

BANDO PER LA SELEZIONE DI PROPOSTE PROGETTUALI PRESENTATE DA SOGGETTI PUBBLICI LOCALIZZATI NELLE REGIONI DEL MEZZOGIORNO PER LA REALIZZAZIONE DI ATTIVITA' DI RICERCA, SVILUPPO, SPERIMENTAZIONE E DIMOSTRAZIONE NEGLI AMBITI DI INTERESSE DELLO SPOKE 4 "SMART AND SUSTAINABLE PORTS" DELL'ECOSISTEMA DELL'INNOVAZIONE "RAISE – ROBOTICS AND AI FOR SOCIO-ECONOMIC EMPOWERMENT"

ALLEGATO 2

AMBITI DI RICERCA, SVILUPPO, SPERIMENTAZIONE E DIMOSTRAZIONE E DESCRIZIONE ATTIVITÀ DELLO SPOKE 4 "SMART AND SUSTAINABLE PORTS"

1 – AMBITI DI RICERCA, SVILUPPO, SPERIMENTAZIONE E DIMOSTRAZIONE

Lo Spoke 4 "Smart and Sustainable Ports" dell'ecosistema dell'innovazione RAISE – Robotics and AI for Socio-economic Empowerment ha come obiettivo lo sviluppo e l'applicazione di soluzioni innovative basate sulla robotica e sull'intelligenza artificiale che consentano di ridurre l'impatto del porto sul territorio, migliorare la sostenibilità del porto, migliorare le prestazioni delle operazioni che vengono svolte in ambito portuale, aumentare la sicurezza delle persone (lavoratori e passeggeri), migliorare l'esperienza degli utenti che accedono ad aree portuali (porti turistici, terminal traghetti). Nello Spoke 4 "Smart and Sustainable Ports" vengono considerati i grandi porti commerciali ma anche i porti turistici che in Liguria rivestono un ruolo molto importante; viene considerato il traffico merci ma anche quello passeggeri; vengono considerati gli aspetti ambientali e marini e gli aspetti logistici e di movimentazione fisica delle merci; vengono considerate aree e punti specifici dei porti ma anche la rete intermodale regionale e multiregionale in cui i porti sono nodi di un sistema di trasporto complesso.

AMBITI DI RICERCA, SVILUPPO, SPERIMENTAZIONE E DIMOSTRAZIONE		
Uncrewed and automated systems for port automation	Machine learning and real-time data for port safety, security, and sustainability	Port management in an integrated framework of transport infrastructures
SOTTOAMBITI	SOTTOAMBITI	SOTTOAMBITI
Terrestrial robots	Inbound and outbound traffic flow monitoring and forecast	Digital twins and virtual models for ports / Advanced TOSs
Marine and underwater vehicles	Nowcast and forecast of marine conditions	Smart solutions and innovative processes for port management
Aerial systems	Sustainability assessment and masterplan of port areas	Energy and resource efficiency of the port
Physical and virtual gate automation	Risk assessment and resiliency of port areas	Regional and multiregional transport network optimization
HPC e Data Centric Computing for smart ports	Port protection and cybersecurity	Disruption management
Automated human-centred services for tourism and recreational services	Predictive maintenance of port resources and infrastructures	Scalability and replicability of port smart solutions
	Harbour pollution and natural resources monitoring	

Gli ambiti di ricerca, sviluppo, sperimentazione e dimostrazione sono riportati nel seguito, insieme ad una breve descrizione di essi e ai relativi sottoambiti.

Uncrewed and automated systems for port automation

L'ambito "Uncrewed and automated systems for port automation" è principalmente legato alla robotica e allo sviluppo di soluzioni hardware per il porto. Esso mira a incrementare il livello di automatizzazione dei processi e delle attività portuali anche attraverso l'introduzione di sistemi robotici terrestri, marini, subacquei e aerei che operano, anche in maniera autonoma, nell'area portuale. Tra gli obiettivi che vengono perseguiti all'interno di tale ambito vi è l'aumento dell'adozione di veicoli intelligenti e sostenibili per lo svolgimento di attività logistiche e di servizi portuali; inoltre, si intendono sfruttare le potenzialità dell'intelligenza artificiale per il controllo delle flotte e per una gestione in completa sicurezza degli asset portuali. Nell'ambito "Uncrewed and automated systems for port automation" vengono sviluppate le funzionalità necessarie di sistemi e veicoli autonomi per renderli parte di un'infrastruttura integrata in cui vengono realizzati servizi cooperativi terrestri, portuali e costieri. Sistemi autonomi e dispositivi innovativi vengono proposti anche per marine e porti turistici con l'obiettivo di aumentare l'esperienza degli utenti.

