuti) | Tipo   | Containers  | Booking    | Data pianificata | Azioni |
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Figure 3 Truck appointment system at the Port of La Spezia

- **Gate Operating System (GOS) and LoS detection infrastructure**

Operations at the Varco Stagnoni gate are streamlined with an automated system to aggregate and synchronize transit information seamlessly collected from OCR cameras (vehicle plate recognition) and from trucks OBUs, both already installed within the Ursa Major neo action.

The GOS integrates data from OCR cameras, OBU detection buoys, and other sensors to detect gate-in and gate-out events. These data are used both for operational control and for the computation of Level-of-Service (LoS) indicators.

| Inizio              | Fine     | Direzione | Durata | Pista | Targa   | OBU                  | PAN | Stato |
|---------------------|----------|-----------|--------|-------|---------|----------------------|-----|-------|
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| 11:00:32 22-12-2025 | 11:00:33 | IN        | 0 s    | E01   | EP964TL |                      |     |       |
| 11:00:09 22-12-2025 | 11:00:09 | IN        | 0 s    | E01   | FL941WP | 0028372295           |     |       |
| 10:59:49 22-12-2025 | 10:59:49 | IN        | 0 s    | E01   | CD886CA |                      |     |       |
| 10:59:32 22-12-2025 | 10:59:32 | IN        | 0 s    | E02   | CE281PY |                      |     |       |
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| 10:59:23 22-12-2025 | 10:59:23 | IN        | 0 s    | E01   | HAS86CA | 1094541213           |     |       |
| 10:58:54 22-12-2025 | 10:58:54 | OUT       | 0 s    | U04   | GH888LL |                      |     |       |
| 10:58:53 22-12-2025 | 10:58:53 | IN        | 0 s    | E02   | EF278WC |                      |     |       |
| 10:58:42 22-12-2025 | 10:58:42 | OUT       | 0 s    | U01   | EP258EL |                      |     |       |

Figure 4 Transit list in the GOS dashboard

The appointment system relies on the interaction with the following **port systems**:

- **Port Community System (PCS APNet) and Port Access Permits**  
The PCS provides access to administrative, and regulatory data, including customs status, dangerous goods clearance (HackPack module), and other pre-authorisations required for container handling. Through integration with the PHM, these checks can be started in advance of the physical arrival of trucks.
- **Terminal Operating System (TOS)**  
The TOS provides access to port operational data, including delivery status, terminal bookings, yard status and other info required for container handling.

Through integration with the PCS, these checks can be started in advance of the physical arrival of trucks.

The appointment system relies on the interaction with the following **external systems**:

- **Truck Transport Companies IT Platforms**  
Road haulage companies provide transport and mission data through their own management systems or through Telematic Service Providers. These data include vehicle, driver, and mission information (import/export, container status, destination terminal), and constitute the basis for advance notice of arrival.
- **HGV Flow Detection System**  
Vehicles equipped with On-Board Units (OBU) generate positioning and movement data that allow the computation of a qualified ETA. The ETA is continuously updated, typically at fixed intervals, taking into account traffic conditions and the progression of the mission towards the port.

## Information flows and functional logic

The functional logic of the system is structured around a limited number of core information flows:

1. **Pre-arrival notice and mission definition**  
Transport and mission data are transmitted in advance by road haulage companies, enabling early visibility and ETA monitoring of incoming trucks, enabling the identification of potential peaks and congestion scenarios.
2. **Visibility of advance authorisation checks**  
The PHM queries federated Port Authority systems to verify access permits, terminal readiness, customs clearance, and dangerous goods authorisations (HackPack). Outcomes are consolidated into a clear operational status.
3. **Gate event detection and LoS monitoring**  
Physical transits at gate-in and gate-out are detected by the GOS and associated with the corresponding missions, providing reliable timestamps for performance measurement.
4. **Feedback to stakeholders (road hauliers)**  
Authorisation outcomes and operational status are communicated back to road haulage companies and fleet managers, allowing corrective actions before arrival when needed.

## Role of the appointment system within port operations

Within the overall port ecosystem, the appointment system functions as an enabling layer for coordinated access management rather. Its primary role is to synchronise information availability, reduce uncertainty, and support data-driven decisions by the Port Authority and other operators. By integrating advance notice, federated authorisations, and real-time monitoring, the system establishes the technical foundation for improved gate performance, measurable service levels, and a more resilient and sustainable port access process.

