Yeosu Gwangyang Port

“Architecting a Next-Generation Smart Port Driven by Physical AI”

Executive Summary

Yeosu Gwangyang Port Authority(YGPA) is advancing a comprehensive digital transformation roadmap targeted for completion by 2029. By shifting from traditional rule-based software to a 'Physical AI' ecosystem, we aim to directly control cargo-handling equipment, presenting a highly efficient digital standard for the global maritime community.

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YEOSU GWANGYANG PORT AUTHORITY

Agenda

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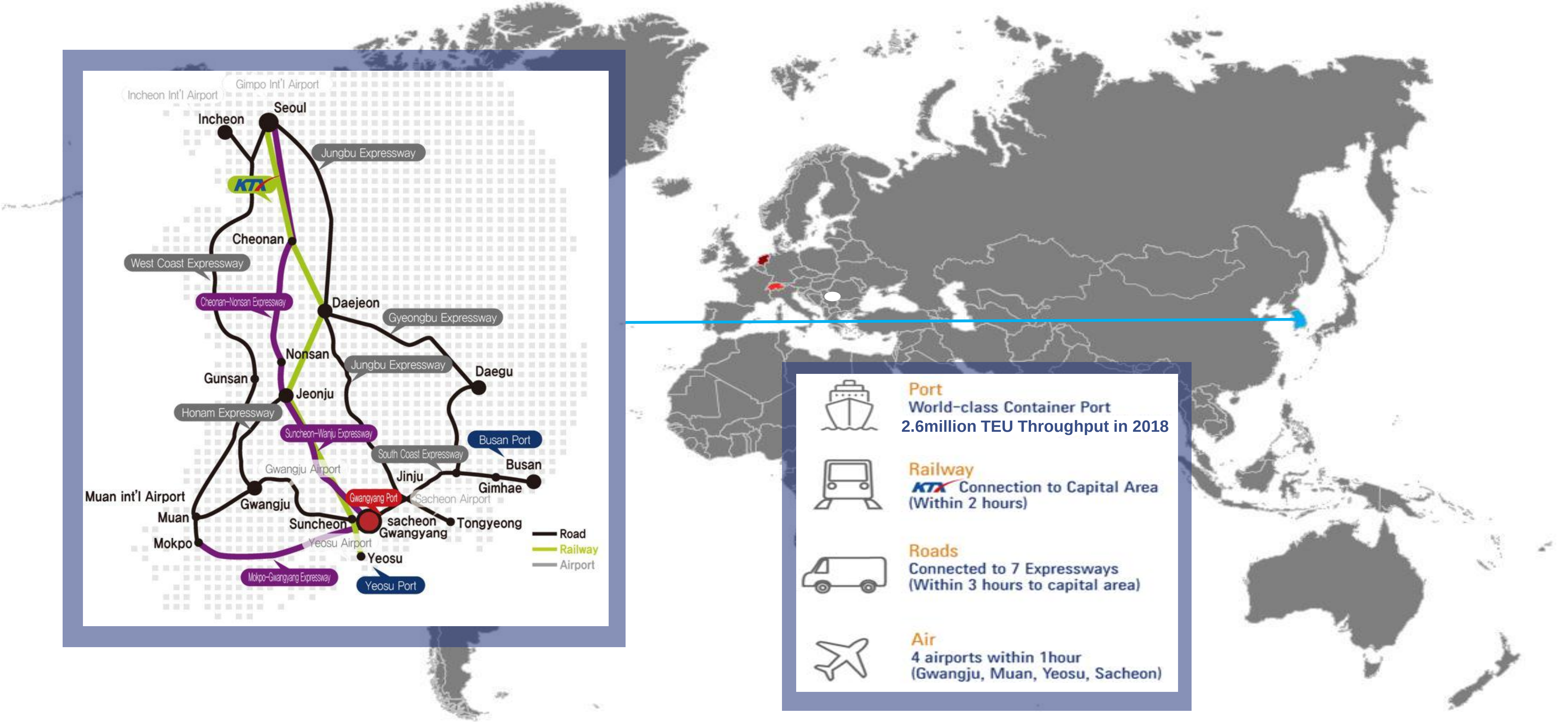
01

Yeosu Gwangyang Port(YGPA)

Location and Inland Transportation Network of Yeosu Gwangyang Port



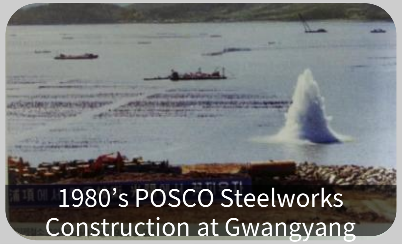
History of Yeosu Gwangyang Port

"Yeosu Gwangyang Port is History of Industrial development in Korea "

