MOSES

Pilot Demonstration

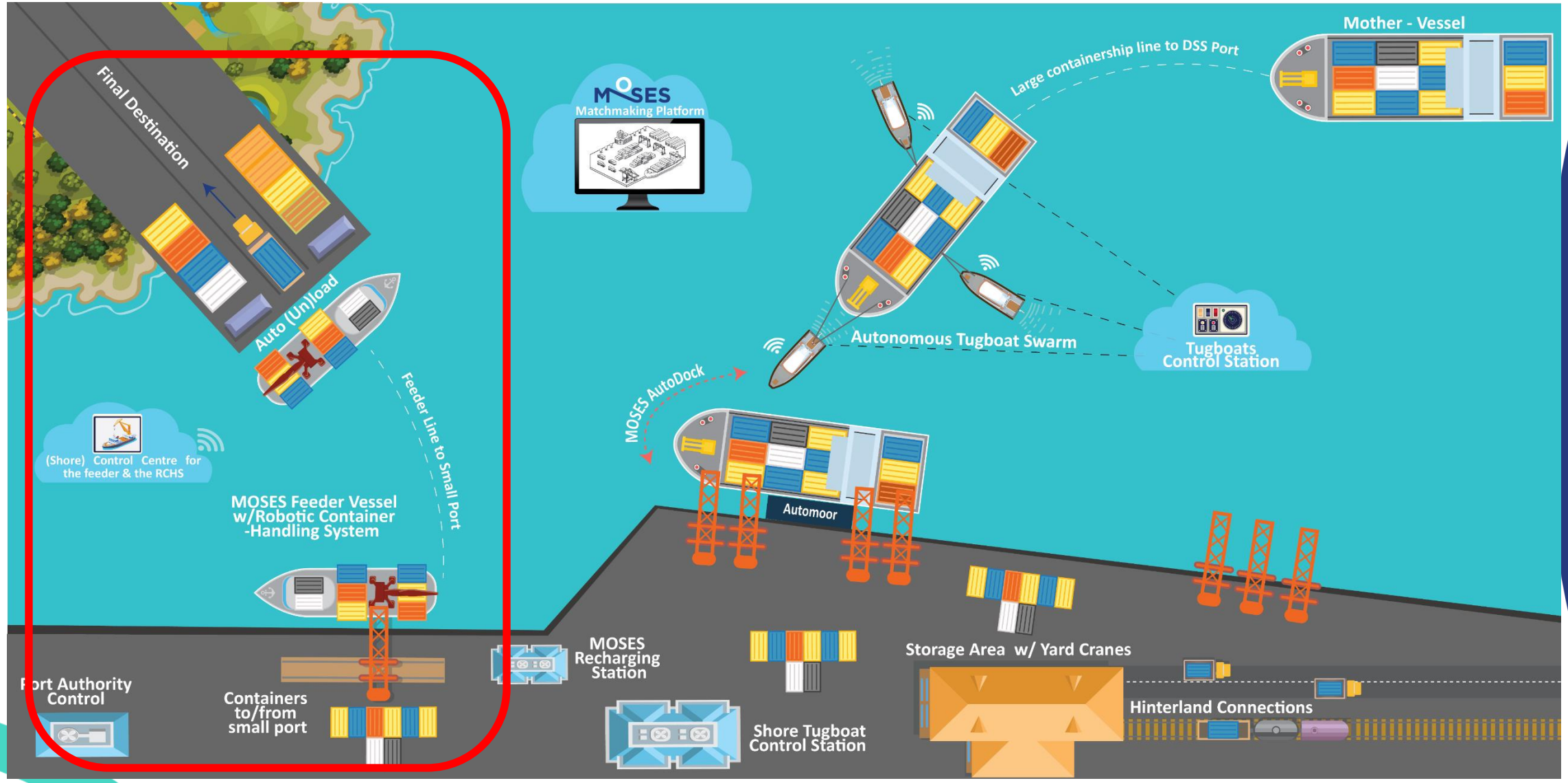
# Robotic Container Handling System

TNO innovation for life

Hans van den Broek

Frank ter Haar

28-09-2023, Soesterberg, The Netherlands and Örnsköldsvik, Sweden


Final Destination
Auto (Un)load
Feeder Line to Small Port
(Shore) Control Centre for the feeder & the RCHS
MOSES Feeder Vessel w/Robotic Container -Handling System
MOSES Matchmaking Platform
Large containership line to DSS Port
Mother - Vessel
Autonomous Tugboat Swarm
Tugboats Control Station
MOSES AutoDock
Automoor
Storage Area w/ Yard Cranes
Hinterland Connections
MOSES Recharging Station
Shore Tugboat Control Station
Containers to/from small port
Port Authority Control



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# PILOTS

## Pilot 1: AutoDock

Still to be performed

Intelligent cooperation of **autonomous tugboat swarm** to **manoeuvre** a large floating vessel and **dock it** by collaborating with an **automated mooring system**.

## Pilot 2: Feeder

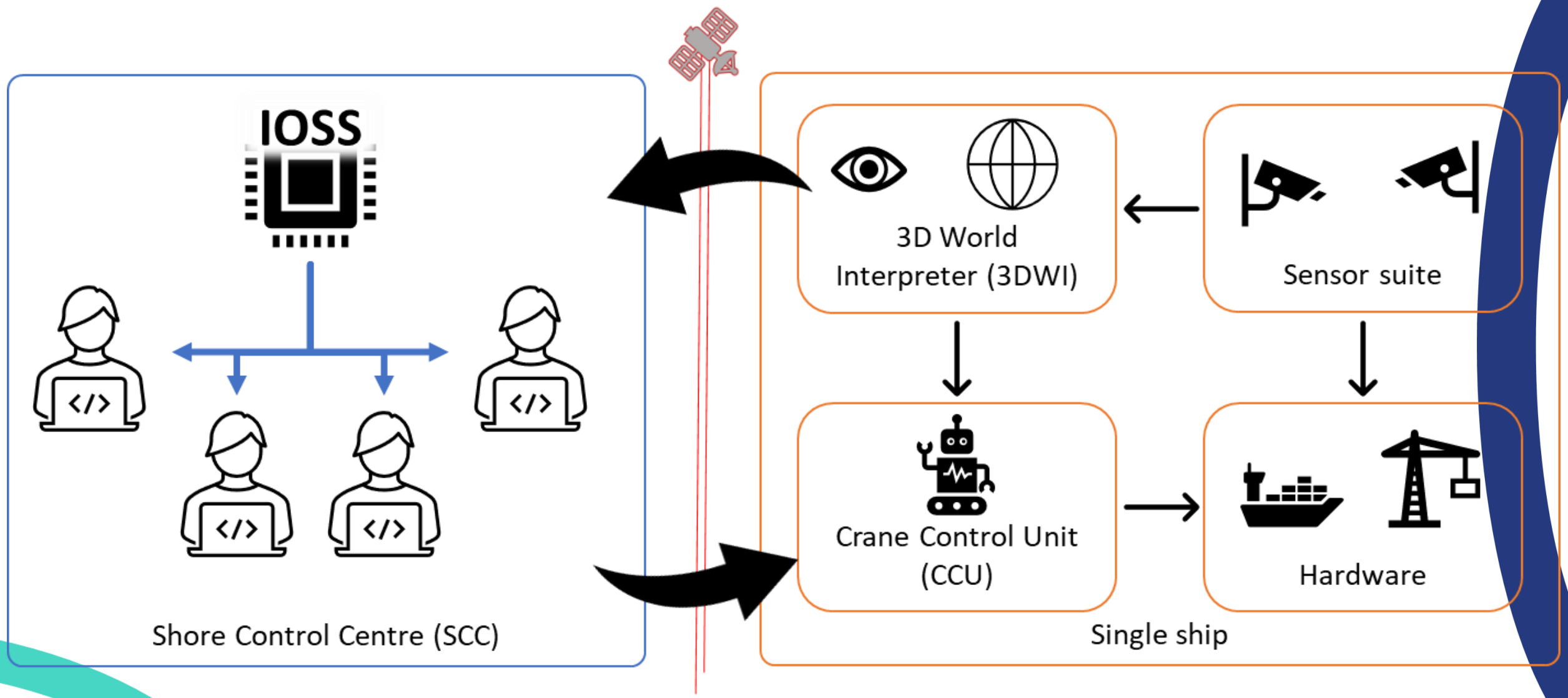
performed on September 14 at MARIN

**Seakeeping** and **energy** performance **capabilities**. Capability to be used for **automated mooring**.

## Pilot 3: Robotic CHS

**Autonomous container handling capability** and shared control between human operator and system.


Port of Rotterdam, NL
Port of Mykonos, Greece


IOSS
3D World Interpreter (3DWI)
Sensor suite
Crane Control Unit (CCU)
Hardware
Shore Control Centre (SCC)
Single ship