Sottoambiti:

- Terrestrial robots
- Marine and underwater vehicles
- Aerial systems
- Physical and virtual gate automation
- HPC e Data Centric Computing for smart ports
- Automated human-centered services for tourism and recreational services

Machine Learning and real-time data for port safety, security, and sustainability

L'ambito "Machine Learning and real-time data for port safety, security, and sustainability" è legato principalmente all'acquisizione di dati e all'analisi di essi tramite metodi di intelligenza artificiale. In esso vengono raccolti diversi dati e segnali (da varie fonti eterogenee) che sono successivamente analizzati ai fini del monitoraggio del traffico, delle previsioni marine e meteorologiche, della valutazione della sostenibilità, della valutazione del rischio, della protezione dei porti e della manutenzione delle infrastrutture. Le tecnologie robotiche e di intelligenza artificiale sviluppate in questo ambito comprendono soluzioni basate sull'IoT per localizzare, tracciare e riconoscere i flussi in entrata e in uscita di veicoli e persone; modelli data-driven per il nowcast e la previsione delle condizioni meteo-marine, modelli per la valutazione degli impatti antropici sull'ambiente marino; strumenti per la valutazione dei consumi energetici e delle emissioni (e dell'inquinamento), nonché per il monitoraggio dei segnali acustici per la salute dei lavoratori; reti di sensori intelligenti per la protezione dei porti; squadre di robot aerei e terrestri per il monitoraggio e l'ispezione delle attività cantieristiche, delle aree portuali e delle merci.

Sottoambiti:

- Inbound and outbound traffic flow monitoring and forecast
- Nowcast and forecast of marine conditions
- Sustainability assessment and masterplan of port areas
- Risk assessment and resiliency of port areas
- Port protection and cybersecurity
- Predictive maintenance of port resources and infrastructures
- Harbour pollution and natural resources monitoring

Port management in an integrated framework of transport infrastructures

L'ambito "Port management in an integrated framework of transport infrastructures" considera il porto come nodo di una rete logistica complessa e propone soluzioni per migliorare le prestazioni di essa. L'ottimizzazione delle prestazioni del porto viene perseguita da più punti di vista (gestionale, ambientale, energetico), sfruttando anche i dati raccolti e analizzati tramite i metodi di intelligenza artificiale. In questo ambito vengono proposti strumenti di simulazione, modelli virtuali e gemelli digitali delle attività e dei processi portuali. In generale, i porti sono considerati in un'ottica sistemica come nodi di una rete regionale o multi-regionale di infrastrutture di trasporto e a tale proposito vengono sviluppati sia metodi e strumenti concepiti per i porti intesi come nodi della rete integrata (come l'integrazione di nuove soluzioni all'interno dei Terminal Operating System, schemi avanzati di AI e IoT per migliorare i processi portuali, nuove

soluzioni di efficientamento energetico), sia metodi e strumenti specifici per le reti di trasporto (come il monitoraggio, la previsione e l'ottimizzazione dei flussi di merci e lo sviluppo di procedure per reagire tempestivamente a disruption e altre problematiche sulla rete).

