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AutoMoTIF

LOGISTICS SOLUTIONS SYNERGIES

AutoMoTIF

HORIZON EUROPE

Automated Port Operations: simulation-driven automation assessment

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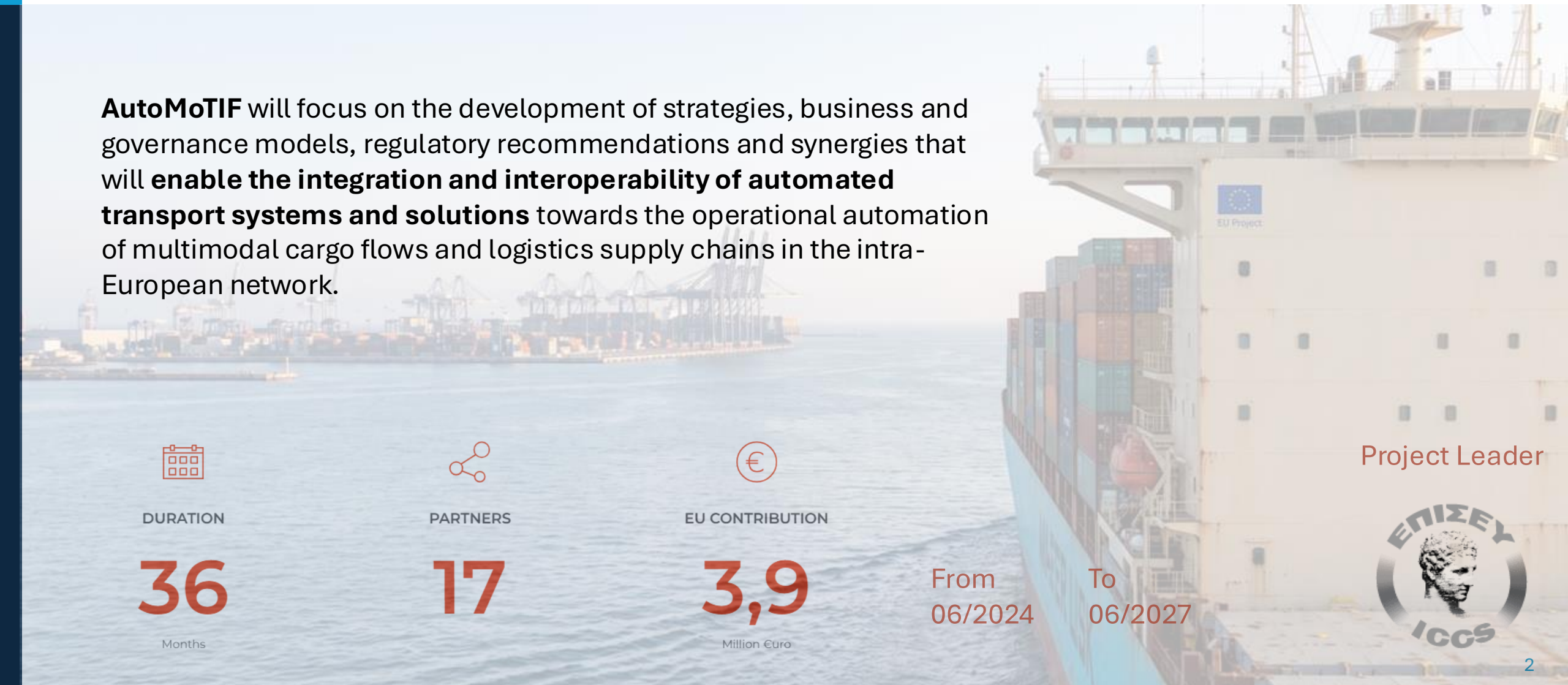
Project Overview

AutoMoTIF will focus on the development of strategies, business and governance models, regulatory recommendations and synergies that will **enable the integration and interoperability of automated transport systems and solutions** towards the operational automation of multimodal cargo flows and logistics supply chains in the intra-European network.



