



Arab Academy

for Science , Technology and Maritime Transport



The International Maritime Transport
and Logistics Conference

“MARLOG 13”

**Towards _____
Smart Green Blue
Infrastructure**

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Autorità di Sistema Portuale del Mar Tirreno Settentrionale

Porti di Livorno – Piombino – Portoferraio – Rio Marina – Cavo – Capraia Isola

An innovative approach to Port Monitoring: Digital Twins, Strategic Decision Systems and Port Governance

Mr. Francescalberto De Bari
North Tyrrhenian Seaport Network Authority (AdSP-MTS)



KEY POINTS

- ❖ Innovative approach to port monitoring systems, emphasizing the *transformative potential of digital twin technology* in the dynamic and complex port environment.
- ❖ Need of a *decoupled layers architecture* for port monitoring, focusing on open, scalable, and standard digital architecture.
- ❖ Significance of digital twins in enhancing innovative port governance.

According to
topics



DIGITAL TWIN: CONCEPT AND RELEVANCE TO SEAPORTS

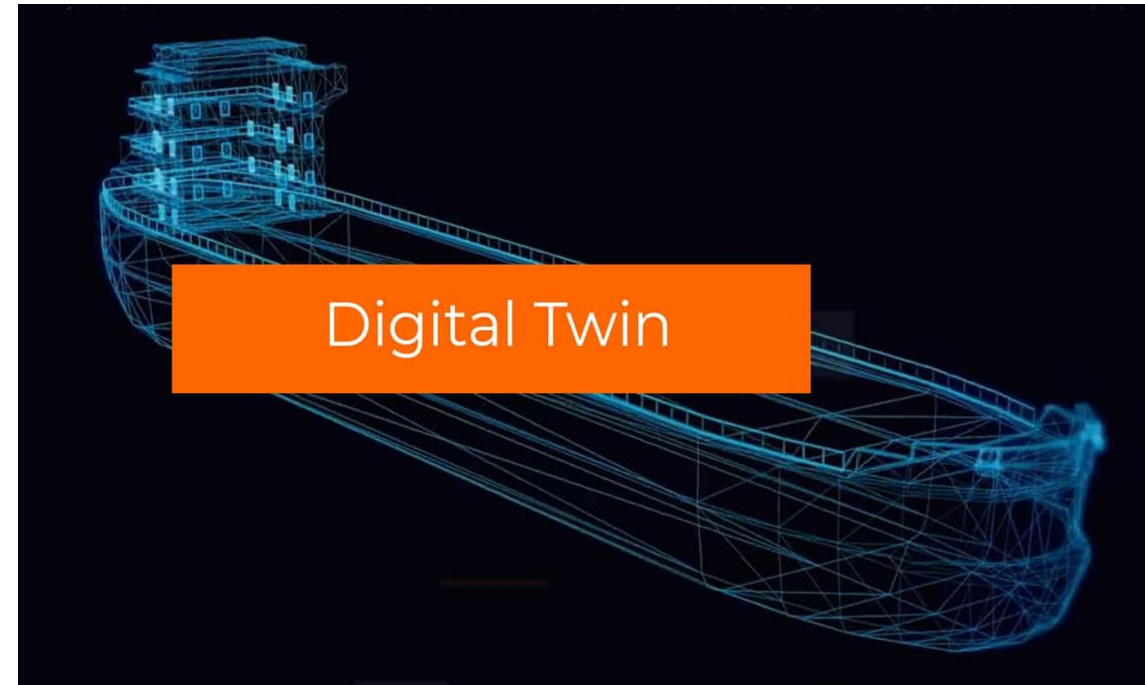


Digital twin technology creates virtual replicas of physical objects or systems in real-time.

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: CONCEPT AND RELEVANCE TO SEAPORTS