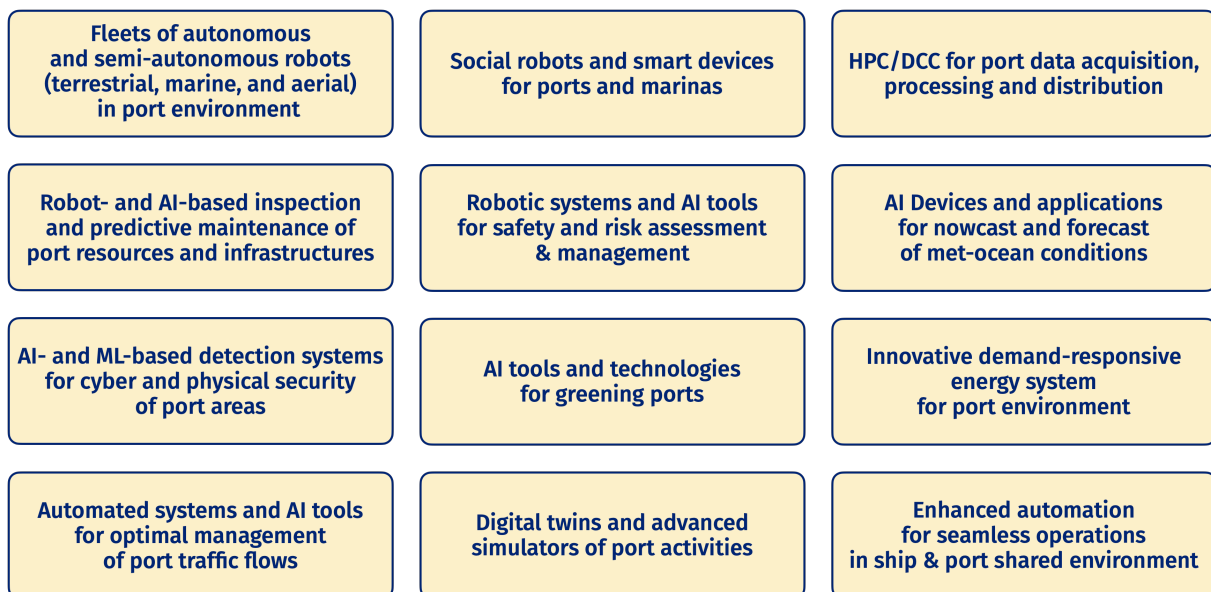
Sottoambiti:

- Digital twins and virtual models for ports / Advanced TOSs
- Smart solutions and innovative processes for port management
- Energy and resource efficiency of the port
- Regional and multiregional transport network optimization
- Disruption management
- Scalability and replicability of port smart solutions

2 – DESCRIZIONE ATTIVITÀ DELLO SPOKE 4 “SMART AND SUSTAINABLE PORTS” (in English)

In order to overcome an excessive fragmentation of the activities, make R&D activities and the deployment of their results more effective, increase the opportunities for collaboration between the participants of Spoke 4 “Smart and Sustainable Ports”, the research, development and innovation activities are organized in twelve projects:

1. Fleets of autonomous and semi-autonomous robots (terrestrial, marine, and aerial) in port environment
2. Social robots and smart devices for ports and marinas
3. HPC/DCC for port data acquisition, processing and distribution
4. Robot- and AI-based inspection and predictive maintenance of port resources and infrastructures
5. Robotic systems and AI tools for safety and risk assessment & management
6. AI Devices and applications for nowcast and forecast of met-ocean conditions
7. AI- and ML-based detection systems for cyber and physical security of port areas
8. AI tools and technologies for greening ports
9. Innovative demand-responsive energy system for port environment
10. Automated systems and AI tools for optimal management of port traffic flows
11. Digital twins and advanced simulators of port activities
12. Enhanced automation for seamless operations in ship & port shared environment



Projects 1, 2, and 3 are relevant to the area of research, development, experimentation, and demonstration “Uncrewed and automated systems for port automation”. Projects 4, 5, 6, 7, and 8 falls within the framework of the area “Machine Learning and real-time data for port safety, security, and sustainability”). Lastly,

projects 9, 10, 11, and 12 are related to the area “Port management in an integrated framework of transport infrastructures”. In any case, due to the various links existing between project, all the projects can be in general intended as multi-area.

A brief description of the twelve projects together with the list of tasks and a list of keywords/topics are reported in the following.

PROJECT 1

Fleets of autonomous and semi-autonomous robots (terrestrial, marine, and aerial) in port environment

BRIEF DESCRIPTION

Autonomous robots have a high potential to impact on the efficiency and effectiveness of many tasks to be accomplished in a port environment. Logistics services, pollution monitoring, surveillance, infrastructure inspection, mapping, data acquisition and others. Where advantageous, the use of fleets of robots rather than individual ones allows to distribute tasks spatio-temporally enhancing coverage while also granting higher robustness to individual vehicle failures or faults. The project aims at developing fundamental and applied research on land, marine and aerial platforms to be exploited in fleet applications in port environments.