## Integration with port IT systems (PCS and beyond)

The integration phase addressed under Milestone MS5.05.2 represents the transition from architectural design to operational interoperability. Its objective was to verify and implement the effective integration of the appointment system with the existing IT platforms operated by the Port Authority of the Eastern Ligurian Sea and by port terminal (Terminal Operating Systems - TOS), ensuring that advance transport information could be systematically used to perform authorisation checks and support gate operations.

### Integration scope and approach

The integration strategy was based on the principle of interoperability, where existing systems operate according to their established responsibilities while exposing selected services and data through controlled interfaces. The Port Hauler Module (PHM) stands as the central component for road transport management and is responsible for:

- receiving transport and mission data from road haulage companies and telematics providers;
- distributing pre-arrival information to Port Authority systems.

### Integration with the Port Community System (PCS APNet)

The Port Community System plays a key role in the integration architecture. Through the APNet connector, the appointment system interfaces with multiple port-related processes, including:

- customs procedures and clearance status;
- terminal booking and operational readiness;
- documentation required for container interchange;
- dangerous goods declarations and authorisations.

### Integration with port access permit systems

A critical element of the integration concerns the verification of port access permits for vehicles and drivers. Through dedicated interfaces with the Port Authority's access control systems, the appointment system checks the validity of permits prior to arrival.

The outcomes of these checks are returned to the PHM and classified into clear operational states, allowing the confirmation of port access, early identification of issues and timely corrective actions by road haulage companies. This functionality is essential to preventing unnecessary gate interactions and unproductive waiting times.

### Validation of integration results

The integration activities conducted under MS5.05.2 demonstrated the technical feasibility and operational reliability of the appointment system connected to the IT systems of the port environment. Interfaces were successfully tested, data exchanges

were validated, and end-to-end workflows were exercised using realistic transport scenarios. This milestone confirmed that the appointment system is capable of operating as an effective intermediary between private and public systems, providing the necessary foundation for the subsequent pilot phase and for the monitoring of performance and service levels at the port entrance.

## Gate Operating System and Level of Service monitoring

The implementation of the appointment system is complemented by a detection infrastructure at the Varco Stagnoni with a dedicated Gate Operating System (GOS), which together provide the physical and operational link between the digital planning layer and real-world gate operations. This component is essential for validating pre-arrival information, monitoring actual vehicle movements, and measuring the performance of port access processes through objective indicators.

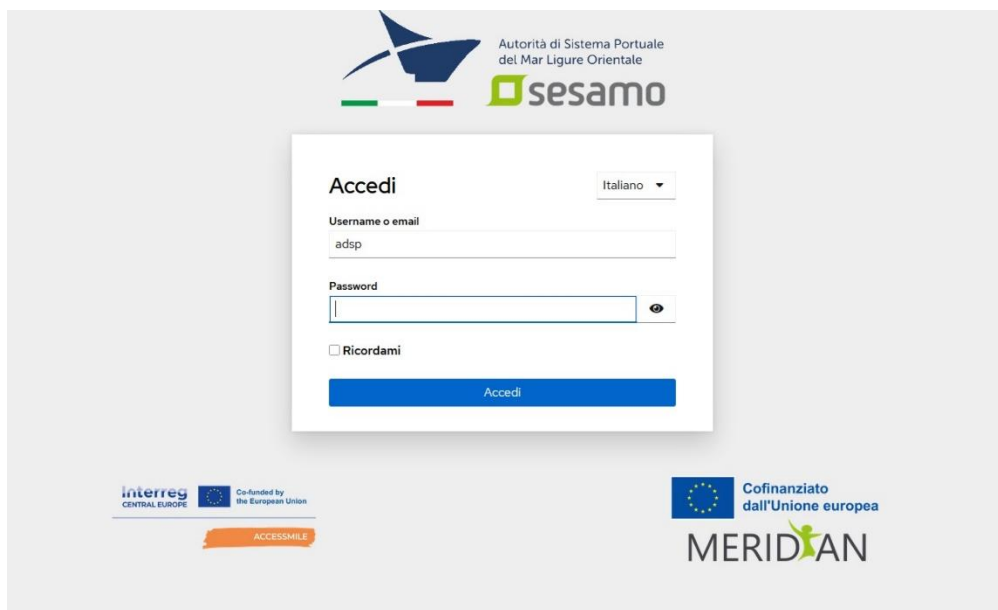


Figure 5 GOS dashboard at the Port of La Spezia

## Detection technologies and data acquisition

At the Varco Stagnoni, the GOS integrates data from multiple sensing technologies, including:

- **On-Board Unit (OBU) detection buoys**, used to detect vehicles equipped with certified telematics devices;
- **OCR cameras**, deployed on entrance and exit lanes for automatic license plate recognition.

These technologies operate in a coordinated manner to ensure high reliability of transit detection and to reduce ambiguities in vehicle identification.



Figure 6 OCR Cameras at the Port Gate

## Role of the Gate Operating System

The GOS is designed to manage and monitor gate-in and gate-out events of heavy goods vehicles accessing the port. Its primary function is to detect and timestamp vehicle transits, associate them with the corresponding transport missions, and transmit validated events to the Port Hauler Module.

Within the overall architecture, the GOS does not act as an authorisation system itself, but as a trusted source of operational evidence, enabling:

- confirmation that authorised missions are executed as expected;
- measurement of dwell times and transit durations;
- continuous assessment of gate performance.

## Association of digital missions and physical transits

A core functionality enabled by the GOS is the association of physical gate transits with digital transport missions generated during the pre-arrival phase. This association is performed through temporal correlation and identifier matching (e.g. license plate, OBU data), allowing each gate event to be linked to a known mission.

This linkage ensures continuity between:

- advance authorisation checks performed through the appointment system;
- actual execution of access and exit operations at the gate.

As a result, discrepancies between planned and actual operations can be identified and analysed, supporting both operational control and performance evaluation.

## Level of Service indicators

The availability of accurate gate-in and gate-out timestamps enables the computation of Level of Service (LoS) indicators defined by the Port Authority as part of its traffic regulation and monitoring framework. These indicators provide a quantitative representation of the quality and efficiency of port access operations and typically include:

- average time spent by vehicles in pre-gate or gate areas;
- average and maximum dwell time within the port between entry and exit;
- relationship between incoming truck flows and effective access capacity over defined time intervals.

The GOS supplies the raw data required for these calculations, while aggregation and analysis are performed at system level to support further evaluations.