DURATION

36

Months

PARTNERS

17

EU CONTRIBUTION

3,9

Million €uro

From 06/2024

To 06/2027

Project Leader

Agenda



01 The Use Case

- UC2 – Port Operations
- Operational Challenges



02 Automation Solutions

- Automation Solutions
- Technological Developments



03 Web Interface

- Web Interface
- User Experience Demo



04 Towards Deployment

- Deployment Roadmap
- Transferability
- Value Proposition



Open Discussion

Your experience and questions

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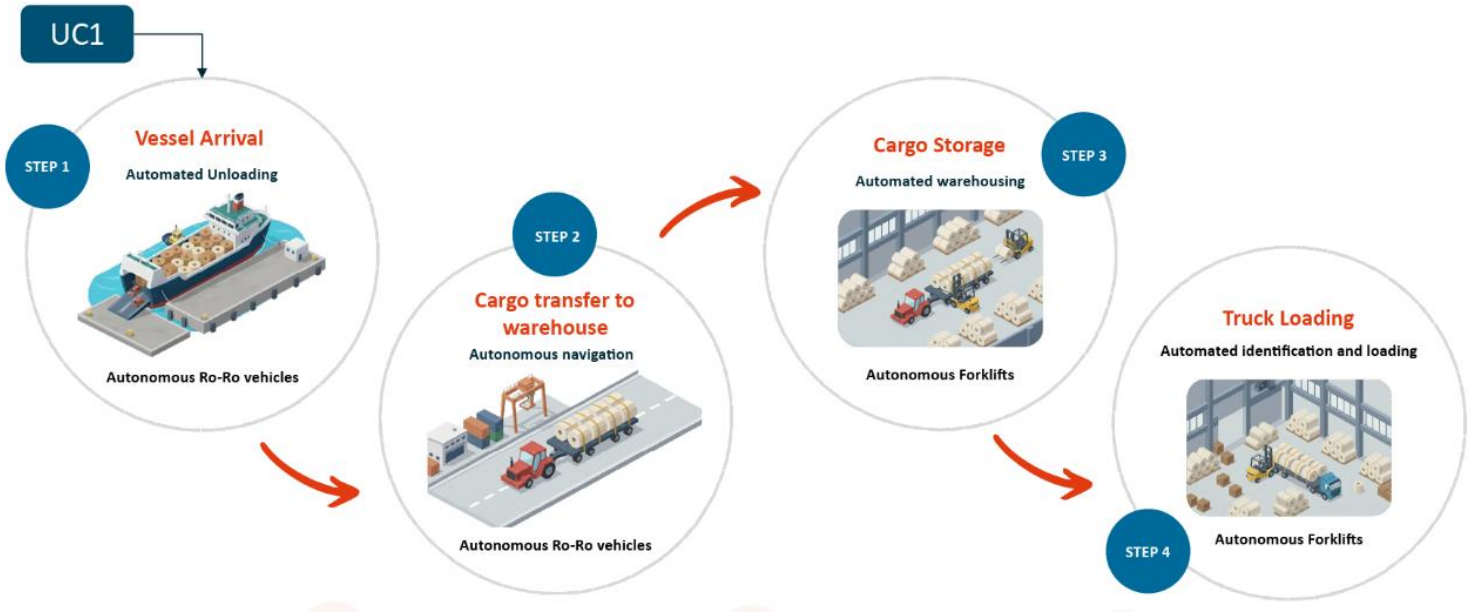
UC2 - Port Operations

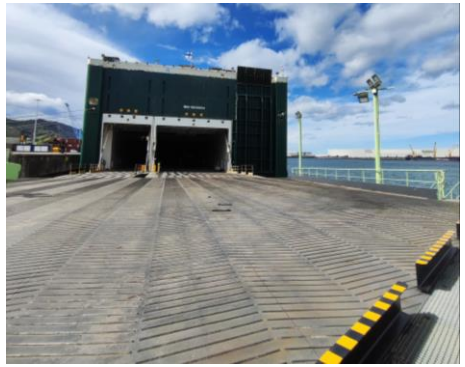
Overview: from vessel to truck



Toro y Betolaza: Paper-Reel Ro-Ro Operation



Vessel Unloading



Autonomous Ro-Ro Trucks



Warehouse Automation



Operational Challenges

Bottlenecks at the maritime–hinterland interface



VESSEL



TRANSFER



WAREHOUSE



TRUCK

Multimodal Desynchronization

Poor coordination between vessel operations, warehousing, and truck dispatches

Congestion and resource downtime

Manual Inefficiencies

Over-reliance on manual cargo handling, identification, and inspections

Idle times, human errors, poor space use

Reactive Planning

Fragmented data and no real-time visibility

No dynamic allocation, slotting or forecasting

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Automation Solutions

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From autonomous vehicles to an orchestrated terminal



VESSEL UNLOADING



CARGO TRANSFER



WAREHOUSING



TRUCK LOADING

AUTONOMOUS VEHICLES

Autonomous Forklifts
Autonomous navigation and cargo handling inside the warehouse

Autonomous MAFI Trucks
Self-driving Ro-Ro shuttling cargo from the vessel to the warehouse

SMART OPERATIONS

Shunting Operations
Cargo identification, inspection and handling via AI embedded cameras

Truck Gate Documentation
OCR-based automatic capture of truck documents at the gate