PROJECT TASKS

- P1.1 – Terrestrial robots
- P1.2 – Marine and underwater vehicles
- P1.3 – Aerial systems

PROJECT 2

Social robots and smart devices for ports and marinas

BRIEF DESCRIPTION

Project #2 focuses on technological innovations in small ports and marinas, including (i) Social Robots for interaction with individuals and groups, (ii) distributed cameras and other devices for people tracking during port activities and for tourism, and (iii) wearable and mobile technologies to monitor the state and increase the safety and comfort of people and yachts. In addition, the project will include socio-economics studies on selected technological solutions to increase their impact during and after the project lifecycle.

PROJECT TASKS

- P2.1 – Definition of Requisites and Co-creational process
- P2.2 – Social Robots for Interaction with Groups of Individuals
- P2.3 – People Tracking in Port Activities and for Tourism
- P2.4 – Sensorised Mobile Technologies for People in Port and for Tourism
- P2.5 – Socio-Economics Studies on Digital Solutions for ports and marinas

PROJECT 3

HPC/DCC for port data acquisition, processing and distribution

BRIEF DESCRIPTION

One of the main goals of project 3 is defining a federated system for data ingestion and data sharing based on microservices, for moving computation close to data sources (e.g. close to the edge), for their analysis using AI procedures (alerts/alarms, correlations, forecasting, etc) and for the distribution of the resulting analyses via dashboards, microservices, and APIs. More in particular, the focus will be on the study of the design principles for an efficient and scalable analytics framework based on the following components: i) a federated IoT platform for (continuous/periodic) condition monitoring, service integration and code migration; ii) an artificial intelligence component for (predictive) analytics based on machine learning algorithms; iii) a big data component for scalable analysis based on Hadoop Spark. The microservices

architectural style will ensure an adequate level of flexibility and data decentralization required in the complex application scenario considered in RAISE. Semantic web and linked data technologies can be applied in this setting in order to improve interoperability, e.g., via SparQL endpoints, for a large set of heterogeneous data sources. Blockchain technology will also be considered for securing transitions. Applications related to the Terminal Operating Systems (TOS), Port Community Systems (PCS), and to the automatic management of vehicle transits at access gates will provide interesting case-studies for data acquisition, integration and analysis.

PROJECT TASKS

- P3.1 – Integration of data-based and model-based methods for the optimal management of heavy vehicles movements at road gates of container terminals
- P3.2 – Efficient management of data from heterogeneous sources via IoT platforms and HPC/Big Data infrastructures
- P3.3 – Retrieval of semantic information from large amounts of heterogeneous and geo-referenced data
- P3.4 – Blockchain Technology in Port Community Systems
- P3.5 – Data sharing and collaborative analytics for Port operation support and performance monitoring and improvement
- P3.6 – Digital technologies to support the Business Transformation in Logistics: Moving applications to the Cloud and to the Edge
- P3.7 – Economic Assessment Framework

PROJECT 4

Robot- and AI-based inspection and predictive maintenance of port resources and infrastructures

BRIEF DESCRIPTION

The main objective project “Robot- and AI-based inspection and predictive maintenance of port resources and infrastructures” is the study and development of novel technological solutions towards the adoption of digital, robotic, and artificial intelligence technologies in the inspection during construction, operations, maintenance, and end-of-life activities in ports, including transportation, handling, and storage of goods, infrastructure works, shipbuilding and shipping in general. Main goals of proposed research activities are related to the adoption and integration of digital, robotic, and artificial intelligence technologies in shipyards (to support the quality checks of hull blocks, assemblies as well as the completed hull in the dock), in container yards (to monitor container stacks after severe weather events, or to check for the leakage of dangerous material) and in major infrastructural projects (to periodically monitor the state of advancement of works). The project will define and implement an advanced and innovative monitoring system based i) on the use of drones as mobile sensors for the collection of heterogeneous data and ii) the consequent processing of these data using AI approaches for automatic and real-time detection of potential anomalies or danger scenarios.

PROJECT TASKS

- P4.1 – User Requirements and Technology Specification
- P4.2 – Sensor Analytics and Situation/Self-Awareness of Autonomous Agents
- P4.3 – Autonomous Platform Subsystem
- P4.4 – Planning, Control and Decision
- P4.5 – System Integration and Pilot Deployment

PROJECT 5

Robotic systems and AI tools for safety and risk assessment & management

BRIEF DESCRIPTION

The safety of port workers is a sensible item of paramount importance. Using state-of-the-art AI-inspired technologies the project aims to define a modern framework that will reduce and manage risks in port operations. Starting from a thorough assessment of the working conditions and stakeholders’ needs, the

best strategy to minimize risks and define a work plan for continuous monitoring of the port environment will be deployed. A combination of hardware (e.g. remotely operated vehicles, robots, and a network of monitor systems) and software technologies (e.g. platforms for big-data collection and elaboration) will be developed and optimized by public and private partners of the project to increase the current safety operations in the port environment and provide a long-range plan to ensure continuous monitoring and risk minimization in future.