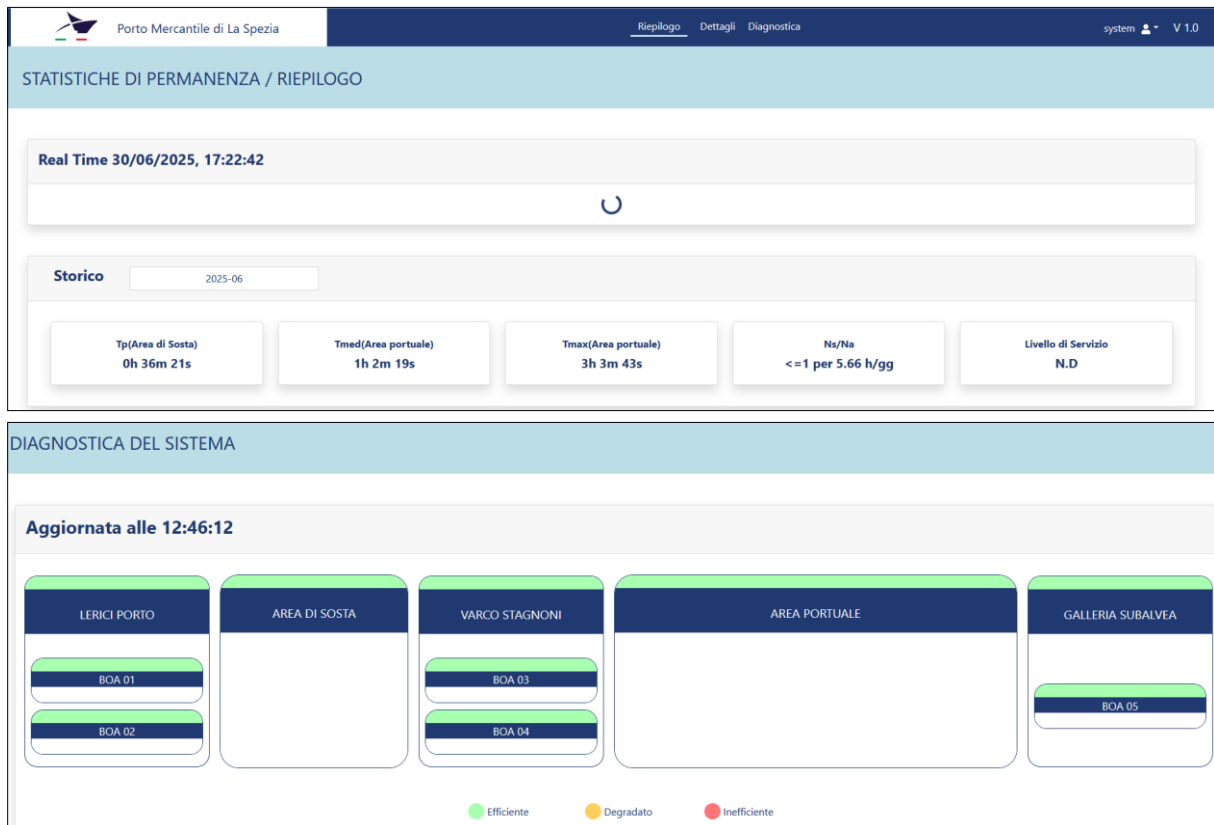


Figure 4 LoS monitoring dashboard at the Port of La Spezia

## Use of LoS monitoring for operational management

LoS monitoring transforms gate operations from a purely reactive process into a data-driven management activity. By continuously tracking performance indicators, the Port Authority is able to:

- identify congestion patterns and bottlenecks;
- verify compliance with predefined service thresholds;
- evaluate the impact of regulatory or organisational measures on access efficiency.

The integration of LoS indicators with the appointment system further enables anticipatory actions, such as adjusting operational priorities or informing stakeholders in advance of critical situations.

## Contribution to system validation

Beyond its operational role, the GOS and the associated LoS monitoring framework provide essential evidence for validating the effectiveness of the appointment system. By comparing planned arrivals, authorised missions, and actual gate transits, it is possible to assess the consistency, reliability, and added value of the implemented solution.

In this sense, the GOS acts as a cornerstone of the overall system, ensuring traceability, measurability, and transparency of truck access operations at the Port of La Spezia.

## Pilot action implementation and validation

The pilot action carried out under Milestone MS5.05.3 represents the operational validation phase of the appointment system implemented at the Port of La Spezia. The objective of this phase was to verify the correct functioning of the system in a real operational environment, assess its integration with existing port processes, and evaluate its capability to support improved management of truck access and gate operations.

### Scope and setup of the pilot action

The pilot action focused on container transport operations at the Port of La Spezia, with particular reference to truck access through the Varco Stagnoni. A selected group of road haulage companies, some already equipped with compatible telematics solutions, participated in the pilot, enabling the generation and transmission of pre-arrival notices.

The pilot setup included:

- the operational use of the Port Hauler Module for collecting and distributing transport and mission data;
- active integration with the Port Community System and other Port Authority IT platforms for advance authorisation checks;
- deployment of the GOS and detection infrastructure for real-time monitoring of gate-in and gate-out events.

This configuration ensured that the full end-to-end workflow, from pre-arrival planning to physical gate transit, could be exercised and observed.

### Execution of pilot workflows

During the pilot phase, transport missions were managed according to the appointment system logic. Road haulage companies transmitted mission data and pre-arrival notices in advance, enabling the Port Authority systems to perform authorisation checks before the arrival of vehicles at the port.

As trucks arrived and left the port, gate-in and gate-out events were detected by the GOS and associated with the corresponding missions, providing a complete trace of each transport operation.

### Functional validation

The functional validation of the pilot action was conducted through a combination of qualitative and quantitative criteria, including:

- correctness and reliability of data exchanges between systems;
- consistency between digital mission data and physical gate events;
- ability to be informed in advance about arrivals and their data;

- stability of system components during sustained operation.