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

ENABLING TECHNOLOGIES AND INFRASTRUCTURE



ADVANCED SENSING



5G NETWORKS



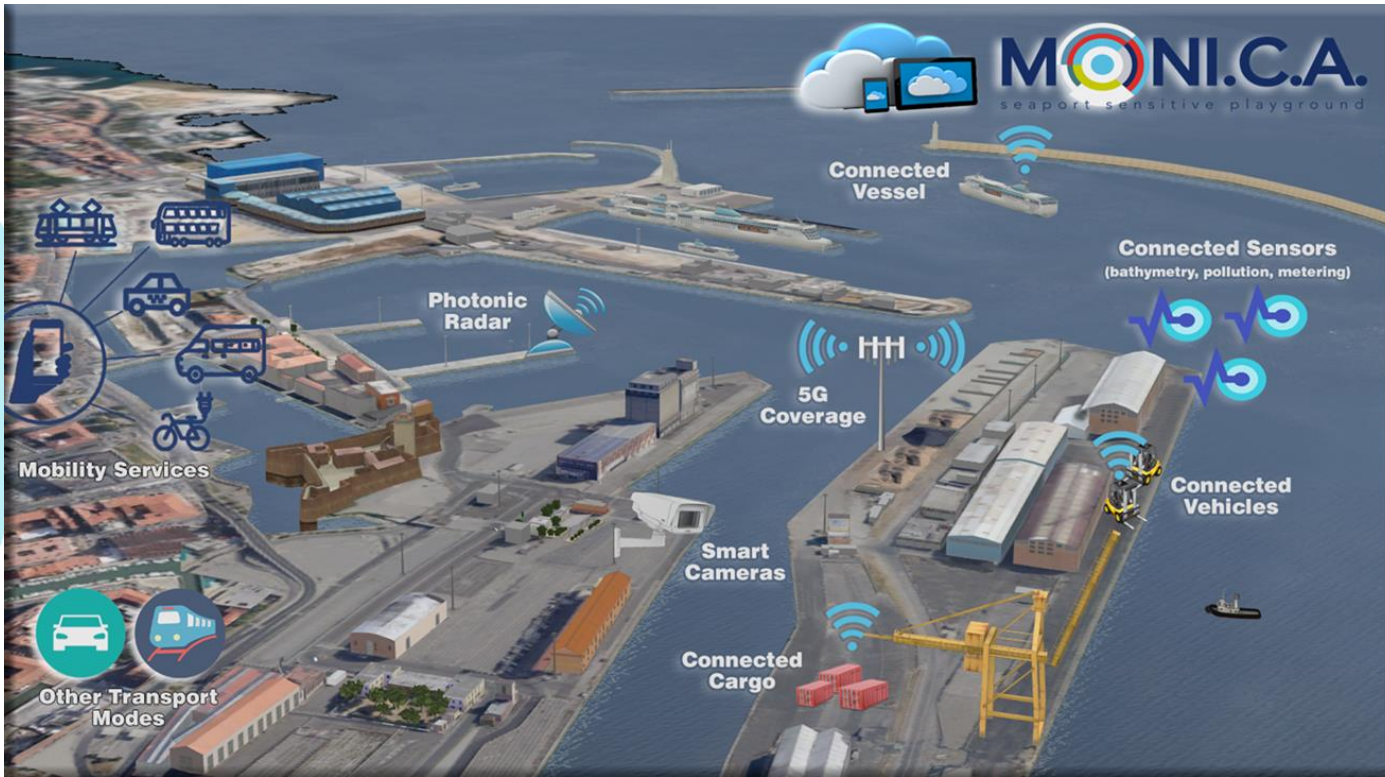
EDGE COMPUTING



BIG DATA ANALYTICS



FROM PORT MONITORING TO SEAPORT DIGITAL TWIN



- ❖ Since 2016, many Port Authorities have focused on creating advanced port monitoring tools.
- ❖ In the first phase, until 2019, port monitoring tools were developed in a fragmented way, with a 'silo' type data architecture that was difficult to integrate.
- ❖ This approach often resulted in technological lock-in, with dependence on specific suppliers and their vertical tools.

