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Multimodal activities workshop

"Optimizing flows and reducing footprint: the digital transformation of logistics"

Munich - 04th June 2025

THE PORT OF LIVORNO

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AdSP MTS
North Tyrrhenian Port Network Authority

Livorno is an international seaport and a core node locate along TEN-T SCANMED corridor :

▶ Multipurpose (containers, break/dry/liquid bulk, Ro-Ro);

▶ passengers and freight;

▶ freight village (RRT), car stocking (25,000 cars capacity);

▶ Coordinator of a comprehensive maritime cluster encompassing Piombino and minor ports in Tuscan Islands

I numeri del sistema

39.246.385 tonnellate movimentate

663.680 TEU

9.842.994 passeggeri ferry

904.762 passeggeri cruise
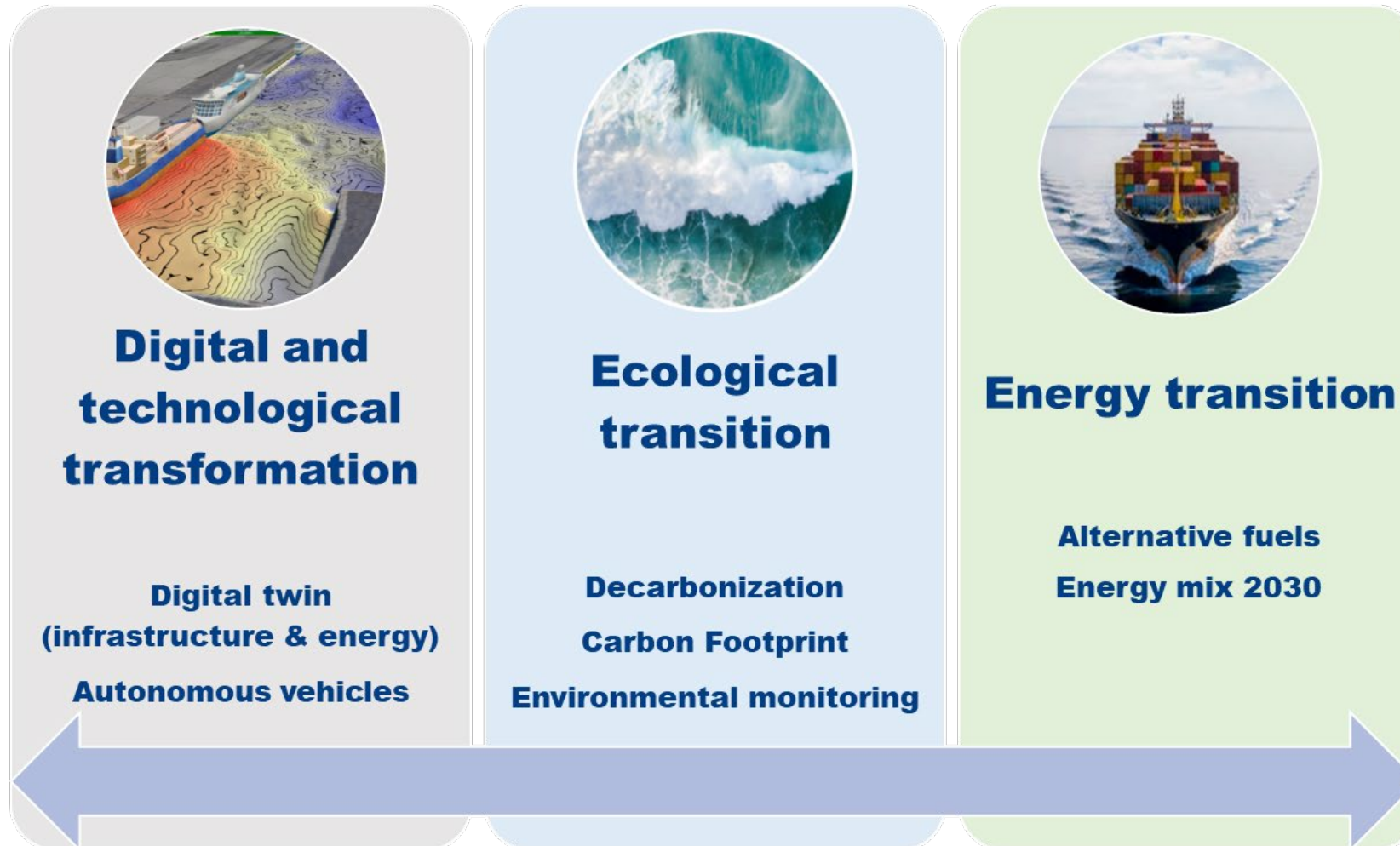
673.369 rotabili