Smart Warehouse Automation
Pre-staging, dynamic slotting, and synchronized storage

ORCHESTRATION

WMS & TOS Synchronization
Automatic real-time data sync

24/7 Warehousing
Round-the-clock storage operations

Resilient Fleet Management
Robust to starvation and incidents

Seamless Shift Handover
Dynamic handover with no workflow interruptions

IMPACT

Reduced Operational Variability
More stable and predictable operations

Lower Incident Occurrence & Severity
Fewer disruptions and smaller impact when they happen

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Technological Developments



Discrete Event Simulation Engine

Tailored SimPy-based engine for Dynamic resource & operation management



Advanced Digital Twin

Digital replica to evaluate alternative scenarios, internal capacities, & automation



Uncertainty & Incident Management

Integrated modelling of unpredictable events for operational resilience



Modular Web-Based Dashboad

Scalable and modular interface providing interpretability to simulation outcomes

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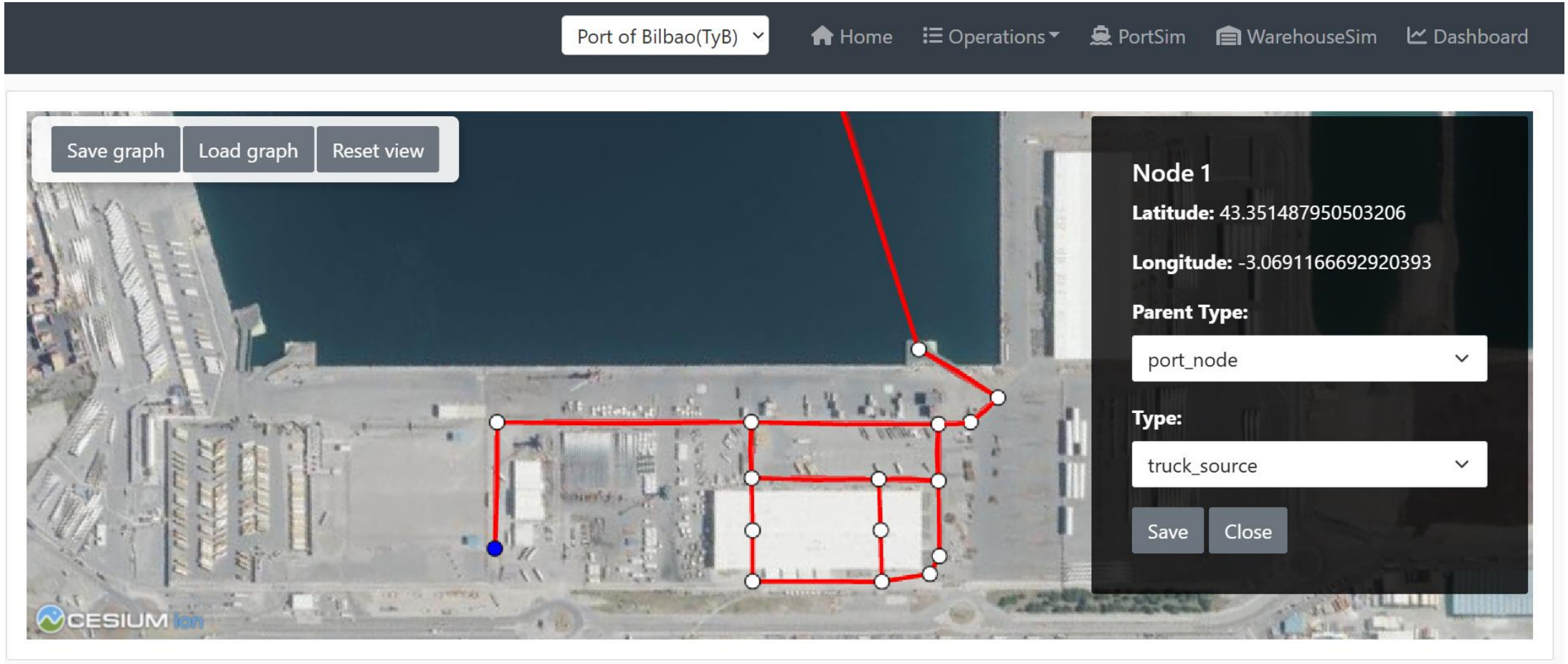
Web Interface

1 Build | 2 Configure | 3 Simulate | 4 Decide

Port Network Creation:



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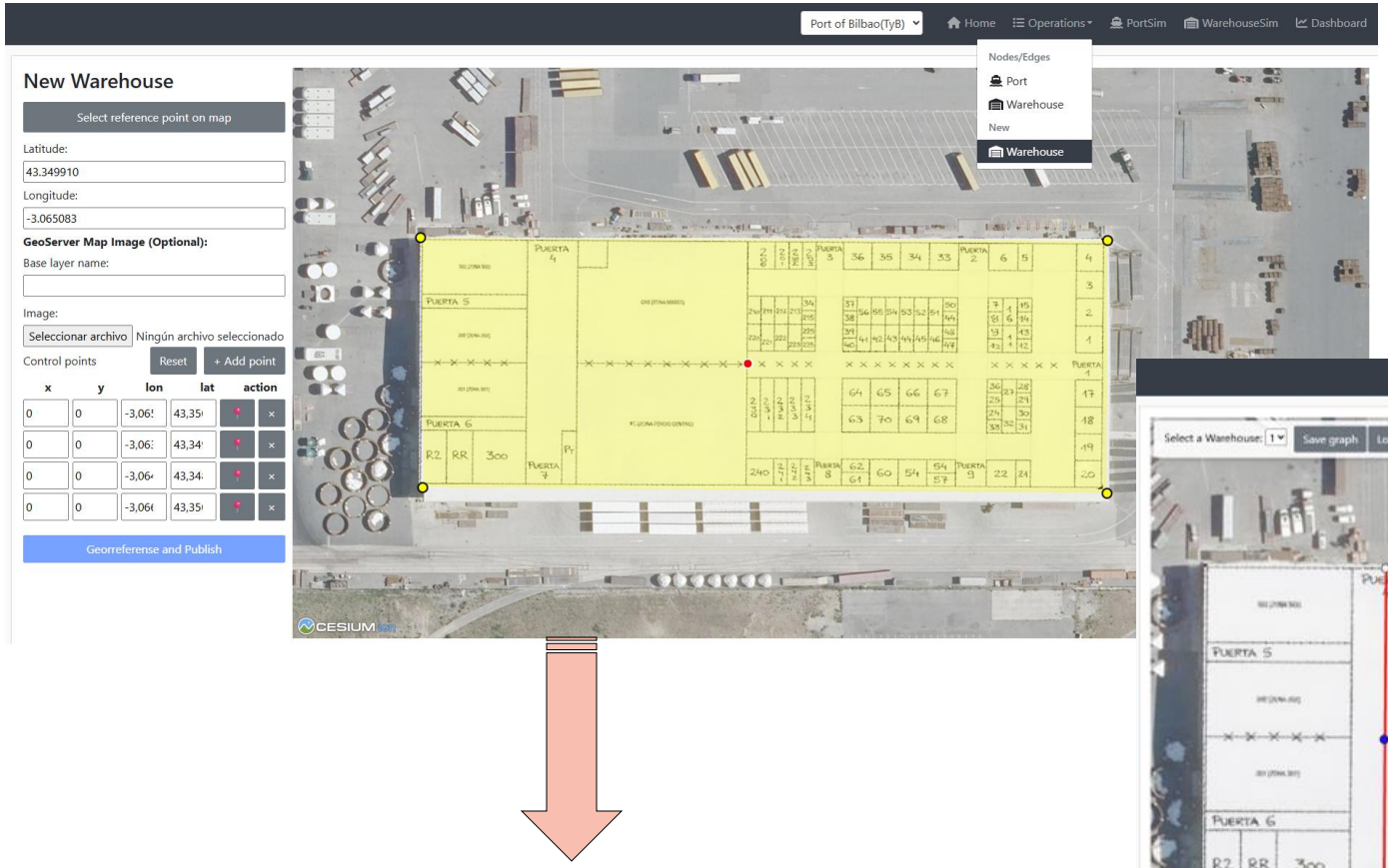
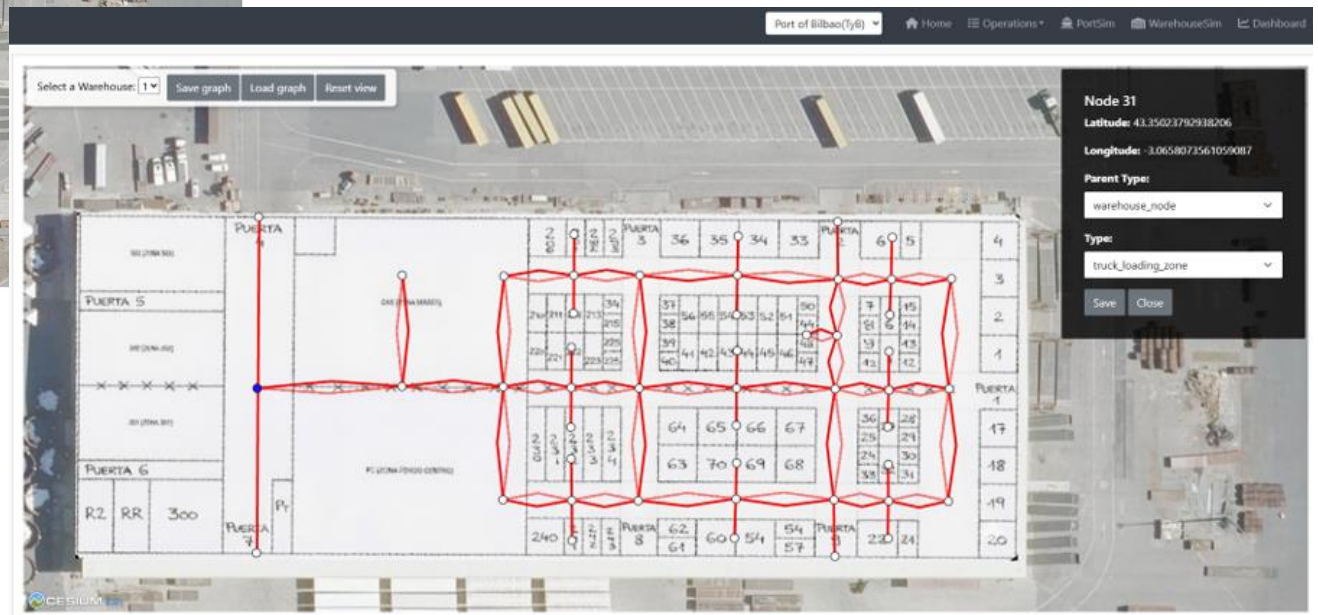
Warehouse Creation:



Warehouse Creation and Georeferencing

Warehouse Network Configuration



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Web Interface

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SCENARIO PARAMETERS

General Configuration

Name *	Simulation name							
Description *	Simulation description							
Duration *	1	d	0	h	0	m	0	s
Incidence Threshold *	0.15							

OPERATIONS CONFIGURATION

Operations Variables + Add Operation

Operation #1

Select Operation

cargo_inspection

Probability Distribution

triangular

For expert estimation or on-site measurement

Mean	
Std Dev	
Mode *	5
Min Value *	3
Max Value *	60

Truck Variables

Truck Interarrival Time *	0	d	0	h	1	m	0	s
Truck Std Dev Interarrival Time *	0.3							

Automated Electrified

Vessel Variables

Vessel AVG Cargo Units *	1500							
Vessel Interarrival Time *	7	d	0	h	0	m	0	s
Vessel Std Dev Interarrival Time *	0.05							
Vessel Std Dev Cargo Units *	200							

Automated Electrified

Mafi Variables

Mafi Fleet *	

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Forklift Variables

Forklift Fleet *	

Automated Electrified

EXTERNAL ENTITIES

INTERNAL WORKFORCE

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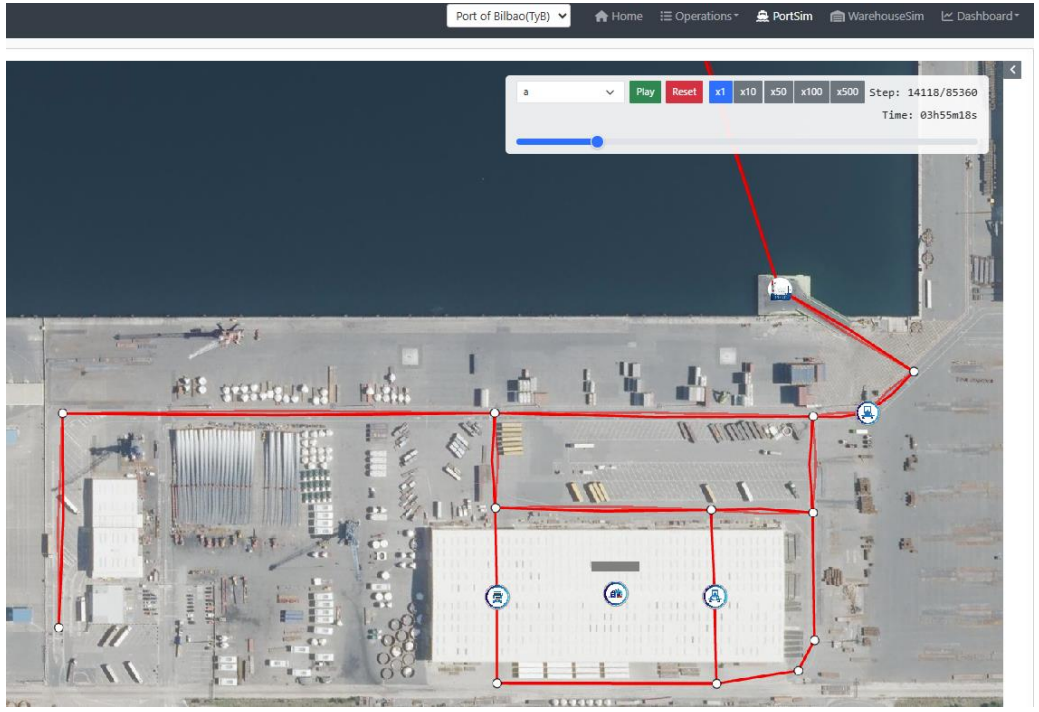
Web Interface