1923
Open Port

1920's Waterfront view of Yeosu(Jongwha-dong)

1970's Yeosu National Petrochem Complex Construction



1980's POSCO Steelworks Construction at Gwangyang

1990's early Gwangyang Port site development

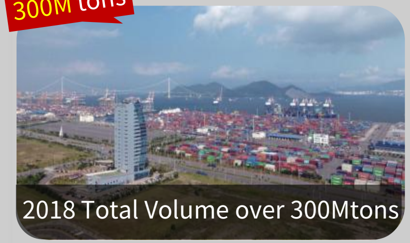
100M tons

1997 Gwangyang Container Port Phase1 Completion

200M tons

20's Industrial Core Port in Korea

300M tons



2018 Total Volume over 300Mtons

2022~ Automated Container Terminal Constructing

Overview Map of Yeosu Gwangyang Port

PIERS / BERTHS

45 PIERS

112 BERTHS

CARGO HANDING CAPACITY

369million tons

2.72million TEU

The Optimal Hub for Physical AI Port

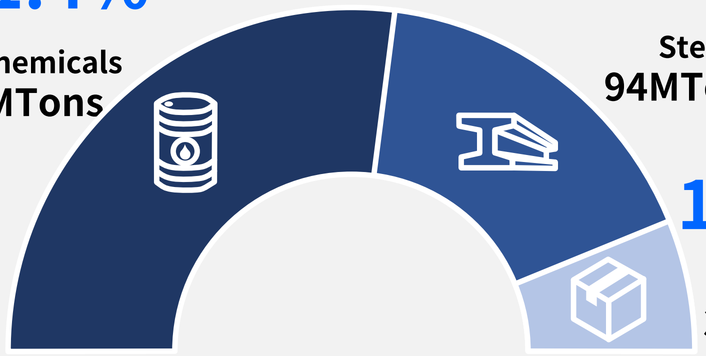
Korea's No.1 Import & Export Gateway

CARGO by Category

51.4%
Petrochemicals
137MTons

35.2%
Steel
94MTons

13.4%
Etc.
36MTons



No. 1 Multi-Purpose Port in Korea
Total Throughput 267M R/T in 2025

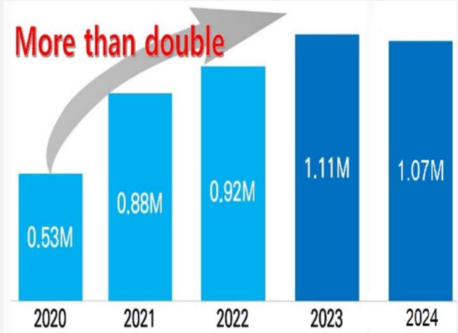
Container
2.06MTEU

88% Import/Export 1.81MTEU

12% T/S 0.25MTEU

CAR
1.00M+
(2023-2025 avg.)

RO-RO Throughput



Industry Challenge: The Limitations of Early Automation Port

Decline in Initial Productivity

Many ports worldwide are pursuing automation, but reliance on rigid, rule-based systems often leads to prolonged stabilization periods and a drop in initial productivity.

High Dependency on Select Tech Providers

Heavily relying on a few overseas vendors for core operating systems makes it difficult for ports to quickly adapt their digital infrastructure to local operational needs.

Inflexibility in Dynamic Environments

Traditional automated systems struggle to adapt to sudden weather changes or minor sensor errors, frequently triggering emergency stops that cause operational bottlenecks.

Inefficiencies of Remote Maintenance

Depending on overseas support for system trouble shooting extends downtime, highlighting the need for more autonomous diagnostic systems.

Disconnected Equipment Operations

The lack of real-time data sharing between different types of equipment leads to inefficient movement and frequent traffic congestion in the yard.

The Need for Independent Digital Control

Ports must secure control over their core software and operating technologies to ensure stable services and protect national logistics networks.