# Robotic Container Handling System
# Pilot Demonstration

# 3D world interpreter

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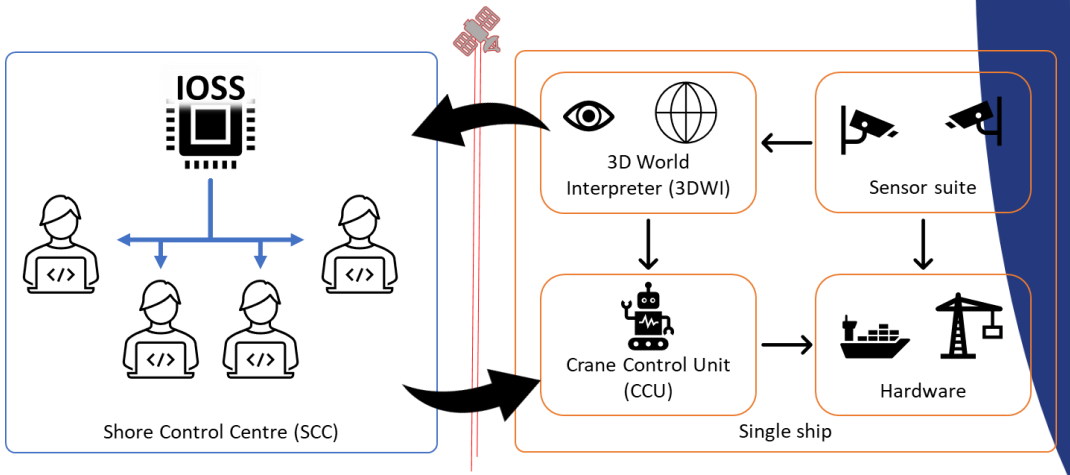
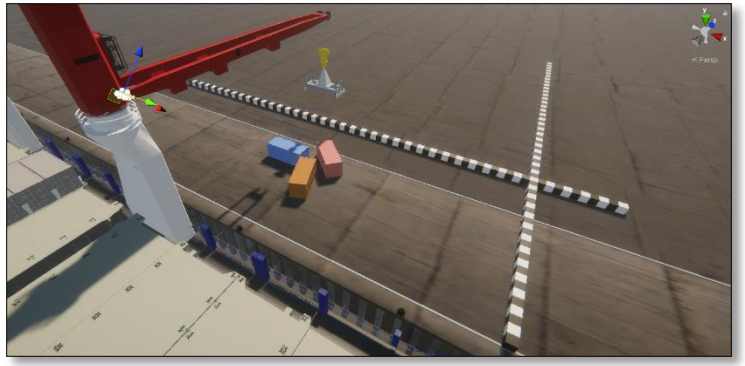
# How to saveguard the persons and objects from the crane and vice versa?
# How to locate the container in the order list?

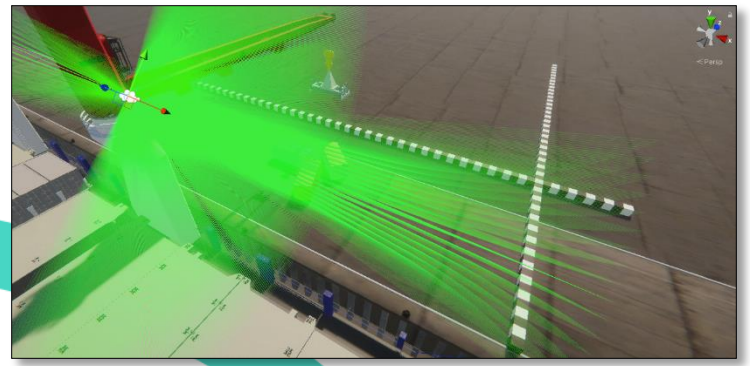
- 3D World Interpreter functionalities
  - F1 Sensor Suite Design
  - F2 Object recognition and 3D reconstruction algorithms
    - → initial 3D world to CCU
    - → initial 3D world to IOSS
  - F3 Safeguarding crane and humans
    - → live red-alert to CCU emergency stop
    - → live alerts and CCU info to IOSS