498.948 auto nuove

Ports and air quality

How did port environmental priorities change over the years?

The data was obtained from the responses of 90 European ports, representing 20 countries, in the EcoPorts Network, to the EcoPorts Self-Diagnosis Method (SDM). SDM is a is a checklist that allows to identify and reflect on environmental risks in ports. Aggregated and anonymised data provided by EcoPorts members are used to build and update the sector's benchmark of performance in environmental management.

	1996	2004	2009	2013	2019	2020	2021	2022	2023
1	Port development (water related)	Garbage/ Portwaste	Noise	Air quality	Air quality	Air quality	Air quality	Climate change	Climate change
2	Water quality	Dredging: operations	Air quality	Garbage/ Portwaste	Energy consumption	Climate change	Climate change	Air quality	Air quality
3	Dredging disposal	Dredging disposal	Garbage/ Portwaste	Energy consumption	Climate change	Energy efficiency	Energy efficiency	Energy efficiency	Energy efficiency
4	Dredging operations	Dust	Dredging operations	Noise	Noise	Noise	Noise	Noise	Noise
5	Dust	Noise	Dredging disposal	Ship waste	Relationship with the local community	Relationship with the local community	Relationship with the local community	Water quality	Water quality
6	Port development (land related)	Air quality	Relationship with the local community	Relationship with the local community	Ship waste	Ship waste	Water quality	Relationship with the local community	Ship waste
7	Contaminated land	Hazardous cargo	Energy consumption	Dredging operations	Garbage/ Portwaste	Water quality	Ship waste	Ship waste	Relationship with the local community
8	Habitat loss/ degradation	Bunkering	Dust	Dust	Port development (land related)	Garbage/ Portwaste	Dredging operations	Garbage/ Portwaste	Port development (land related)
9	Traffic volume	Port Development (land related)	Port development (water related)	Port development (land related)	Dredging operations	Dredging operations	Port development (land related)	Port development (land related)	Garbage/ Portwaste
10	Industrial effluent	Ship discharge (bilge)	Port development (land related)	Water quality	Water quality	Port development (land related)	Garbage/ Portwaste	Dredging operations	Port Development (water related)

ESPO Environmental Report 2023 – EcoPortsinSights 2023

Modern Port Authorities: strategic pillars

Digital and technological transformation

Digital twin (infrastructure & energy)

Autonomous vehicles

Ecological transition

Decarbonization

Carbon Footprint

Environmental monitoring

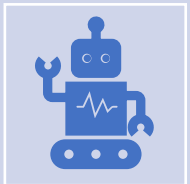**Energy transition**

Alternative fuels

Energy mix 2030

KEY POINTS

The port and integrated logistics sector is a complex and interconnected network of people, objects, processes, and technologies.

Digital twin is a new stage of evolution of complex information systems and represents a very promising frontier for seaports.

The frontier is constituted by the digital twin and A.I. together, as these two technologies enable each other.