The Future Direction: Transitioning to Physical AI

Direct Hardware Control via Digitalization

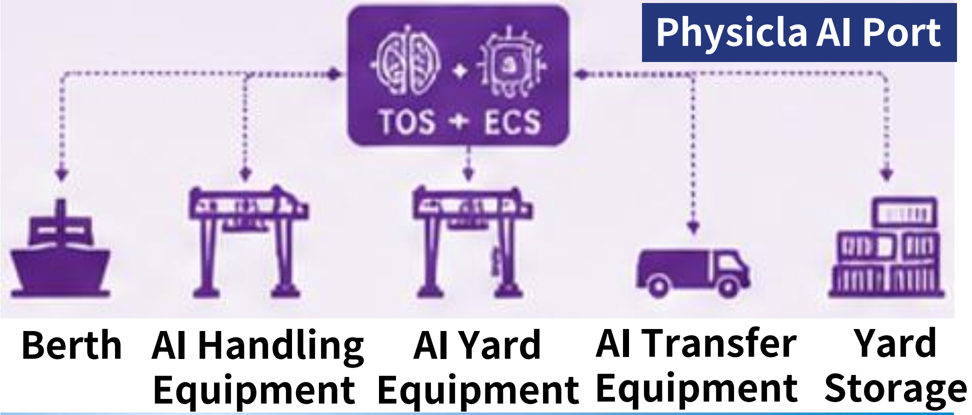
The future Physical AI system will use advanced sensors to perceive the environment and deep-learning networks to directly control hardware motors in real-time.

Achieving Full Autonomy by 2029

Moving beyond simple programmed rules, the system aims to enable fully unmanned handling for both standard containers and complex bulk cargo upon completion.

Resolving Operational Inefficiencies

This digital leap is expected to directly address current industry challenges, such as productivity drops and inflexible systems, setting a stable global standard.



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02
‘Physical AI Port’ - Yeosu-Gwangyang

K-Smart Port Automation Testbed

Direct Hardware Control via Digitalization

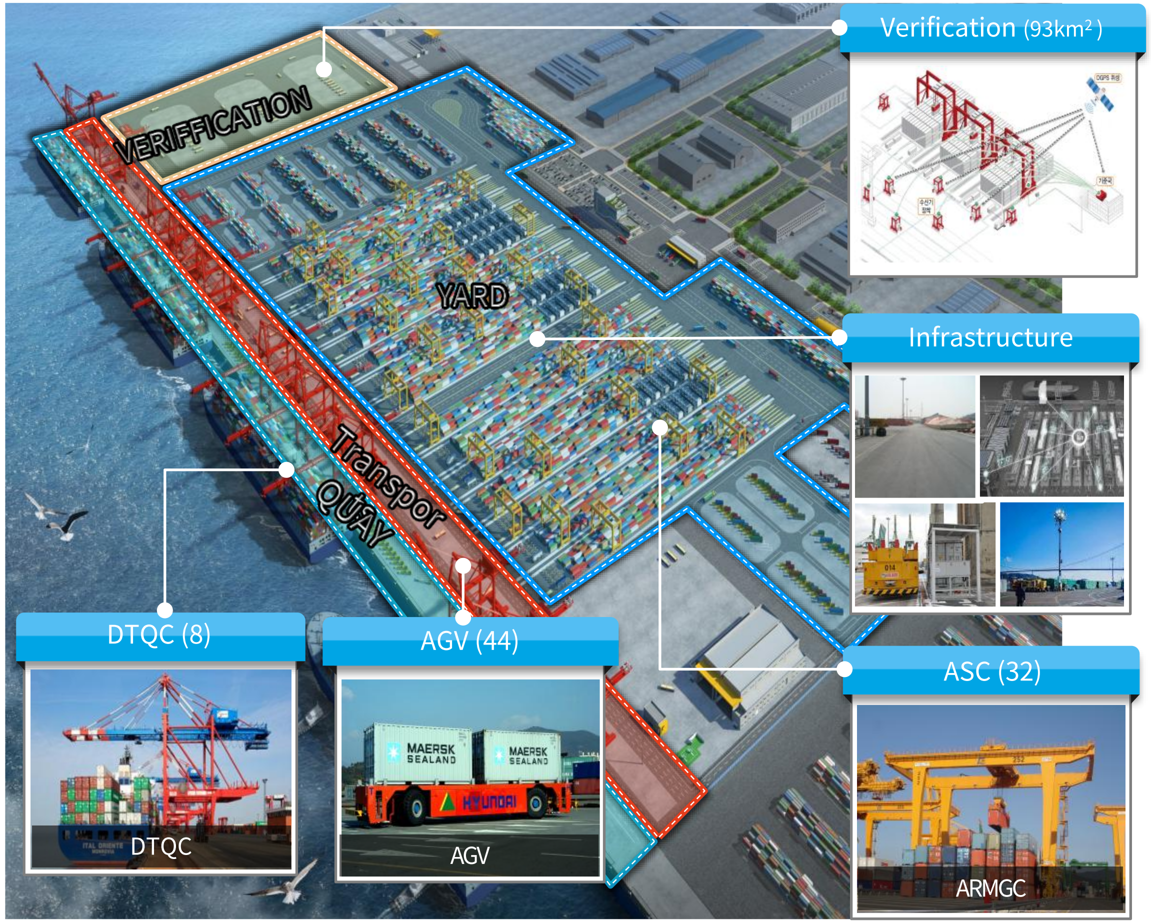
Supported by a KRW 759.2 billion investment, this project is constructing a massive 870,000 sqm automated terminal at Gwangyang Phase 3-2.