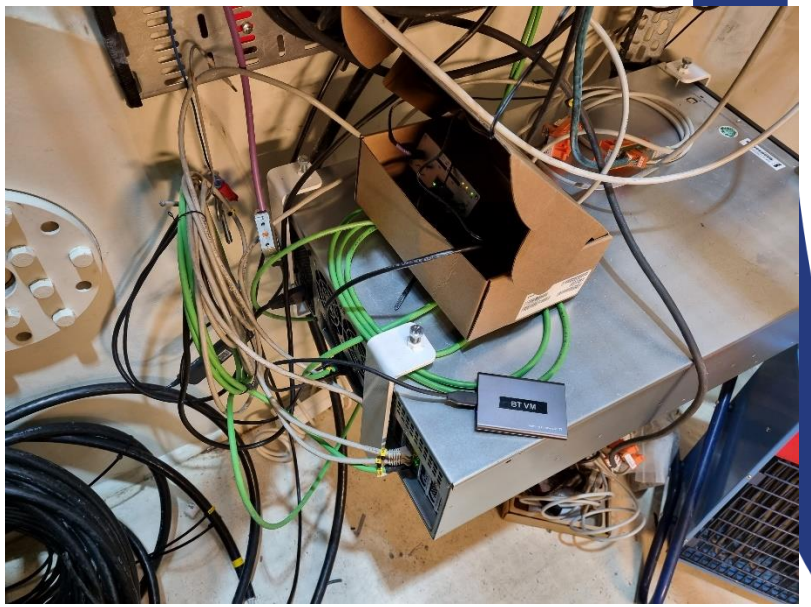


- **F1 Sensor Suite Design**

  A sensor suite and data acquisition pipeline

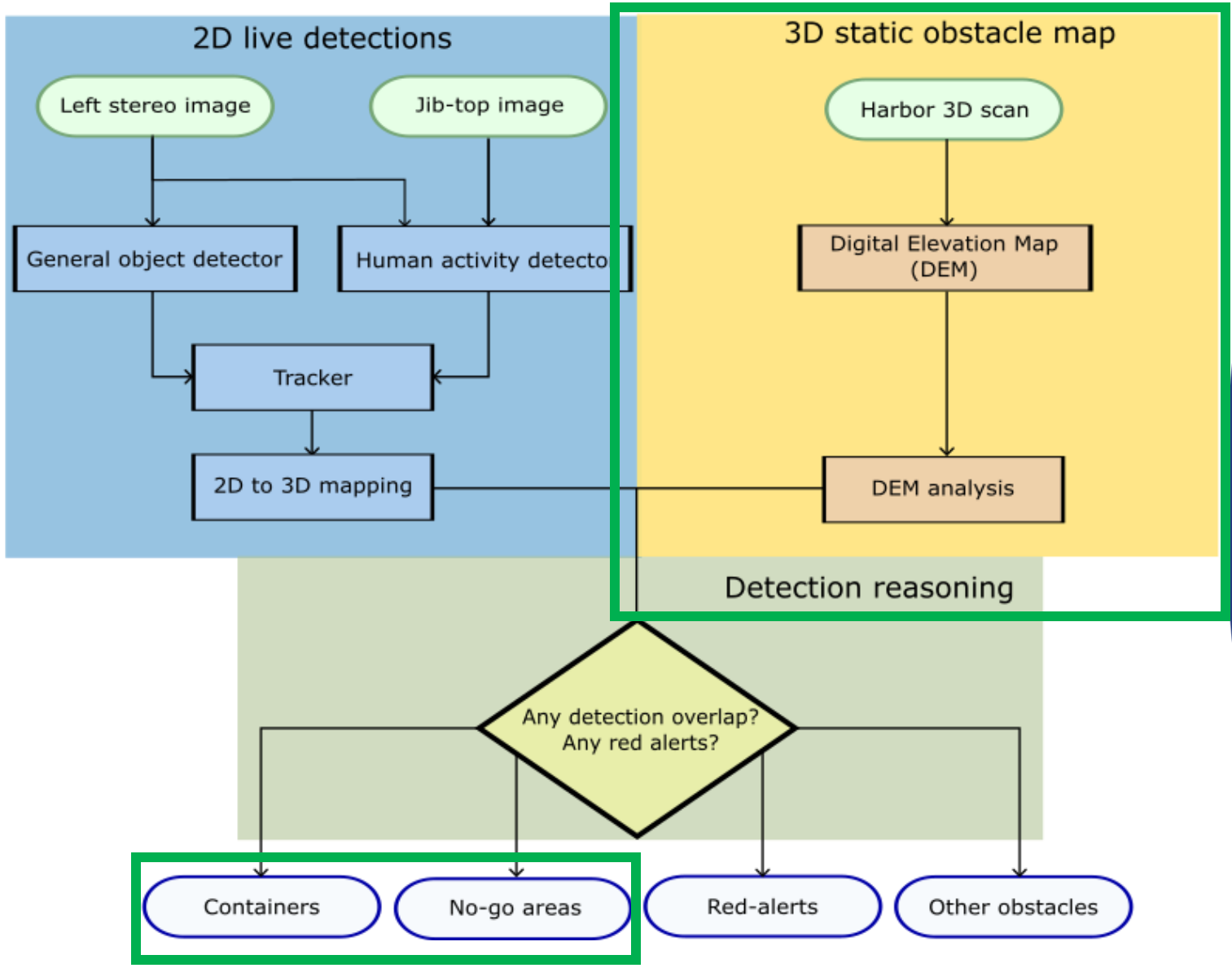




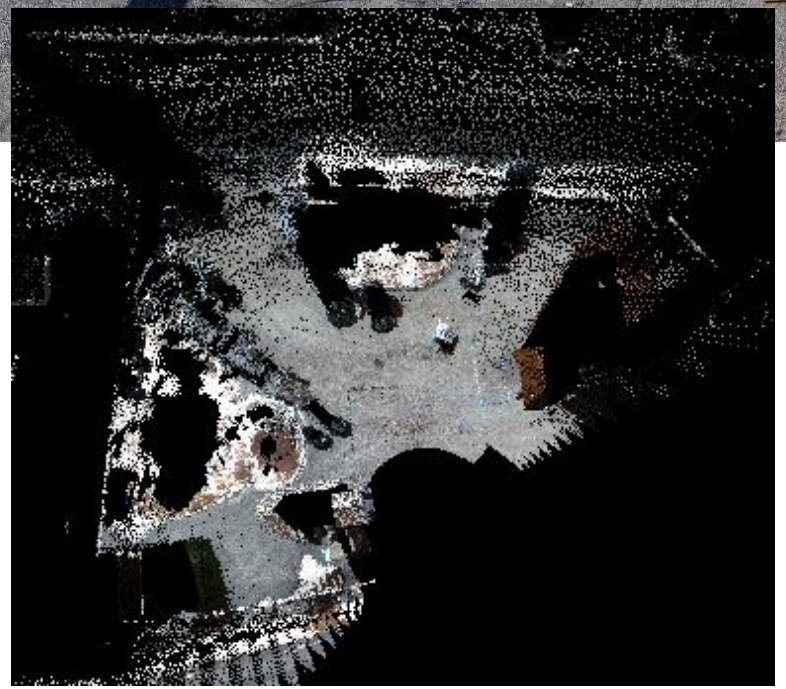



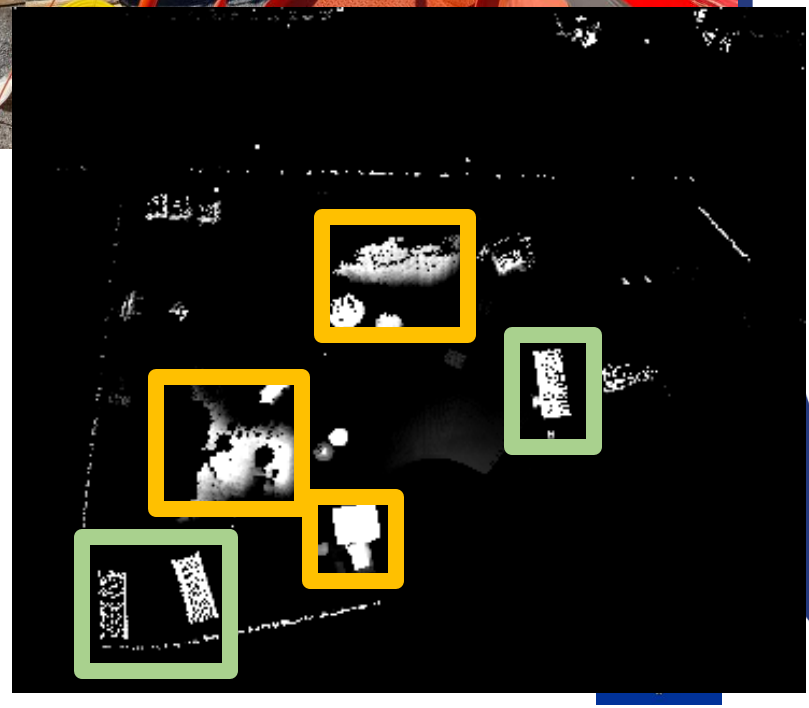
- **F2 Object recognition and 3D reconstruction algorithms**

  Image fusion of an existing 3d model, live stereo camera, live LIDARs, and live crane states to build a 3d reconstruction around the crane and object interpretation for remote SA

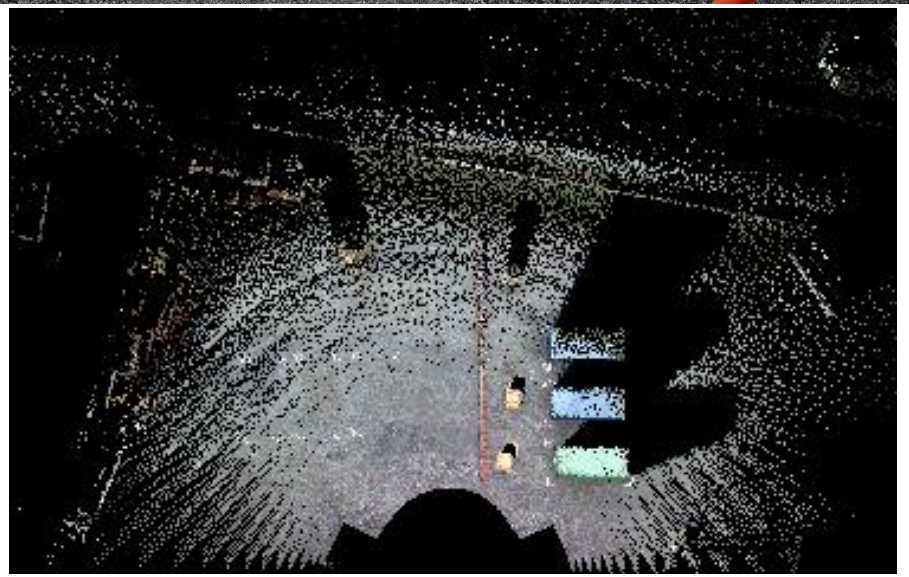


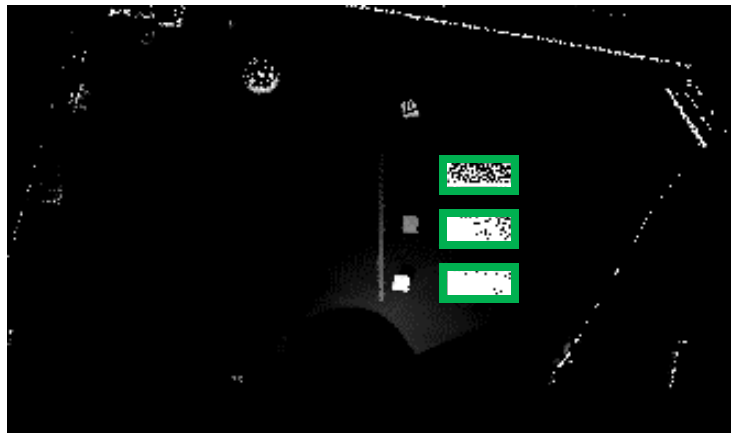

- **F2 Object recognition and 3D reconstruction algorithms** (April)