The digital twin feeds artificial intelligence solutions and applications with structured information in real time, while A.I. assists the digital twin in continuously fine-tuning what, how, how much and when it is meaningful to project digitally.
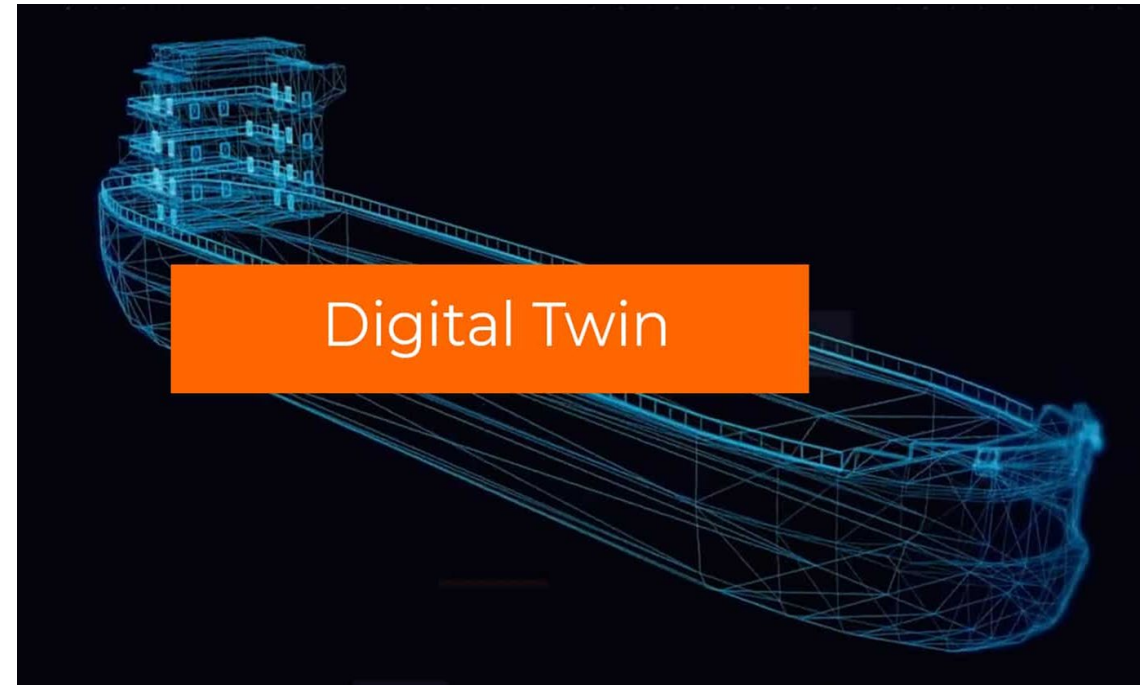
DIGITAL TWIN:
CONCEPT AND RELEVANCE TO SEAPORTS and SUPLLY CHAIN

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Digital twin technology creates virtual replicas of physical objects or systems in real-time.

It enables monitoring, analysis, and simulation of the physical asset or process.

Digital twins mirror the behavior, characteristics, and dynamics of their real-world counterparts.

Digital twins are used in various industries to monitor, analyze, simulate, control, and optimize the performance of physical entities.

Digital Twin

- The potential of the digital twin for seaports is determined by the physical reality, i.e., the physical object.

- Ports are excellent examples of complex systems of artifacts that interact with each other, making them ideal large-scale real field testbeds for piloting, prototyping, and demonstrating applications and solutions based on the digital twin.

- Digital twins can play a significant role in seaports for the improvement of efficiency, safety, decision-making, resilience, and sustainability.

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The "Digital Twin - AI - IoT" Triptych

Interconnected Technologies

Digital twins, AI, and IoT integration enables seamless data flow and analysis for informed decision-making.

Dynamic Decision-Making

Utilizing real-time data from digital twins and IoT sensors, AI algorithms can generate dynamic insights for proactive decision-making.

Predictive Capabilities

The combined power of digital twins, AI, and IoT allows for predictive analytics, forecasting future scenarios, and optimizing operational strategies.

DIGITAL TWIN:
CONCEPT AND RELEVANCE TO SEAPORTS and SUPLLY CHAIN

ENABLING TECHNOLOGIES AND INFRASTRUCTURE

ADVANCED SENSING

Utilizing IoT devices and sensors for real-time data collection on port activities and environmental conditions.

5G NETWORKS

High-speed and low-latency connectivity to support the vast amount of data exchange and communication within the digital twin system.

EDGE COMPUTING

Processing data closer to the source to reduce latency and enhance real-time decision-making in port operations.