1 Build | 2 Configure | **3 Simulate** | 4 Decide

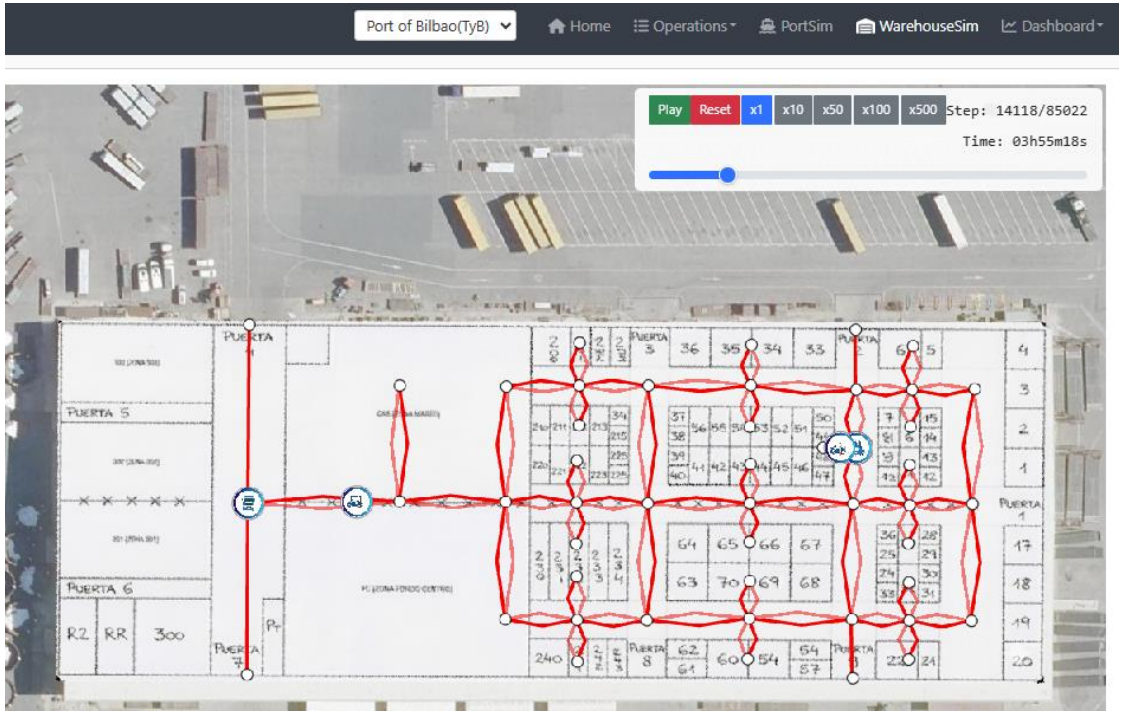
Port Level Animation Visualizer:

- Macroscopic Focus: Global view of logistics and external traffic flows.
- Real-Time Monitoring: Tracking of vessel operations, truck arrivals, and queue accumulations across the primary network.
- Performance Analysis: Identification of systemic bottlenecks and evaluation of overall terminal throughput.



Warehouse Level Animation Visualizer:

- Microscopic Focus: Detailed view of internal storage dynamics.
- Real-Time Monitoring: Tracking of the precise routing of internal handling equipment and the dynamic allocation of cargo across specific storage zones.
- Performance Analysis: Evaluates localized congestion, shared space utilization saturation, and the operational efficiency of the handling fleet.