Achieving Full Autonomy by 2029

Commercial-Scale Design Capacity: Encompassing 4 major berths (three 4,000 TEU and one 2,000 TEU berths) with a total design capacity of 1.36 million TEUs.

Resolving Operational Inefficiencies

Standardized and Scalable Blueprint: Built on an open architecture, the validated AI solutions are designed to be exported and integrated into existing ports worldwide after 2029.



How Physical AI Will Process Data: The 4-Step Cognitive Loop

Step 1: Perception

Data Ingestion

Ultra-precise spatial data is harvested via RTLS (Real-time Locating Systems), mmWave IoT sensors, and 4K CCTV networks, ensuring data transmission with sub-1ms latency for a flawless digital mirroring of the terminal.

Step 2: Cognition

Sensor Fusion

Visual data streams are fused with 3D LiDAR point clouds in real-time. The AI identifies precise cargo coordinates (6 Degrees of Freedom) and detects unauthorized personnel or obstacles in 0.1-second intervals, ensuring absolute spatial awareness.

Step 3: Prediction

Dynamic Routing

Utilizing Deep Reinforcement Learning models, the system predicts the micro-movements of all dynamic assets. It generates optimal, collision-free routes for swarm AGVs, proactively resolving potential deadlocks before they occur.

Step 4: Execution

Micro-Control

Bypassing sluggish middleware, the AI directly controls the motor torque and hydraulic braking systems of Quay Cranes and AGVs. This allows for fluid, millimeter-level precision handling that mitigates equipment wear and tear.

Multi-Modal AI and 3D Digital Twin Foundation

Foundation Model for Ports

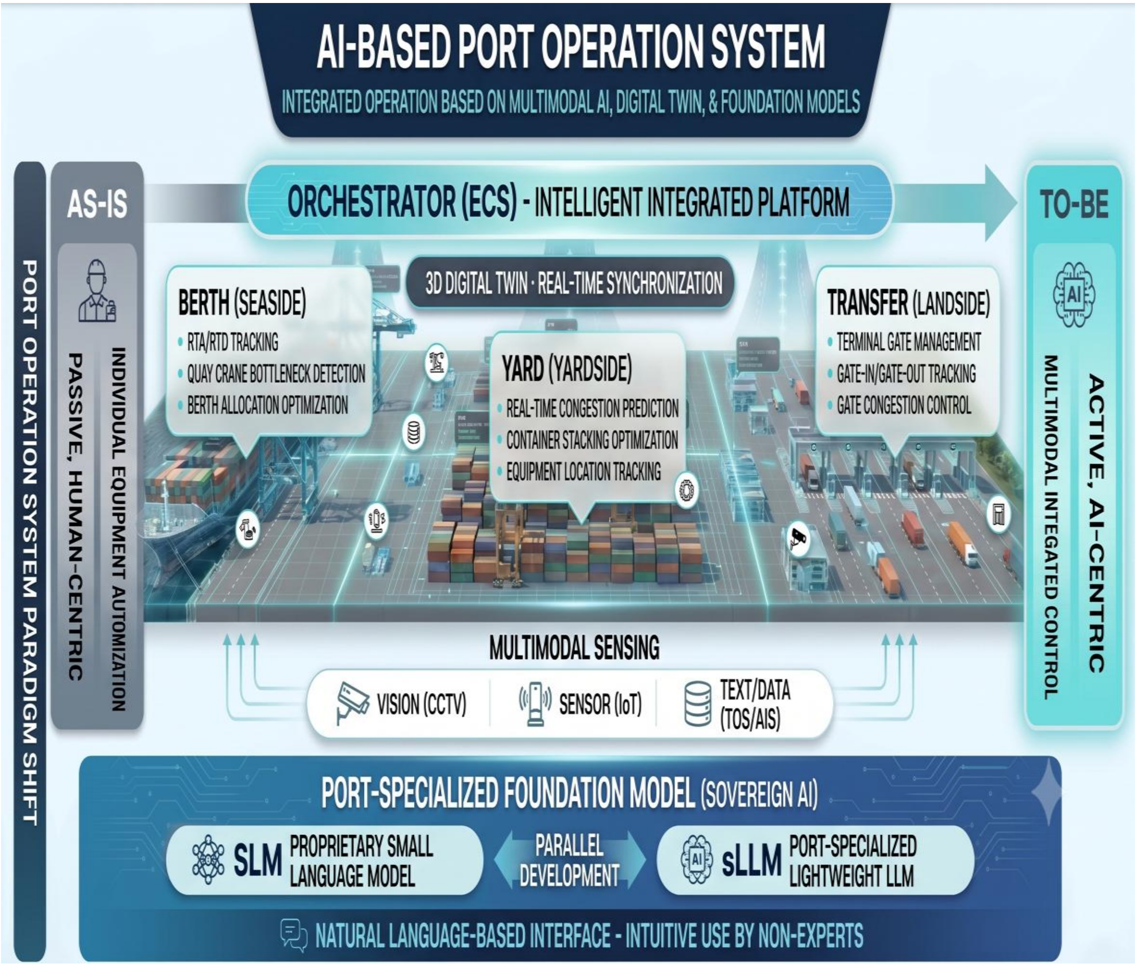
YGPA aims to develop a port-specific Small Language Model (SLM) and lightweight LLM to process text, data, and vision inputs comprehensively.