Need of a profound review of the port monitoring's digital architecture



Development of a general-purpose monitoring system,



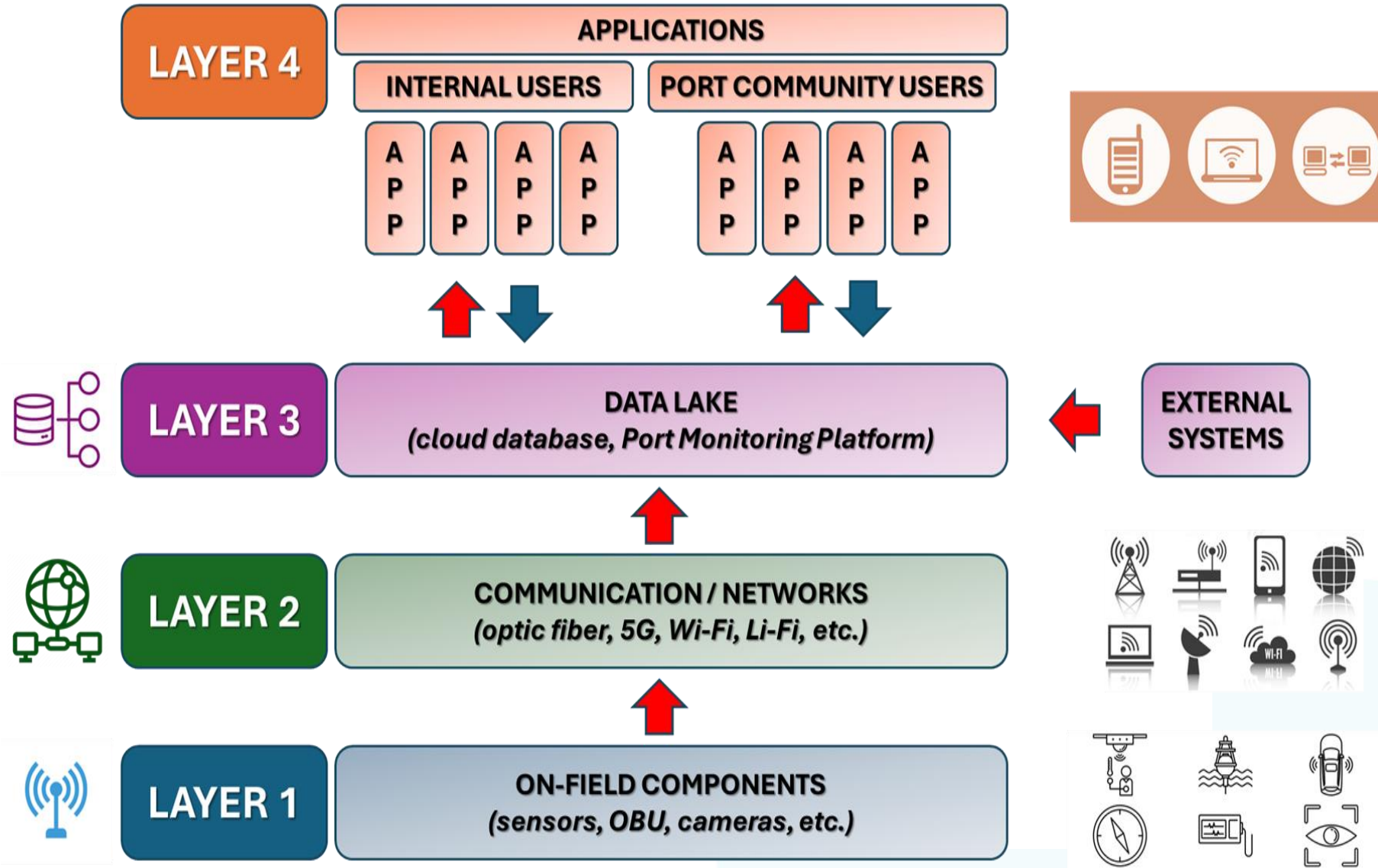
Modern port monitoring must be inspired by the logic of 'As A Service' and 'Open Data'.



Decoupling of the different layers involved in monitoring



DECOUPLED LAYERS ARCHITECTURE



CYBERSECURITY & SEAPORT DIGITAL TWINS



CYBERSECURITY CHALLENGES



- Establishing partnerships between port authorities, technology providers, and cybersecurity experts for comprehensive risk management.
- Implementing industry-specific regulations and standards to ensure data protection and system integrity in digital twin applications.
- Conducting regular audits and assessments to monitor compliance with cybersecurity protocols and identify potential vulnerabilities.



SPECIFIC DIGITAL TWIN FUNCTIONS FOR PORT GOVERNANCE



PORT DEVELOPMENT AND PLANNING

- Digital twins help in planning the expansion of port infrastructure by simulating the impact of new developments, expansions or changes in operations before implementing them in the physical environment.

PREDICTIVE INFRASTRUCTURE MAINTENANCE

- Digital twins enable predictive maintenance, continuously monitoring the evolving condition of equipment and infrastructure to identify potential problems before they cause failure.

ENVIRONMENTAL MONITORING

- Digital twins can incorporate environmental monitoring systems to assess the impact of port activities on air and water quality.

MONITORING, MANAGEMENT, AND CONTROL

- Digital twins enable real-time monitoring of physical assets such as cranes, containers, ships and other infrastructure and spaces within the port.

SECURITY

- Digital twins can be used to model and simulate security scenarios, helping port authorities in planning security and emergency response measures.

OPERATIONAL OPTIMIZATION OF PORT EQUIPMENT

- Digital twins allow terminal operators and authorized companies to optimize port operations.



CONCLUSIONS



1

Digital twin technology offers transformative capabilities in the port sector, enabling virtual representations for efficient monitoring and management.



Enhanced predictive analytics for proactive maintenance and asset optimization.

2

Enhanced port governance through digital twins includes improved development planning, predictive maintenance, and environmental monitoring for sustainable operations.



Integration of machine learning algorithms for dynamic decision support.

3

Addressing cybersecurity challenges is vital in digital twin implementation in ports, requiring robust measures to safeguard data and operations.



Utilizing IoT sensors for real-time data collection and feedback loop refinement.





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Thank You

FOR INFORMATION AND CONTACTS:

Mr. Francescalberto DE BARI
North Tyrrhenian Seaport Network Authority
f.debari@portaltotirreno.it