Operational logs, system dashboards, and Level of Service indicators provided the primary sources of evidence for validation, enabling observation and assessment of the robustness and flexibility of the system under realistic conditions.

## Pilot outcomes

The pilot action confirmed the technical feasibility and operational effectiveness of the appointment system. Pre-arrival notices were successfully exchanged and used to trigger advance checks, reducing uncertainty at the gate and improving visibility of incoming traffic.

The association between transport missions and gate transits was validated, enabling reliable measurement of access and dwell times. No critical integration issues were observed, and system components demonstrated stable behaviour throughout the pilot period.

From an organisational perspective, the pilot highlighted the value of early information sharing and consolidated authorisation feedback, particularly in preventing unproductive arrivals and repeated gate interactions.

## Lessons learned and readiness for operation

The pilot phase also provided important lessons for daily operation, including the need for:

- progressive onboarding of additional road haulage companies and telematics providers;
- clear operational procedures for handling exceptional or non-compliant missions;
- continuous monitoring of data quality and timing.

The successful optimisation and completion of the pilot action under MS5.05.3 demonstrates that the appointment system is ready for extended operational use and provides a solid basis for further optimisation and scaling within the Port of La Spezia and in similar port contexts.

## Results and benefits

The implementation and validation of the appointment system at the Port of La Spezia have generated a set of measurable and qualitative benefits across the port ecosystem. These benefits concern operational efficiency, quality of service at the port entrance, and the overall coordination between public and private stakeholders involved in container transport operations.

### Benefits for the Port Authority

For the Port Authority, the appointment system provides early visibility of incoming truck flows, enabling a shift from reactive to proactive access management. The availability of pre-arrival notices allows:

- anticipation of peak demand periods at the Varco Stagnoni;
- advance info about verification of access permits and operational authorisations;
- improved coordination between gate operations, terminals, and control authorities.

The integration of Level of Service indicators with real-time gate data supports continuous performance monitoring and evidence-based decision-making. This strengthens the Port Authority's ability to assess compliance with defined service thresholds and to evaluate the effectiveness of regulatory or organisational measures.

### Benefits for road haulage companies

Road haulage companies benefit from greater predictability and transparency in port access procedures. Through the appointment system, fleet managers receive structured feedback on the authorisation status of each mission before vehicles reach the port area. This enables early correction of missing or inconsistent data, the reduction of unproductive waiting times at gates and terminals, and ultimately a better utilisation of vehicle and driver working time.

### Benefits for gate operators and terminals

Gate operators and terminal stakeholders gain advance awareness of expected arrivals, facilitating resource planning and workload balancing. The association between digital missions and physical gate transits reduces uncertainty at the point of access and simplifies operational checks.

By receiving consolidated authorisation outcomes, gate operators can focus on execution rather than verification, contributing to smoother and faster gate-in and gate-out processes. Terminals, in turn, benefit from improved synchronisation between truck arrivals and operational readiness.

## Impact on Level of Service and congestion

One of the most significant outcomes of the implemented system is its contribution to improving and stabilising the Level of Service at the port entrance. The combination of advance information, proactive checks, and real-time monitoring supports:

- reduction of congestion in pre-gate and gate areas;
- mitigation of queues and spillbacks onto surrounding road infrastructure;
- more consistent and predictable access times.

These effects are particularly relevant in periods of high traffic demand, where the ability to anticipate and manage flows is critical.

## Environmental and systemic benefits

By reducing idle times, repeated gate interactions, and unnecessary vehicle movements, the appointment system contributes directly to lower emissions and improved environmental performance, in line with port sustainability objectives and TEN-T policy priorities.

At a systemic level, the solution fosters harmonisation and digital maturity within the port community, demonstrating how interoperable ITS solutions can enhance efficiency without disrupting existing operational responsibilities.

## Overall assessment

The results achieved through the implementation of the appointment system confirm its added value as an enabling tool for coordinated access management at the Port of La Spezia. The benefits observed across stakeholders, combined with the system's scalability and interoperability, have been strong drivers towards the long-term operational adoption and for possible replication in other port contexts facing similar challenges.