PROJECT TASKS

- P5.1 – Terrestrial robots
- P5.2 – HPC and Data Centric Computing for smart ports
- P5.3 – Risk assessment and resiliency of port areas
- P5.4 – Predictive maintenance of port resources and infrastructures
- P5.5 – Scalability and replicability of port smart solutions

PROJECT 6

AI Devices and applications for nowcast and forecast of met-ocean conditions

BRIEF DESCRIPTION

Met-ocean data such as waves, currents, temperature, winds have a significant impact on port activities, both on land and sea. This project's objective is to provide reliable now- and fore-casting of met-ocean conditions in proximity of the main commercial harbors of the Ligurian Region. Possible applications range from safety of navigation to environmental and fish farming risk assessment capacity. Met-ocean observing system will be improved and expanded in order to provide a solid input for numerical models, and Artificial Intelligence methods will be applied for quality control of measured data, numerical models training and analysis of models output.

PROJECT TASKS

- P6.1 – Met-ocean observing system maintenance and improvement
- P6.2 – Machine Learning for nowcast and forecast of met-ocean conditions (wind, waves, currents) blending observations and numerical models

PROJECT 7

AI- and ML-based detection systems for cyber and physical security of port areas

BRIEF DESCRIPTION

The management of port ecosystems massively relies on the use of ICT (Information and Communication Technology). The resulting high level of digitization of the port ecosystem on a global scale plays a crucial role for the functioning of some of the most important services as well as critical infrastructures (CIs) interrelated. To consider security from a "system" perspective, it is necessary to address the problem of CI security and protection by looking at the interconnection between cyber and physical threats/attacks and the relationships and dependencies of the subsystems, considering the potential impact on integrity and resilience. In this context, the project addresses protection and security through a holistic approach, integrating physical and cyber security, adopting a multi-stakeholder model based on information sharing, proactivity and collaboration, leveraging and enhancing predictive, risk-based models which use data and information gathered from multiple sources throughout the whole value chain and all the main stages of ecosystem protection.

PROJECT TASKS

- P7.1 – Foundations and data processing frameworks for detection systems in smart ports
- P7.2 – Underwater detection systems for enforcing the peripheral security of port areas
- P7.3 – Innovative methods to detect trafficking of Special Nuclear Materials (SNM)
- P7.4 – Cyber-physical threat intelligence and situational awareness in resilient ports
- P7.5 – Scalability and replicability of port smart solutions

PROJECT 8

AI tools and technologies for greening ports

BRIEF DESCRIPTION

The project aims at developing, testing, and integrating innovative solutions for the transition to greener, more efficient, and sustainable port areas. The project is composed of three main activities: a task focusing on the design, development and implementation of tools and technologies aimed at monitoring the port environment; a task dealing with the conceptualization, design and prototyping of sustainable and circular solutions aimed at greening the port areas and an horizontal task aimed at the identification and development of enabling conditions for the implementation at territorial level, and their replication at wider scale, of the innovative solutions developed and tested in the first two tasks.

PROJECT TASKS

- P8.1 – Monitoring Tools and Technologies for Greening Ports
- P8.2 – Sustainable and Circular Solutions for Greening ports
- P8.3 – Promoting Enabling Conditions for the Territorial Deployment of Sustainable and Circular Solutions in Port Areas

PROJECT 9

Innovative demand-responsive energy system for port environment

BRIEF DESCRIPTION

Ports are among the most energy-intensive infrastructures in the world, and today they are requested to play a leading role in the energy transition. The project will design, implement and test a set of AI-based tools for proper sizing, scheduling and economical valorization of differentiated energy systems within the port environment, according to the emerging Port Renewable Energy Community (PREC) paradigm. The project will build upon complementary methodological approaches, specifically addressing: i) innovative renewable energy community management; ii) advanced energy asset / system simulation; iii) stochastic forecasting of energy production and energy consumption; iv) stochastic scheduling of energy resources for control optimization; v) predictive maintenance of energy systems. The project will release a PoC in simulative conditions integrating the AI-based tools (prototypes), that will be later moved to operative conditions according to the availability of necessary stakeholders (port authorities), assets and related measurements/controls, according to an incremental approach that i) fixes the application boundaries and constraints (given all available energy assets) and ii) considers the possibility to apply different tools in different (as for size/composition) port environments.