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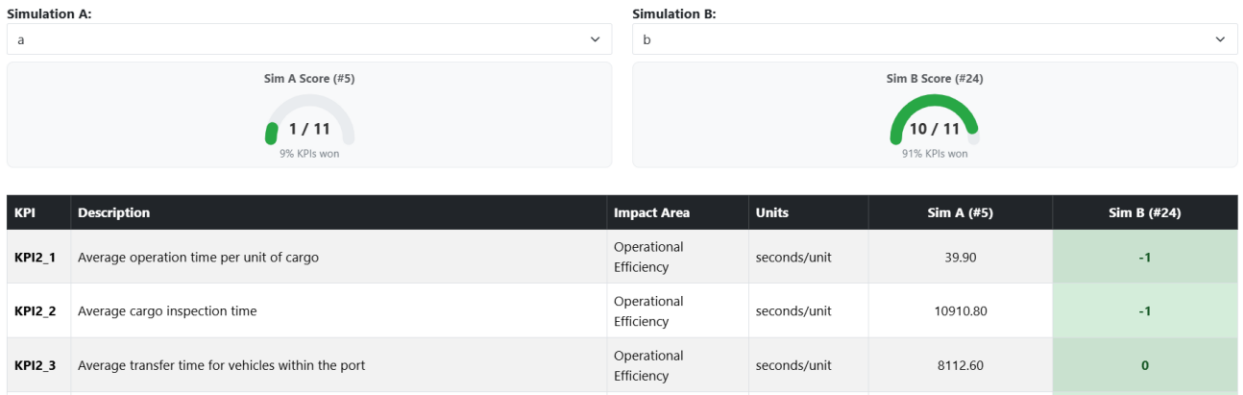
Web Interface

1 Build | 2 Configure | 3 Simulate | **4 Decide**

Single Scenario KPI Summary:

KPI	Description	Impact Area	Value	Units
KPI2_1	Average operation time per unit of cargo	Operational Efficiency	39.904564315352694	seconds/unit
KPI2_2	Average cargo inspection time	Operational Efficiency	10910.8	seconds/unit
KPI2_2	Number of forklifts	Operational Efficiency	5.0	units
KPI2_3	Average transfer time for vehicles within the port	Operational Efficiency	8112.6	seconds/unit
KPI2_4	Average time from the beginning of operations until all the reels are inside the warehouse	Vessel to Warehouse	54303.0	seconds
KPI2_6	Average wait time for entities	Operational Efficiency	4.019441314960857	seconds
KPI2_7	Average number of loaded and unloaded cargo	Operational Efficiency	339.0	units
KPI2_8	Average utilisation rate of resources	Operational Efficiency	13713.981481481482	percentage
KPI2_9	Average response time of resources	Operational Efficiency	15460.111111111111	milliseconds
KPI2_10	time the berth was occupied by a vessel within the simulation	Operational Efficiency	589.35	percentage
KPI2_12	CO2 emission per time unit in this simulation	Environmental Impact	269.5297024516424	percentage
KPI2_13	Energy consumption per time unit in this simulation	Environmental Impact	1023.0288854159818	KwH per time unit

Scenario KPI Comparison:



KPI	Description	Impact Area	Units	Sim A (#5)	Sim B (#24)
KPI2_1	Average operation time per unit of cargo	Operational Efficiency	seconds/unit	39.90	-1
KPI2_2	Average cargo inspection time	Operational Efficiency	seconds/unit	10910.80	-1
KPI2_3	Average transfer time for vehicles within the port	Operational Efficiency	seconds/unit	8112.60	0

Scenario KPI Interactive Dashboard:



Decisions supported

Workforce & shift planning · Terminal capacity under stress · Operational synchronisation · Automation impact

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Web Interface

User Experience Demo:

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Deployment Roadmap

From digital twin to automated terminal

WE ARE HERE · TRL 3–5

1 Digital Twin Baseline	2 Hybrid Pilot Testbeds	3 Scaled Automation	4 Orchestrated Terminal
Test automation 'what-if' scenarios against the current baseline performance	Autonomous forklifts in one warehouse zone alongside manual crews	Autonomous MAFIs on dedicated quay–warehouse lanes	24/7 shift orchestration across vessel, warehouse and gate

DECISION MILESTONES

- Identify which automation brings the most benefit
- Validate pilot KPIs and coexistence, and plan the implementation roadmap
- Confirm system-wide gains before scaling to 24/7 orchestration

KEY BARRIERS TO ADDRESS

Technical

- Integration with TOS, WMS and fleet managers
- Positioning and connectivity on quay and warehouse

Operational

- Mixed manual–autonomous traffic on ramp and yard
- Exception handling: damaged reels, incidents

Organisational

- Stevedoring labour agreements and reskilling
- CAPEX justification and port-community buy-in

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Transferability

One configurable twin, many logistics nodes



WHAT IS REUSABLE

Georeferenced network editor
Any port or terminal layout, drawn from a map

Parametric fleets & operations
MAFIs, forklifts, vessels, and trucks with configurable times and distributions

Scenario & KPI library
Comparable results across sites and automation levels

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Value Proposition

What the digital twin delivers to each stakeholder

Port Authorities

Berth and hinterland capacity planning

Evidence base for automation investment

Terminal Operators & Intralogistics

Crew, shift, and fleet sizing

Strategy and stress testing

Night pre-staging and 24/7 operation

Technology Providers

Virtual commissioning in the client's layout

Quantified impact of your solution without compromising real performance

Logistics Service Providers

Truck turnaround and gate-queue analysis

Reliable pick-up slot planning

From data to decisions: de-risk port automation with simulation-driven evidence

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Open Discussion

Share your experience



OPERATIONAL CHALLENGES

where is your critical bottleneck?