Real-time System Synchronization

Eliminating the delay between physical terminal sensors and the virtual model, ensuring the Digital Twin continuously reflects the actual operational status.

Extensive Traffic Simulation

Running millions of simulations within the Digital Twin to mathematically identify and eliminate any possibility of traffic congestion before physical deployment.



SLAM-based Navigation and Fleet Coordination

Infrastructure-Free Autonomous Driving

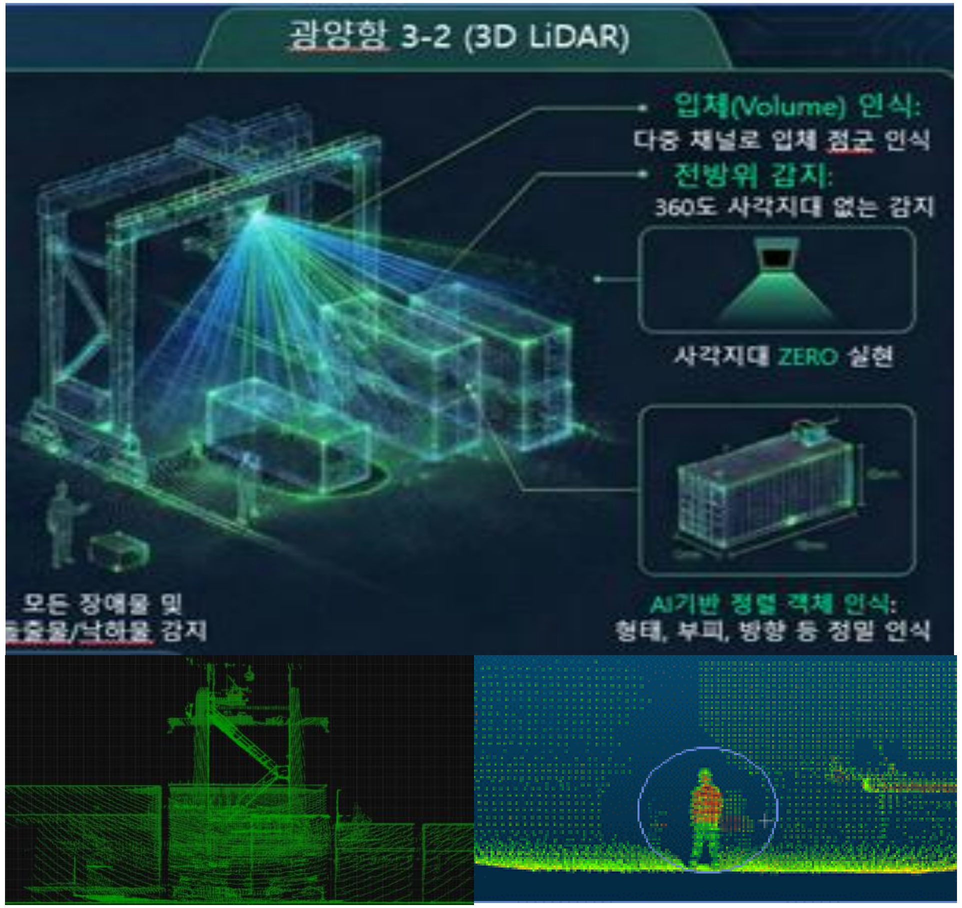
Automated Guided Vehicles (AGVs) will utilize LiDAR-based SLAM instead of fixed ground sensors, allowing autonomous navigation without physical tracks.

Coordinated Fleet Movement

Autonomous equipment will communicate via a localized network, moving together as a coordinated fleet to reduce unnecessary travel and save energy.

Adapting to Layout Changes

This digital navigation approach will allow the automated fleet to adapt instantly to any future changes in the yard layout.