PROJECT TASKS

- P9.1 – Virtual Aggregation Platform for PREC
- P9.2 – AI-based load and generation forecasting tool
- P9.3 – Multi-energy modelling tool for port sizing
- P9.4 – Energy management scheduling and predictive maintenance tool
- P9.5 – Business case investigation for PREC

PROJECT 10

Automated systems and AI tools for optimal management of port traffic flows

BRIEF DESCRIPTION

Project 10 has the goal of strengthening port automation processes through a novel combination of data collection and aggregation from IoT devices, AI/ML and optimization algorithms for (predictive) analytics and automation to improve flows in ports. The application fields are: automated systems, logistics and transportation management, forecast, AI-ML models and end-user interfaces. The project is composed of different pillars, each with a dedicated task: automated systems, control rooms and platforms, AI tools, control and optimization methods.

PROJECT TASKS

- P10.1 – Automated systems
- P10.2 – Control room and platform
- P10.3 – AI tools
- P10.4 – Control and optimization methods

PROJECT 11

Digital twins and advanced simulators of port activities

BRIEF DESCRIPTION

Project 11 is focused on the use and development of digital twin and advanced simulator tools for the port area processes and operations. The activities will be articulated in several dedicated and properly integrable modules and systems. The structure of the Project follows the ideal geographical line of a general import cycle of goods and passengers flows, which arrive in the port area by sea (the opposite order is for a general export cycle). In particular, specific tasks address operations considering seaside and docks, maritime terminal operations and interfaces with the common port areas. Then, proper tasks are devoted to the whole port area and the relation with the surrounding urban network, up to the linked inland terminal. Finally, there will be a layer of transversal activities aimed at efficiency evaluation and output presentation. The Project has a strong synergy with Projects 10 and 12, given that the three concern research activities and applications for the optimization and efficiency enhancement of the overall port area with its connections, from the seaside to the hinterland.

PROJECT TASKS

- P11.1 – Ship operations simulation in port area
- P11.2 – Simulations of maritime terminal operations and interfaces with the common port areas
- P11.3 – Simulations of the port area and the interfaces with the surrounding urban area
- P11.4 – Flows simulation in the port area network related
- P11.5 – Transversal layer of efficiency enhancement evaluation

PROJECT 12

Enhanced automation for seamless operations in ship & port shared environment

BRIEF DESCRIPTION

The acceleration in the digital transformation has pushed the companies to study and test solutions in processes and business operations, particularly with growing adoption of emerging technologies, like artificial intelligence, machine learning, data science and robotics, among others. Such systemic change has the main objective to ensure business continuity, to induce efficiency, to control costs and to develop sustainable business models. The port ecosystems with their constantly growing traffic of goods and passengers is a perfect business case to study for a new design of the activities. When a ship approaches the port, it will be involved into processes that can be optimized acting on many possible variables: some are measures of efficiency, some can maximize effectiveness, others minimize ecological impact, etc. The increasing number of relevant variables that must be considered require new approaches to the problem and a new paradigm of solutions. In the seamless port operations, the inbound/outbound ship traffic, the ship-terminal activities, the optimization of the “multi-ships vs multi-terminals” problem will be studied and modelled to propose a new set of tools for the decision-making. Many of the obtained solutions will be integrated in the prototype of a control room to help the decision-makers. The final demonstration will be performed on reference scenarios, with the objective to describe the solutions and the results of the project 12.

PROJECT TASKS

- P12.1 – System Requirements and Architecture
- P12.2 – Human Factors and Operational User Experience Requirements
- P12.3 – Analysis and Development of SW Interfaces – Interface Requirements Specification

- P12.4 – Study, Analysis and Development of Dock Operations Modules
- P12.5 – Study, Analysis and Development of Multiple Docks Management Optimization Modules
- P12.6 – Studies on modularity, scalability, replicability of the solutions
- P12.7 – Demonstration of Seamless operations in Port environment
- P12.8 – Way Ahead and possible evolutions