BIG DATA ANALYTICS

Employing analytics tools to process and derive insights from the massive volumes of data generated by port activities and monitoring systems.

DECOUPLED LAYERS ARCHITECTURE
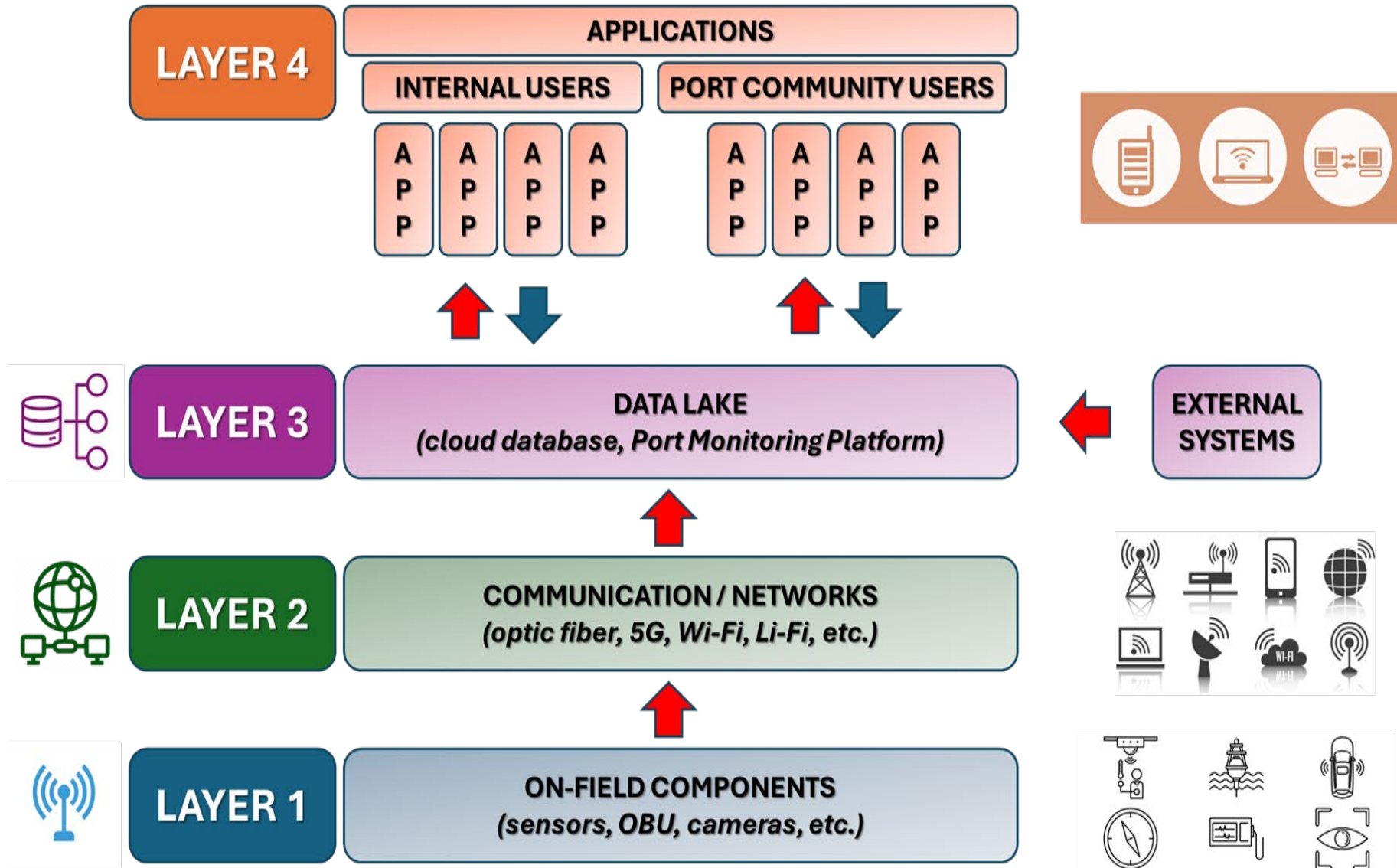
❖ The decoupled layers architecture in port monitoring separates components for enhanced flexibility and scalability.