Intelligent Terminal Operating System (AI TOS)

Active Problem Solving

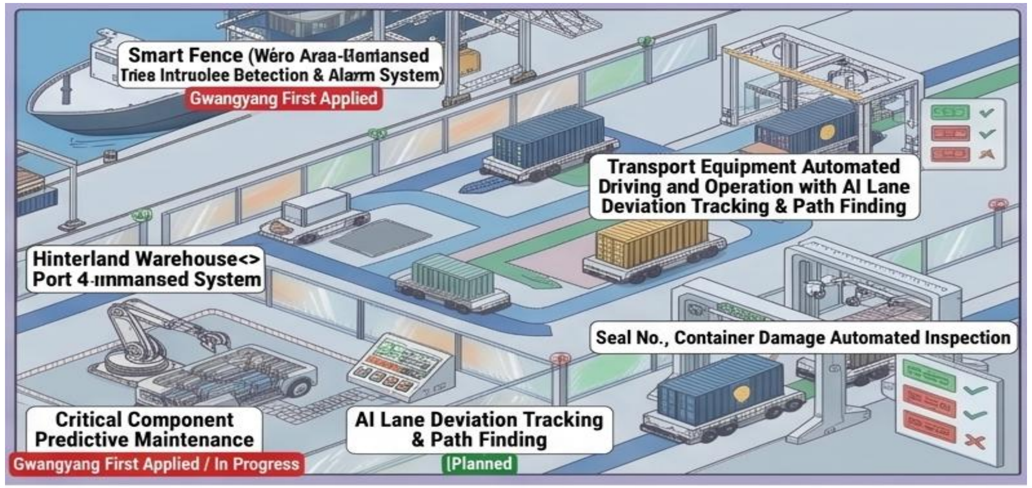
Going beyond simple monitoring, the intelligent ECS (Equipment Control System) and TOS will automatically execute backup plans during equipment failures.

Optimized Coordination

Managing every piece of equipment—from seaside cranes to yard cranes and gates—through a single scheduling system to minimize idle times.

Predictive Maintenance Analytics

Analyzing equipment data continuously to predict part failures in advance, ensuring consistent operational uptime across the terminal.



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03 Expected Transformations via Physical AI

Digitalizing Safety: Expected Reduction in Accidents

Complete Spatial Separation

The new terminal is designed to completely exclude human access from automated equipment zones, fundamentally preventing accidents.

Robotic Task Execution

Using fully automated systems to handle twist-lock engagement, protecting workers from one of the port's most dangerous manual tasks.

Achieving Drastic Safety Improvements

By replacing human-centric operations with AI-based perception and control, we project a 90% reduction in safety-related accidents.

Automated Safety Patrols

Deploying autonomous robots and drones linked to the digital twin to continuously inspect high-voltage areas and elevated crane structures.

Immediate Emergency Response

Edge-computing sensors will detect safety breaches instantly and trigger local motor brakes within 0.1 seconds, bypassing network delays.

Proactive Damage Prevention

Vision systems will scan the interior of vessels before loading to adjust the crane's approach precisely, preventing structural damage.

Digitalizing Environmental Control: Emissions Reduction Target

Drastic Environmental Impact

The comprehensive digitalization of operations is expected to reduce environmental pollution (SOx, CO2, NOx)

Eliminating Truck Wait Times

Integrating a smart Vehicle Booking System (VBS) with yard operations aims to prevent truck congestion at the gates, cutting diesel emissions.

Optimizing Equipment Routes

Preemptively adjusting the moving routes of autonomous vehicles will maintain a steady flow and reduce energy consumption from frequent braking.

Yard Operations for Maximum Efficiency & Logistics Flow

Stabilizing Operations in Extreme Weather

Utilizing software algorithms to counteract the swinging of crane spreaders caused by high winds, allowing safe operations during storms.

Efficient Yard Management

Automatically reorganizing containers during off-peak hours to ensure maximum handling efficiency without requiring extra energy during busy times.

Reducing Vessel Idling

By maintaining operational consistency even in heavy fog, the system aims to minimize the time ships spend waiting at anchorage.

Free-Flow Smart Gate

Implementing advanced OCR and AI vision systems to process trucks at the gate without requiring them to come to a complete stop.

Streamlining Logistics Data

Implementing paperless document processing and integrated data systems to speed up administrative work and improve visibility for cargo owners.

Real-time Tracking

Tracking the exact location of cargo from the moment it is unloaded at the seaside until it passes through the yard and gate.

Expected OPEX Reduction & Building an Open Digital Ecosystem

Slashing Operating Costs

The transition to an automated, AI-driven port is expected to reduce overall operating costs by stabilization.