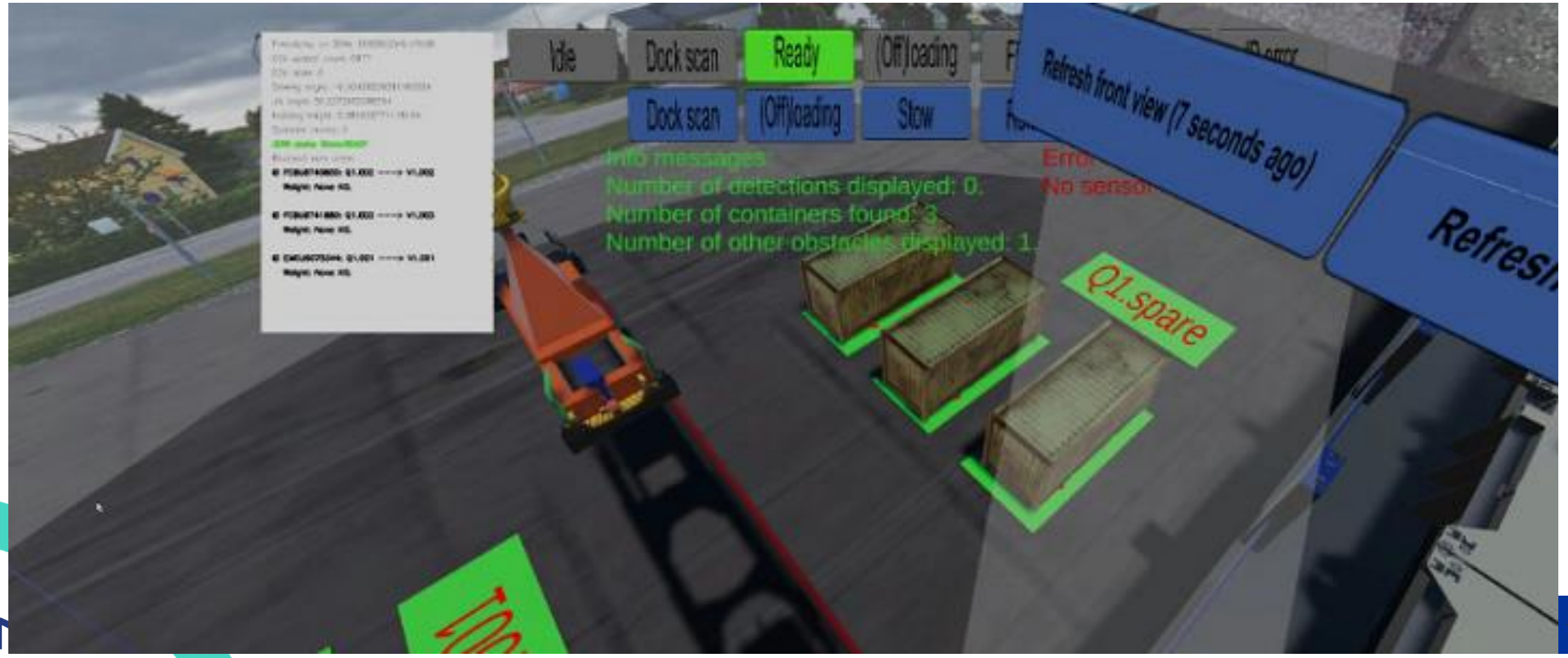




- **F2 Object recognition and 3D reconstruction algorithms**
- Yesterday footage

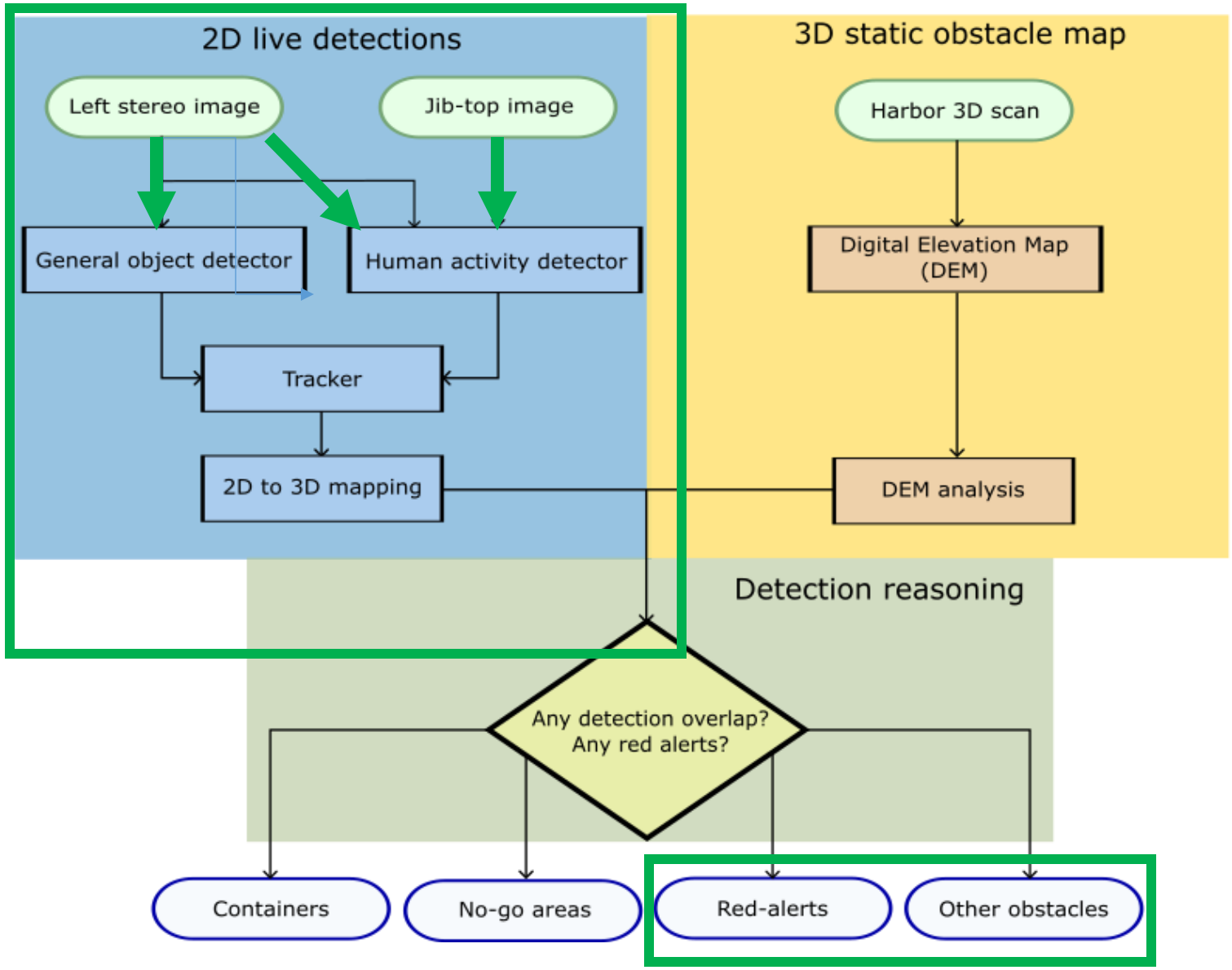



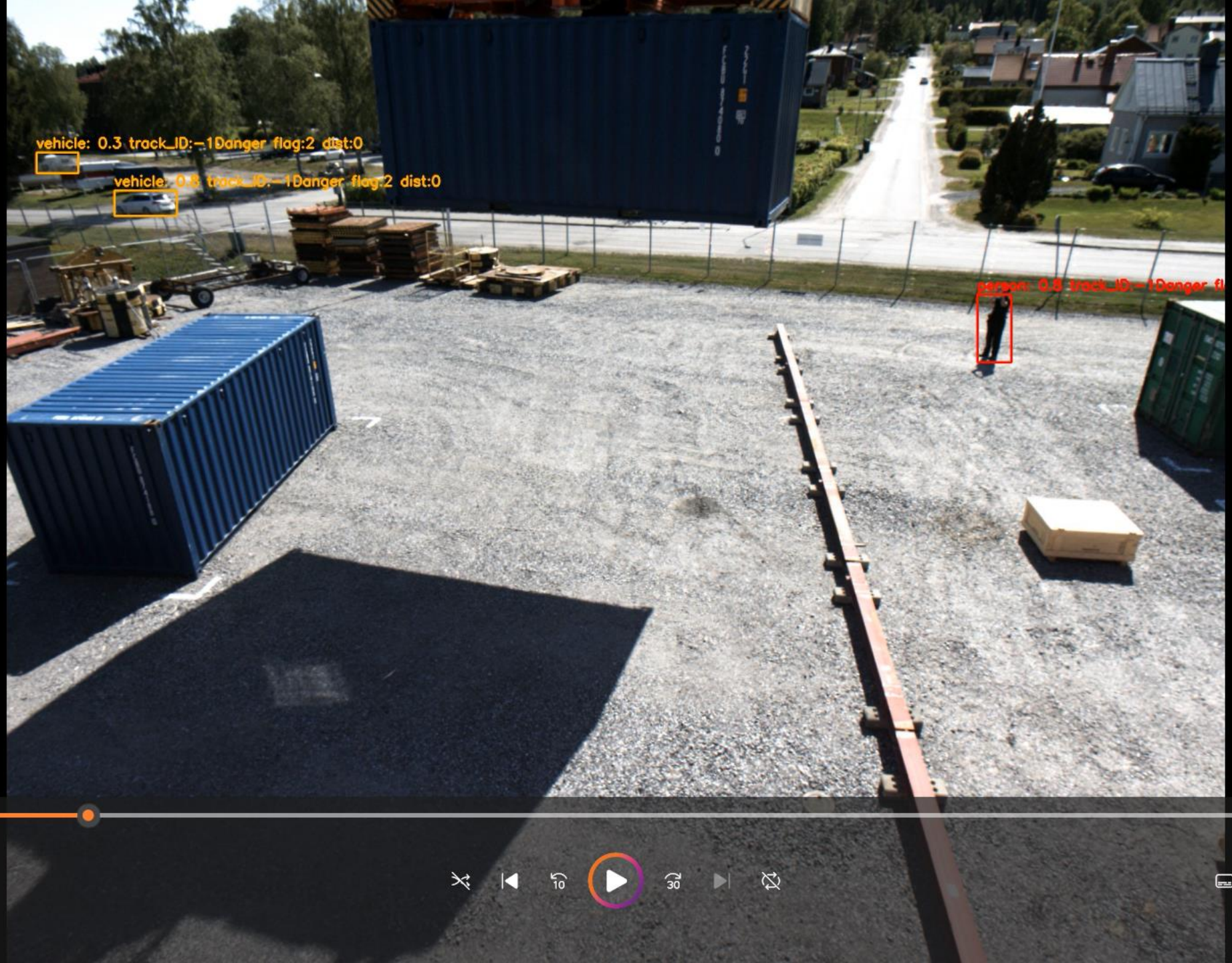



Idle
Dock scan
Ready
(Off)loading
Dock scan
(Off)loading
Stow
Info messages
Number of detections displayed: 0
Number of containers found: 3
Number of other obstacles displayed: 1
Refresh front view (7 seconds ago)
Q1.spare