❖ It promotes an open architecture that allows interoperability and integration of various systems.

❖ Scalability achieved by independently scaling different layers based on requirements and technology advancements.

Port of Livorno VBS pilot actions

Optimizing Cross-Border Logistics Flow – EASYLOG project

Objective
•Create an innovative system to coordinate freight logistics
procedures across border ports
•Reduce fragmentation and ensure data interoperability
•Support transit registration and loading list exchange via **EASYLOG**

Key Functions
•Common traffic management logic
•Support for vehicle handling (in/out operations)
•Connection with maritime destinations (e.g. Port of Olbia)

Focus: digital synchronization across stakeholders

Port of Livorno VBS pilot actions

Optimizing Cross-Border Logistics Flow – EASYLOG project

Pilot Highlights

- Module integrated in **TPCS**
- Verified entry/exit of units in real time
- Confirmed transit occurred **within the scheduled slot**

Result: improved visibility, efficiency and traceability

Port of Livorno C-ITS pilot actions

Devices Vehicular Communications System
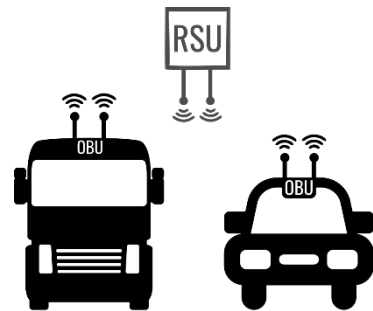
Nr.20 On-Board Units (OBUs)

- Collect and disseminate information regarding the **vehicle status**;
- They are connected to an HMI, used as **communication interface with the user**;
- Responsible for **sending and receiving information** to/from other vehicles (OBUs) or road-side units (RSUs).

Nr.5 Road-Side Units (RSUs)

- **Deployed in strategic positions** along the roadside;
- Are the **middle-point** between the vehicle and the platform;
- In the case of eminent danger, the RSU **can alert users directly** by triggering a warning DENM;
- In summary, they work as **mediators** to OBUs, **enhancing their overall perception** of the complex road environment through CAMs, DENMs, IVIMs, SPATEMs and MAPEMs.

Nr.4 Traffic Radar (Radars)

- kit consisting of **radar unit** and **management unit**;
- detection of vehicle transits, determining the **speed, length and direction** of travel and consequently the **traffic status** by sending alarms in case of **non-flowing traffic** (stop&Go), **congestion** (slow traffic at moderate speed), **queues**;

VEHICULAR COMMUNICATION SYSTEM

Port of Livorno C-ITS pilot actions

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Parking sensor

GW

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LPWAN

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PARKING SYSTEM

✓ **Nr.30 Parking Sensors**

- Deployed on the ground, in **parking space;**
- The sensor does not require cabling, as it **communicates wirelessly** and uses **internal batteries** for power;
- Used to **monitor the occupancy** of specific zones in the port;
- In order to improve reliability, the sensor status is **communicated periodically**;
- If required, dedicated **gateways** shall be deployed to receive **information** from nearby parking sensors, **aggregate and send it to the platform**;
- If possible, the sensor should also **provide a visual output** (e.g. with different light colors) to the drivers at the parking place.

Port of Livorno C-ITS pilot actions

Developing a series of value added C-ITS services for port and logistics operators.