Optimizing Maintenance & Fuel

Through predictive digital health monitoring and efficient autonomous routing, we project a 20% reduction in maintenance costs and a 25% savings in fuel.

Consistent Uptime

By predicting issues before they occur, the digitalized maintenance system will maximize the lifespan and uptime of expensive port infrastructure.

Securing Independent Operating Technologies

Utilizing locally developed, open-architecture systems to ensure the port retains ownership of its data and can modify systems independently.

Fostering Software Integration

Publishing standardized APIs so that innovative software developers can easily add new digital functions to the port system.

Ensuring Equipment Compatibility

Establishing robust communication protocols so that automated equipment from different manufacturers can work together seamlessly.

04
2030 Global Roadmap & YG-Port Vision

Enhancing Local Industry through Tech Localization

Localized Maintenance Support

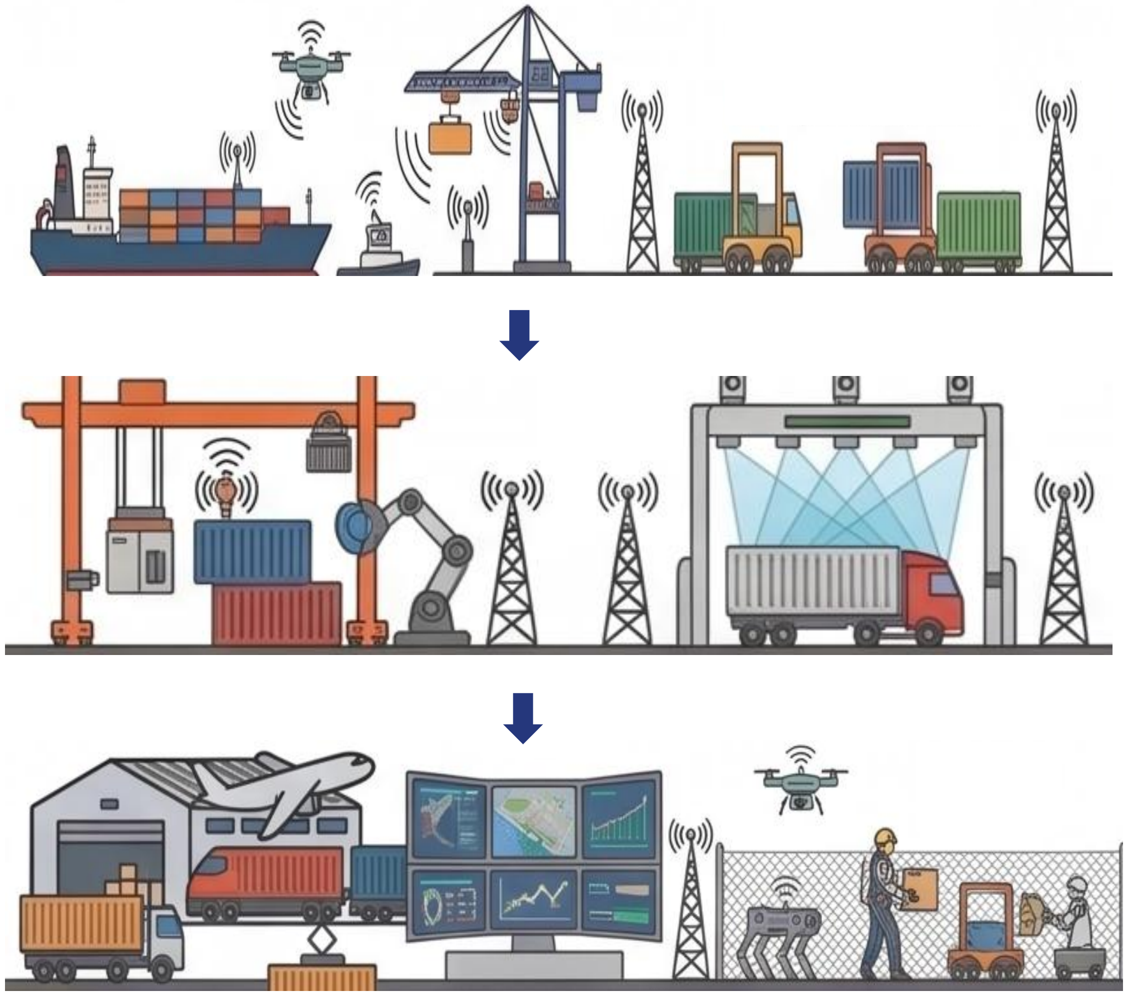
Shifting to a domestic digital maintenance network will ensure faster response times to equipment issues, supporting the 2029 operational goals.