- **F3 Safeguarding crane and humans**

  Construct static and dynamic and red-alert layers to safeguard the crane (obstacles to avoid) and human activity (e.g. persons, bicycles, cars) near the crane

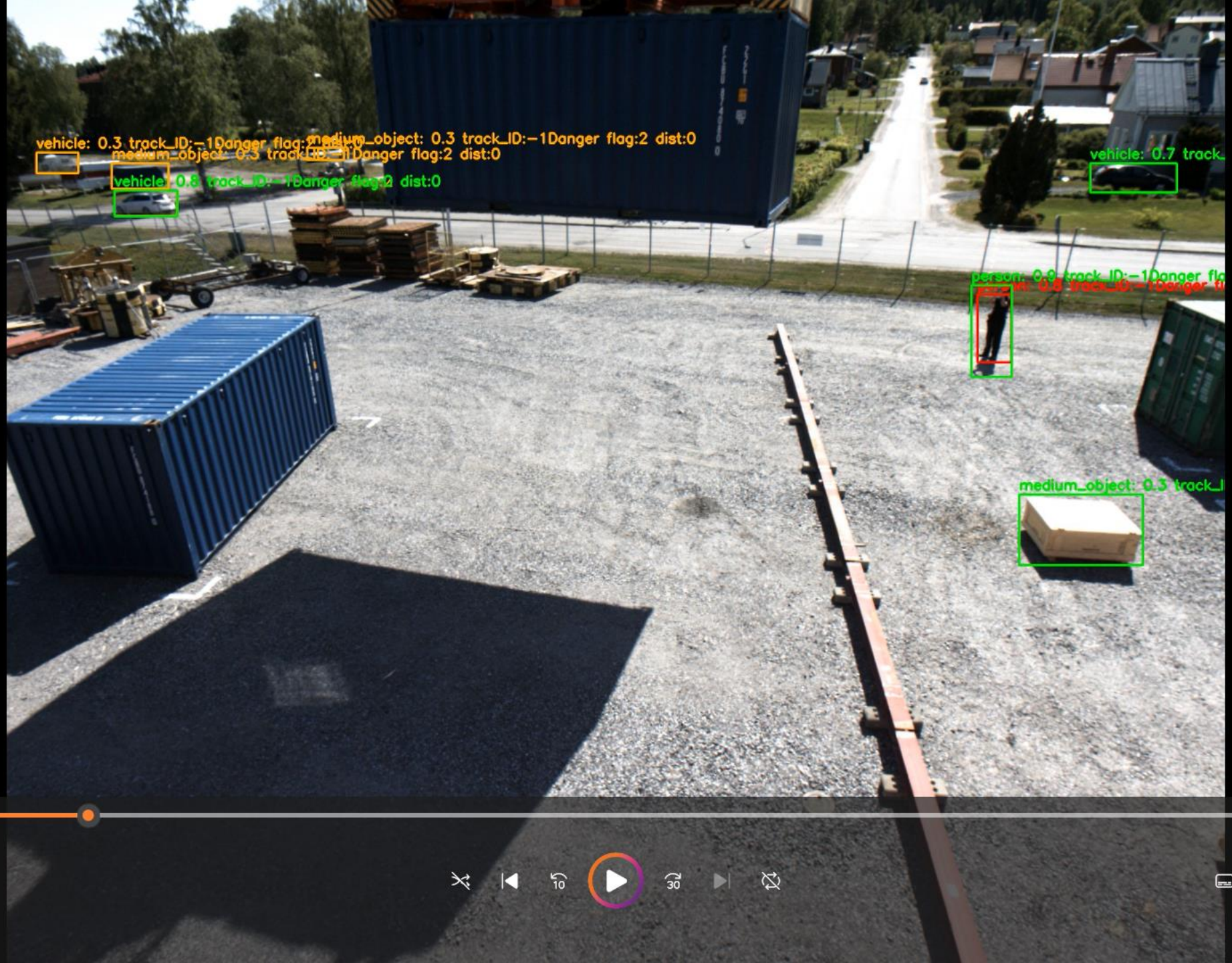





00:00:06

00:00:36

1530_000




00:00:06

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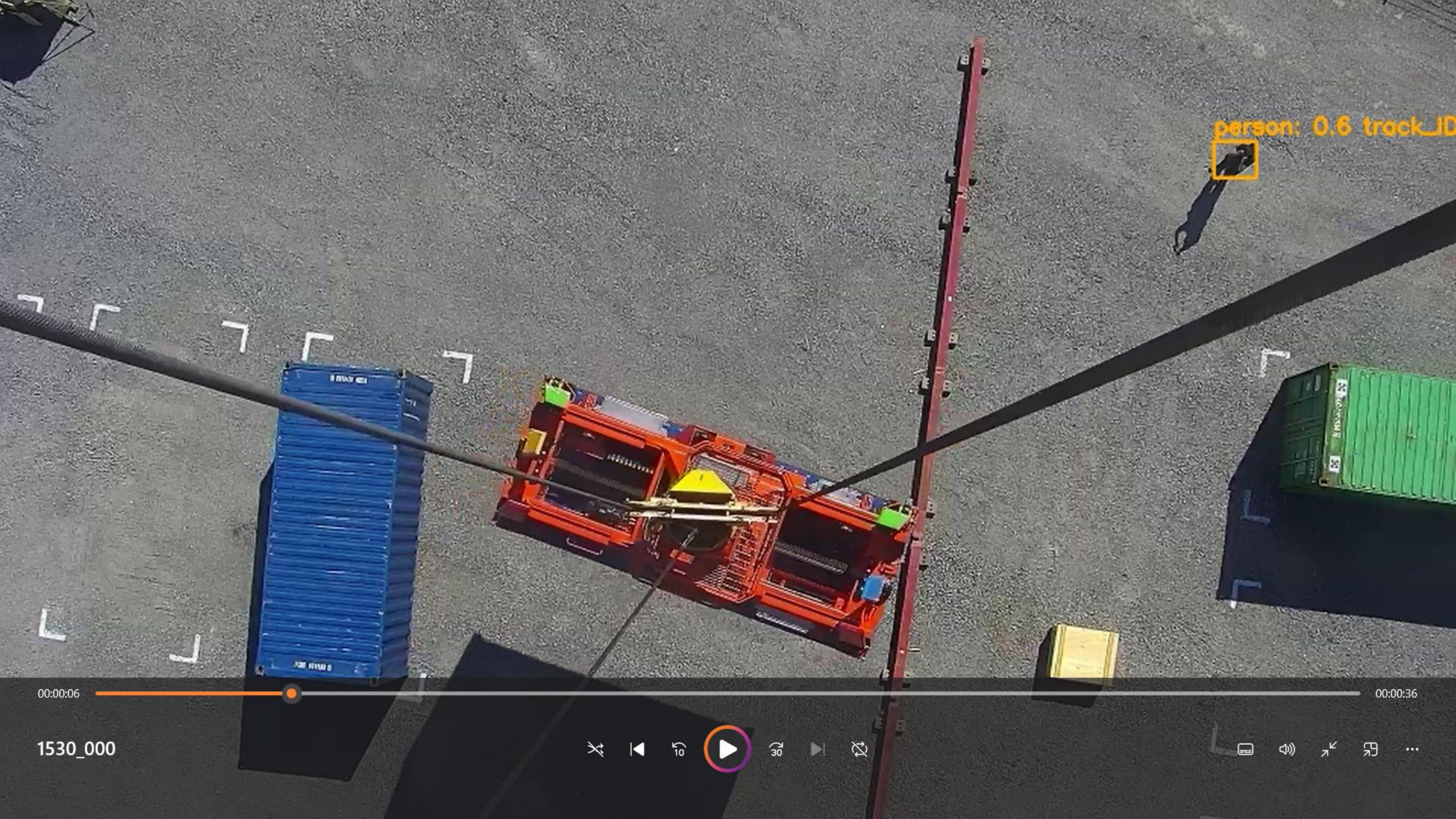
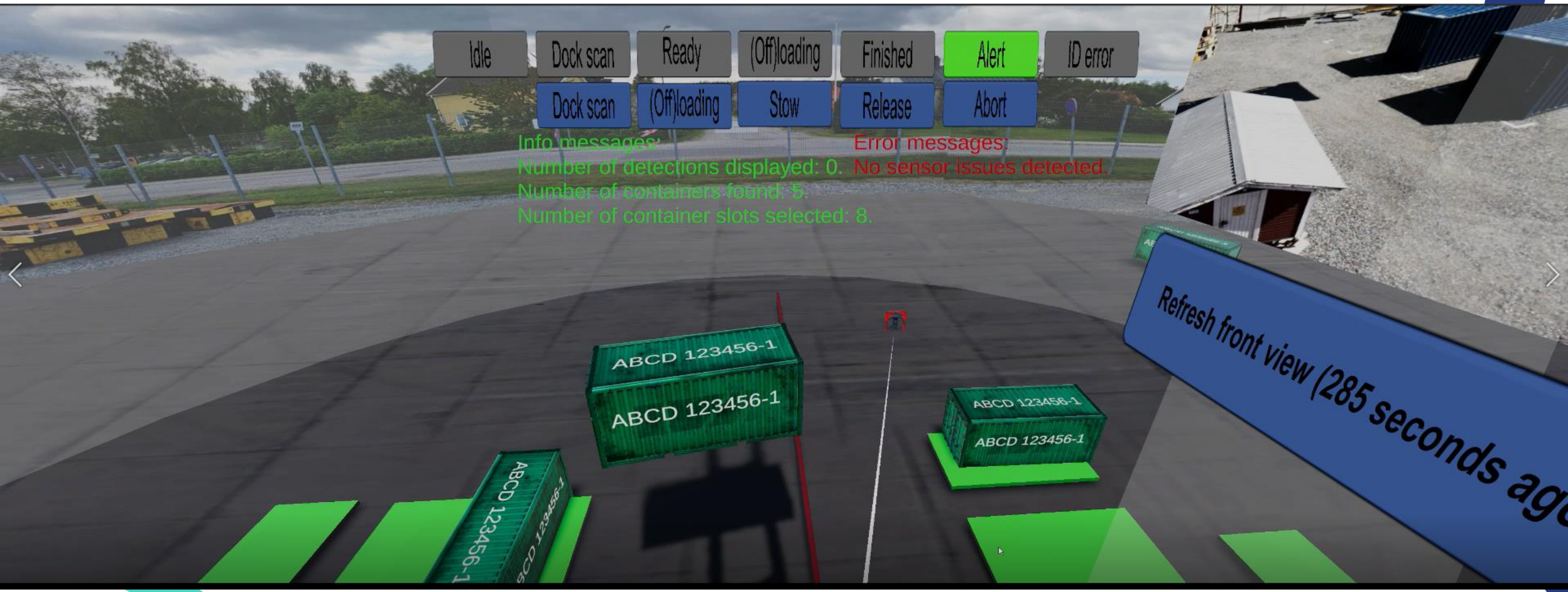