Bottleneck removal
Real time information and early notification about the potential traffic congestion, accompanied by suggestions of alternatives routes
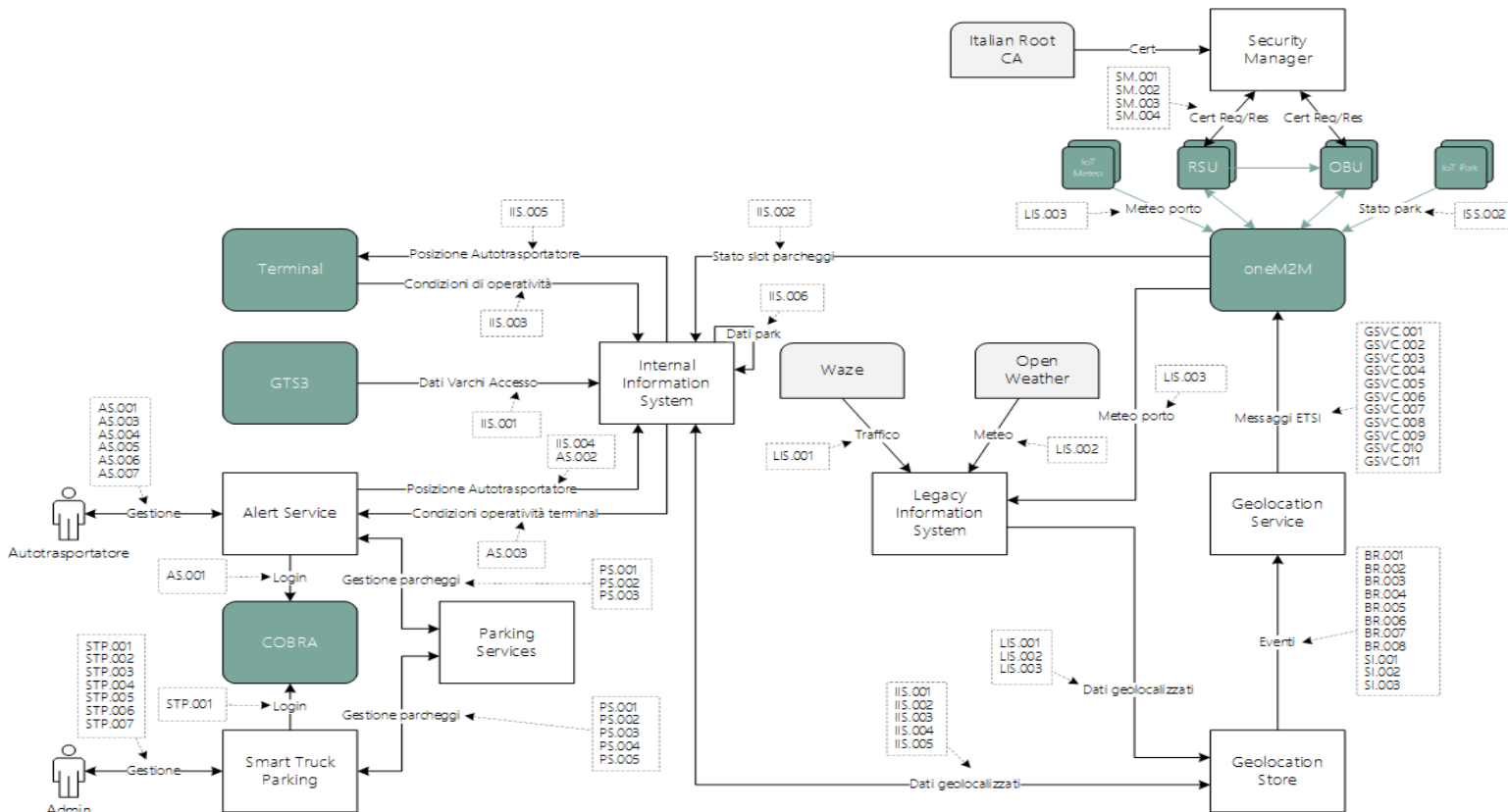
Safety Information
Real time information about hazards detected ahead on the road
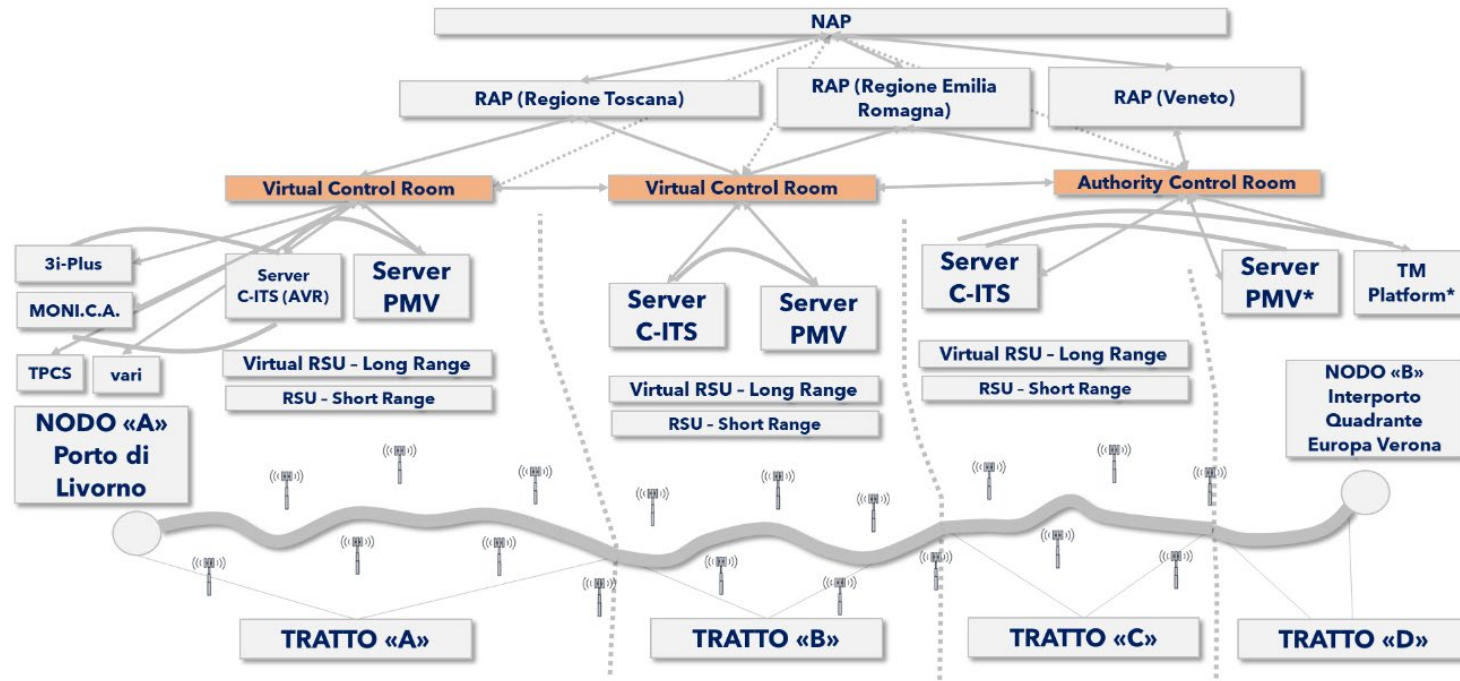
Smart Truck parking
Real time information about parking slots and updated freight villages booking options