Boosting the Regional Economy

Procuring port equipment and software from domestic suppliers aims to revitalize the local manufacturing and AI technology sectors.

Creating High-Tech Jobs

The digitalization of the port directly contributes to creating steady, high-quality jobs for data analysts and automated equipment technicians.



Establishing the Physical AI Port R&D Hub & Leading Standards

A Dedicated Validation Center

Assigning a large zone behind the automated terminal specifically to test and prove the reliability of new digital port systems under real conditions.

Testing Future Innovations

Building infrastructure to test the durability and performance of upgraded AI algorithms before they are deployed commercially.

Fostering Academic Partnerships

Functioning as a central hub where international universities and robotics labs can collaborate on future maritime technologies.

Establishing Physical AI Guidelines

Creating clear and practical testing guidelines specifically for automated heavy machinery and AI sensors in maritime environments.

Contributing to Global Standards

Proposing our successful digital communication methods and autonomous protocols as new international standards for the global port industry.

Exporting the Model

Packaging the validated K-Smart Port solution to export not just cargo, but the digital infrastructure model to ports worldwide.

Master Plan to 2029 Complete Digitalization

Phase 1: 2026

Infrastructure Deployment

Completing the core civil engineering work and deploying the first fleet of automated equipment alongside foundational cloud systems.

Phase 2: 2027

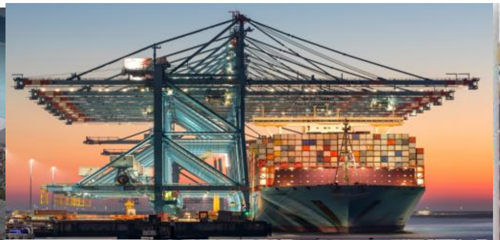
Testing & Optimization

Conducting extensive stress tests on the communication network and refining cargo handling systems using digital twin simulations.

Phase 3: 2028-2029

Full Commercial Operation

Completing unmanned test runs to officially launch the fully digitalized, AI-driven terminal to the global market.



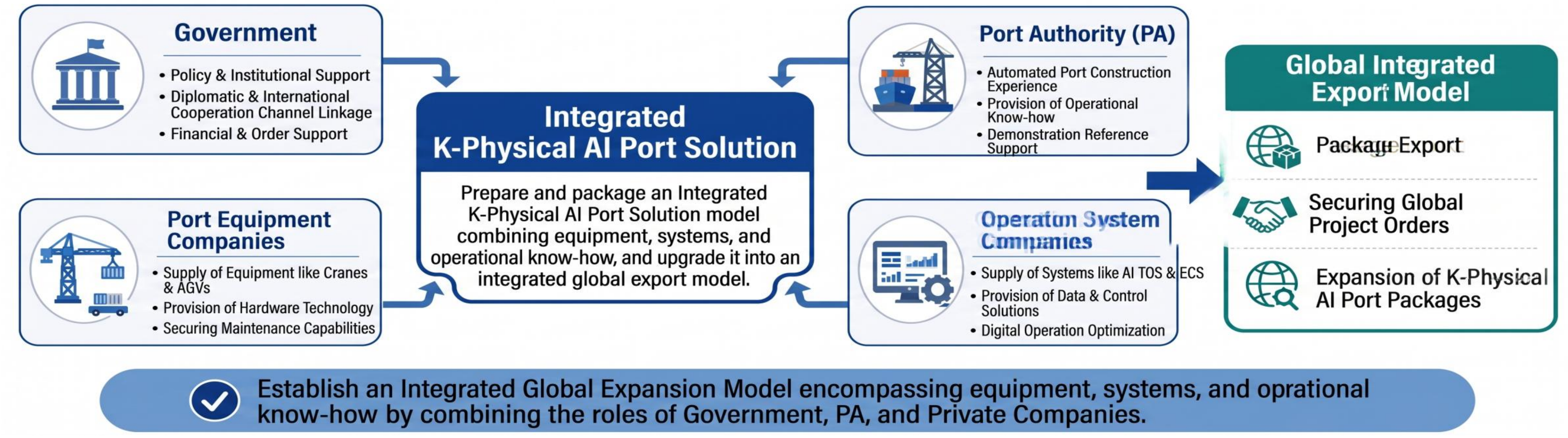
Our Vision: Exporting the Physical AI YG-Port Solution

Providing a Complete Package

YGPA aims to transition into a technology provider, offering a proven package of automated equipment, operating software, and digital maintenance expertise.

A Sustainable Digital Legacy

By directly addressing operational efficiency and automation, YGPA will lead the transformation of digital smart ports beyond 2029.



Thank You

Sustainable Physical Ai Port, Start from Yeosu Gwangyang Port

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