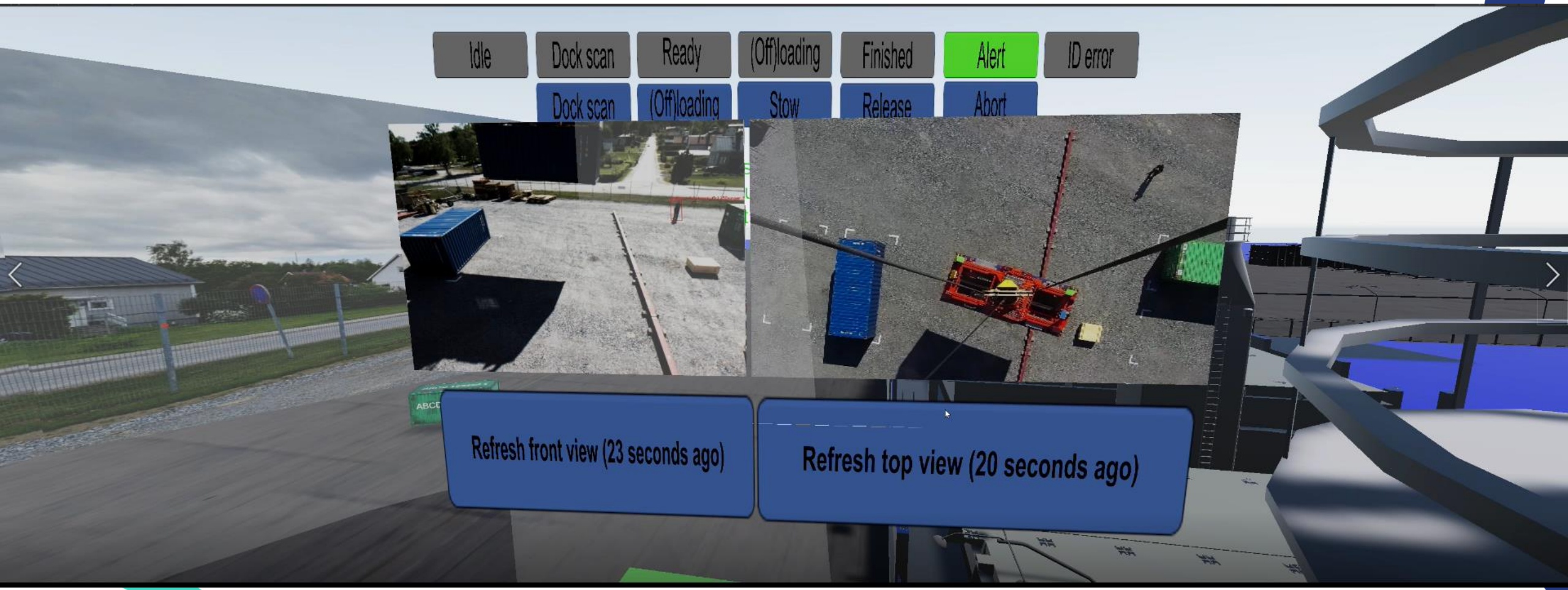

person: 0.6 track_ID
00:00:06
00:00:36
1530_000

# 3D-Twin with the interpretated objects for remote SA




Idle
Dock scan
Ready
(Off)loading
Finished
Alert
ID error
Dock scan
(Off)loading
Stow
Release
Abort
Refresh front view (23 seconds ago)
Refresh top view (20 seconds ago)

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# Intelligent Operator Support for Shore Control Centers