NEXT STEPS

Virtual Control Room

🧭 **1. What is the VCR and why is it strategic**
• A **higher-level governance layer** beyond individual C-ITS servers.
• Acts as a **virtual control hub**, integrating data from:

- port platforms (e.g. MONI.CA, TPCS),
- C-ITS systems

🔗 **2. Main objectives**
• Provide a **synchronized and predictive view** of port, hinterland and urban operations.
• Coordinate multimodal flows in **real time**.
• Break down **technological silos** between infrastructure domains.

🌍 **4. Expected benefits**
• Greater **efficiency across logistics corridors**.
• Improved **response to critical events** (congestion, environmental thresholds, delays).
• Stronger alignment with **sustainability and smart mobility goals**.

NEXT STEPS

Port Sensor Network Plan

Building the digital infrastructure for environmental and logistic intelligence

✅ **Strategic Objectives**

- Enable **real-time environmental and operational monitoring**
- Support the **Digital Twin and AI-driven decision making**
- Expand **sensor coverage** from the port core to the urban and hinterland areas
- Ensure **interoperability** and future-proof architecture

🌍 **Impact**

- Data-driven planning for **sustainable logistics**
- Enhanced **coordination with urban mobility**
- Foundation for **predictive services and alert systems**
- Supports EU Green Deal and Smart Mobility goals

This sensor plan will act as the backbone for the port's digital and environmental transition

Thanks!

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