Vessel, yard, warehouse or gate



INTEGRATION & INTEROPERABILITY

Which systems must share data first?

TOS, WMS, or fleet



DEPLOYMENT BARRIERS

What slows automation most?

CAPEX, mixed-traffic safety, labour agreements or data



TRANSFERABILITY

Which of your processes would you test first in a digital twin?

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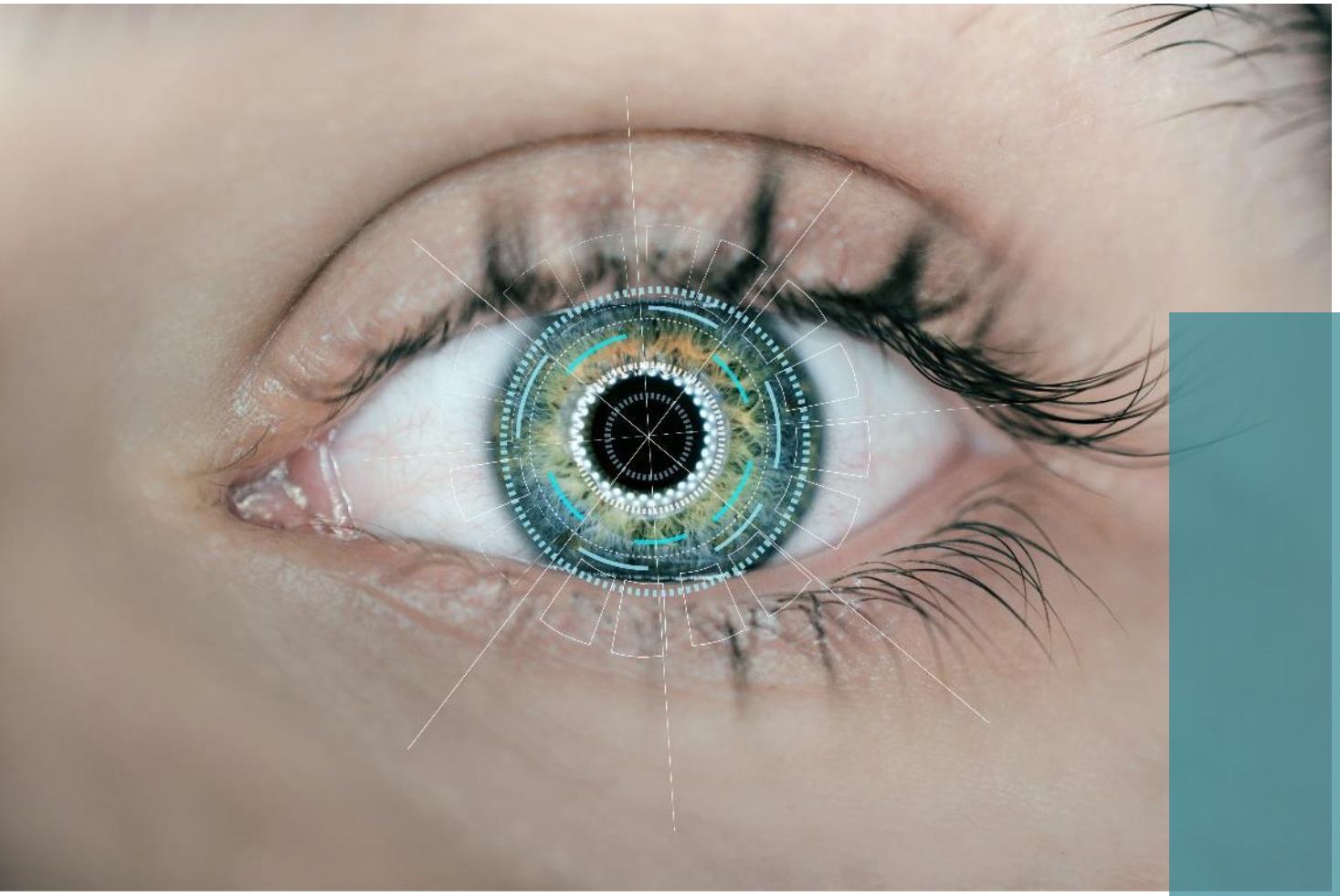

THANK YOU

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