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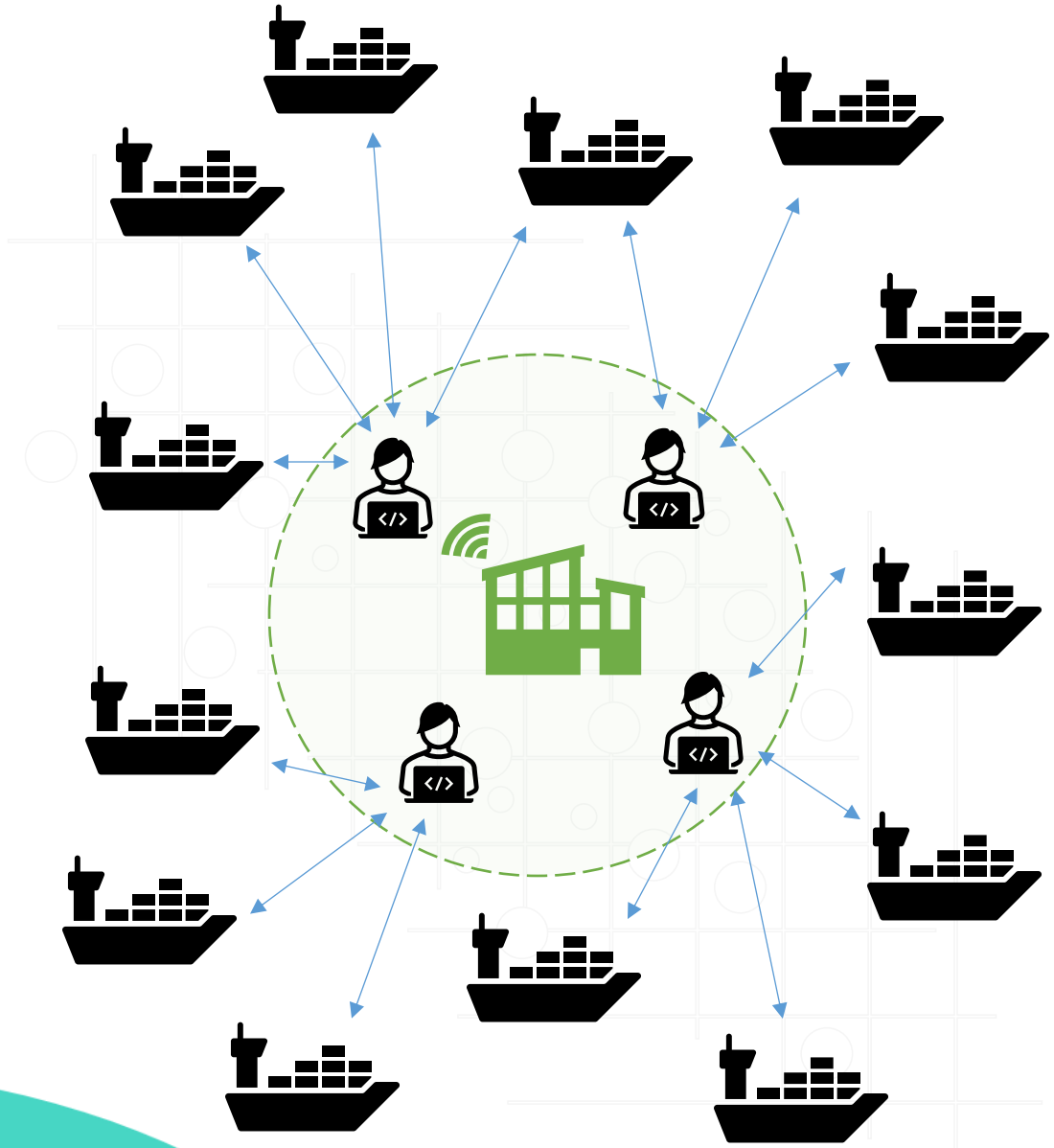
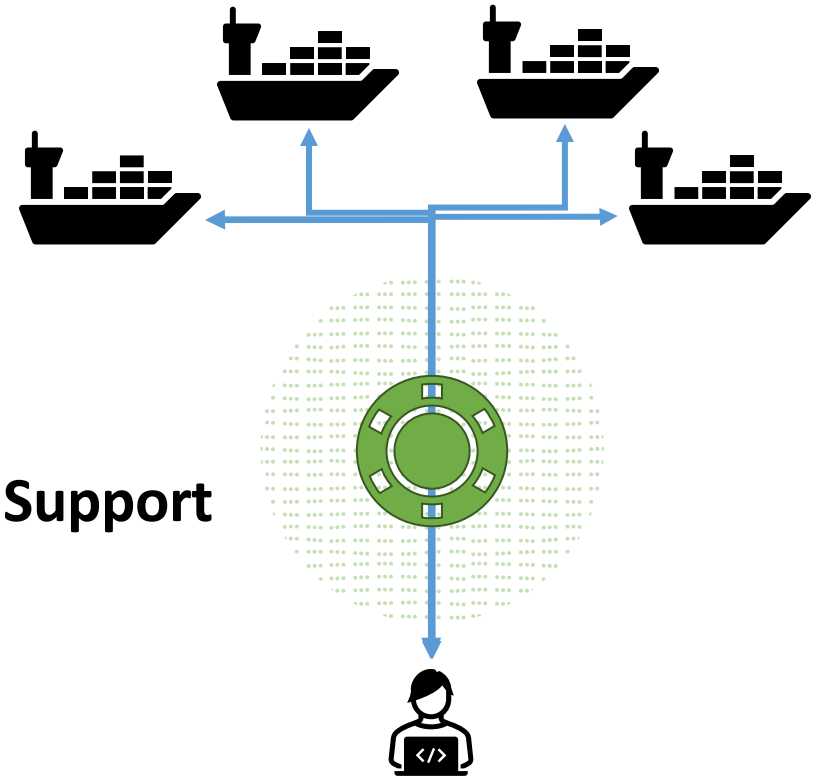
# … and the problem we tackle.


**How to <u>support</u> remote operators in their supervision of dozens of autonomous operations in the maritime industry.**

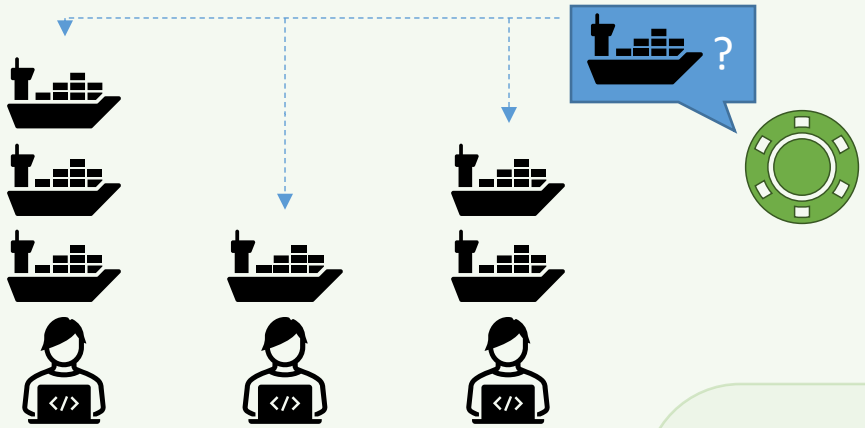


# Intelligent Operator Support

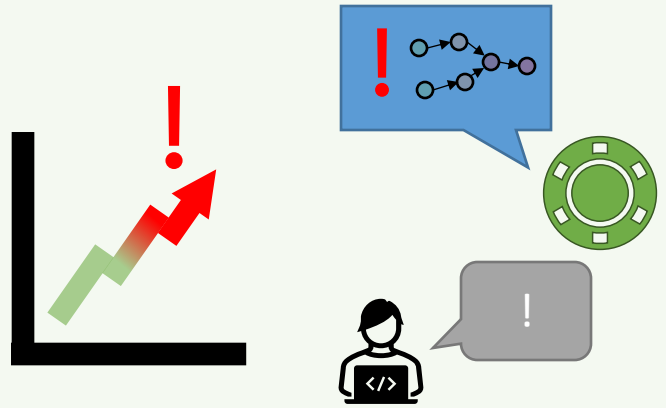


# Support functions

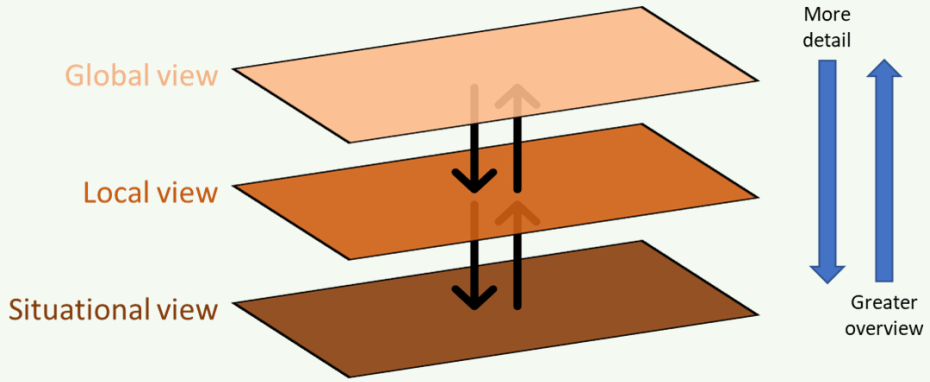
## Dynamic Allocation of Operations to Operators



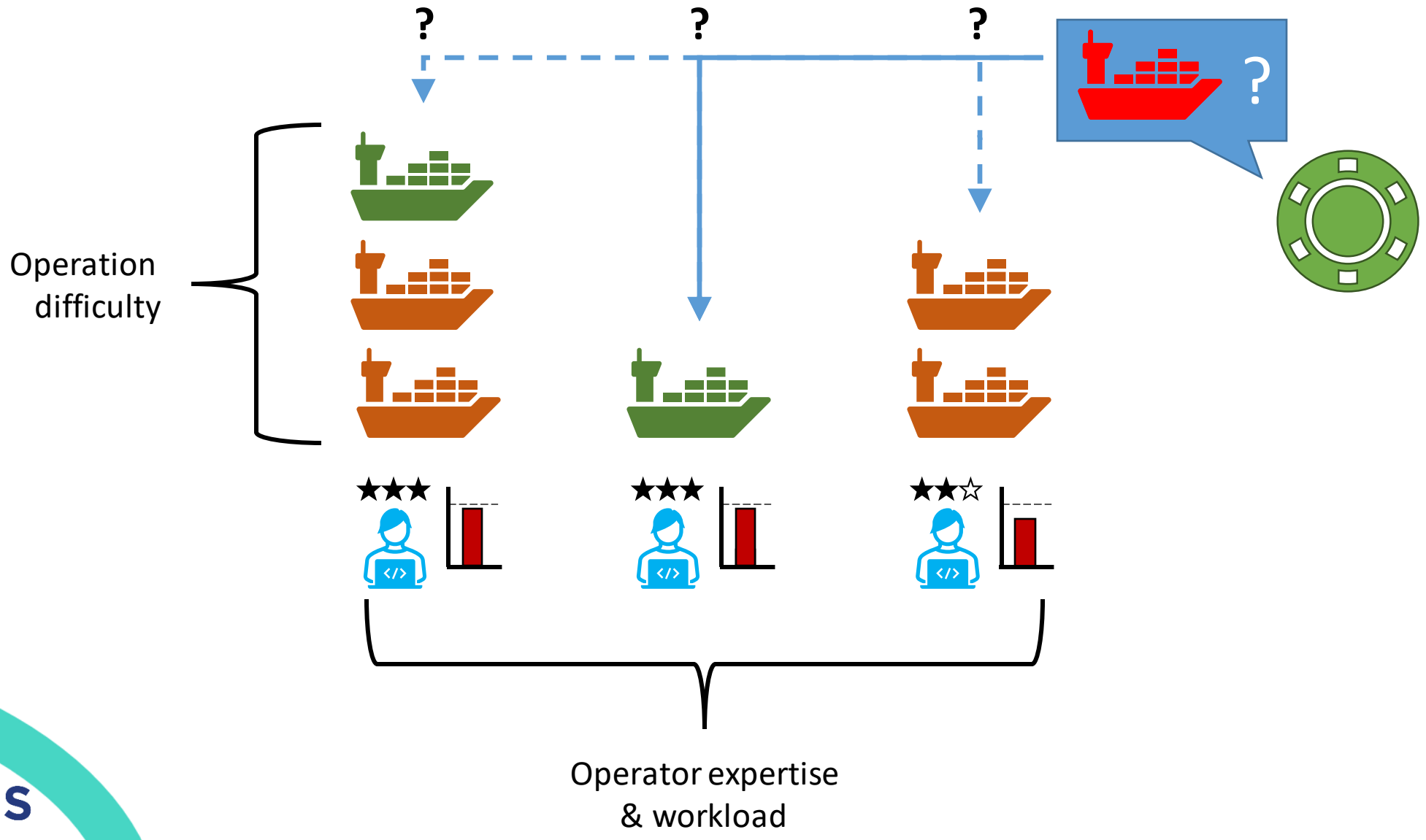

## Continuous Intepretable Risk Assessment



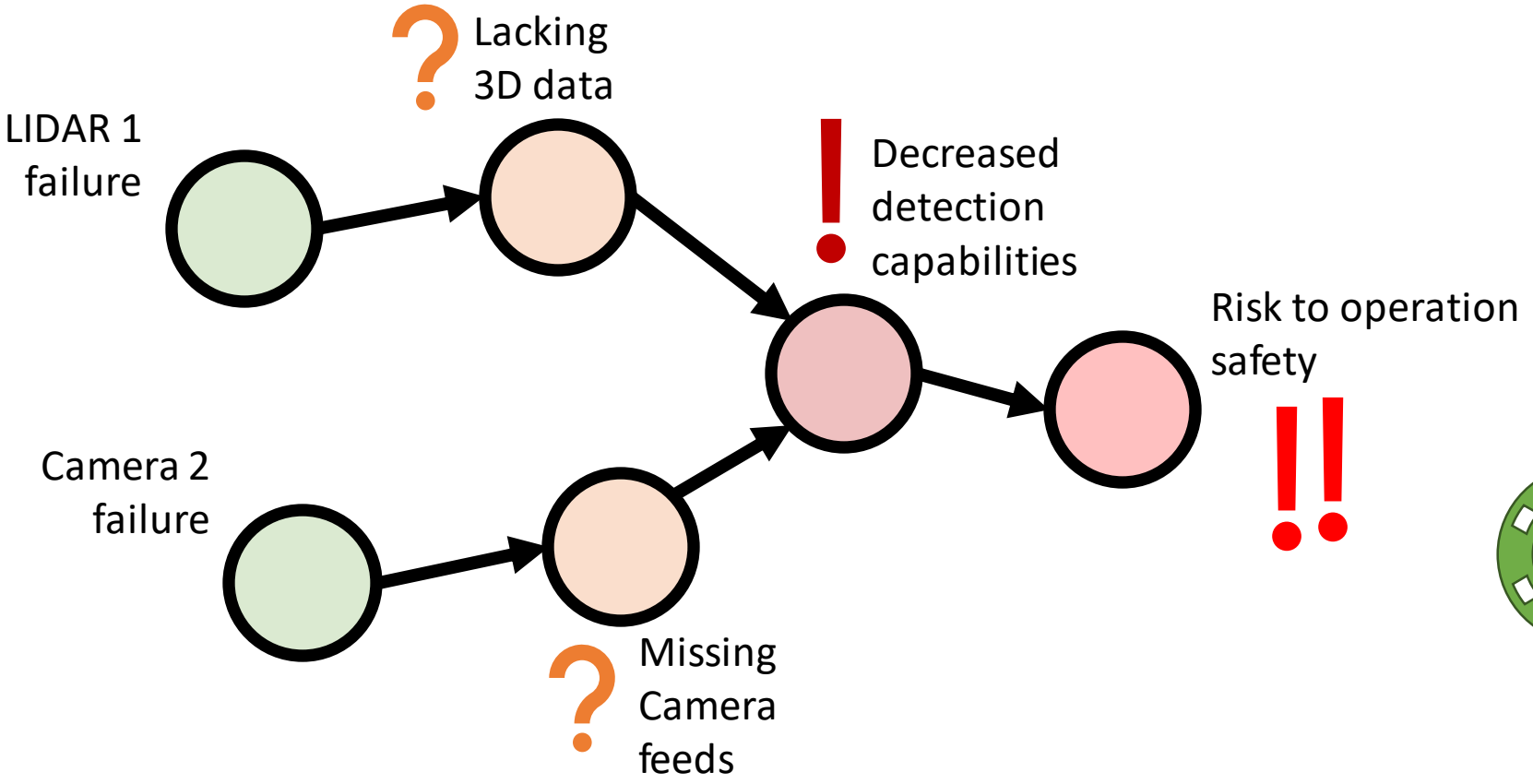

## Progressive Disclosure



# Dynamic Task Allocation; Who does what?



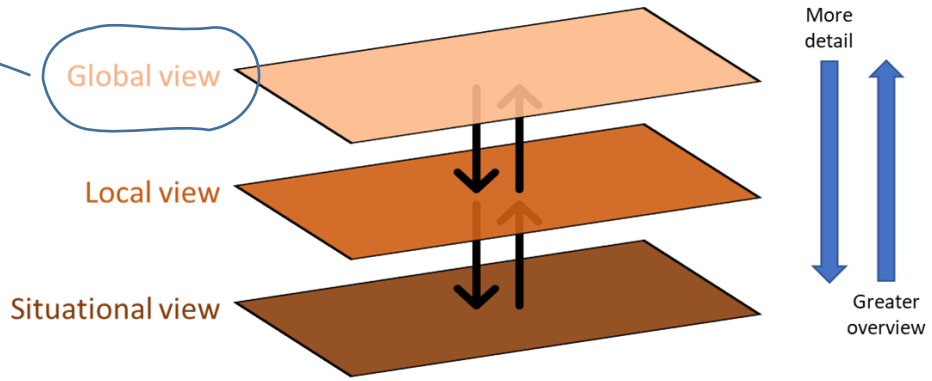
# Risk Assessment: Timely and interpretable notifications



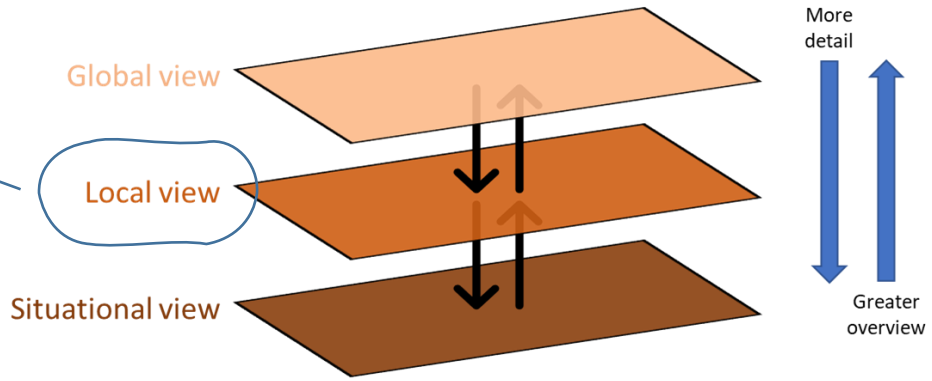

Higher risk to physical harm due to decreased detection capabilities caused by several sensors failing.

At next port, contact the local port authorities to review LIDAR 1 and Camera 2.

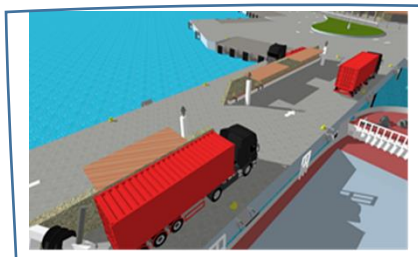
# Progressive Disclosure; What to show when?

# Progressively Disclosing Interactions; When to show what?

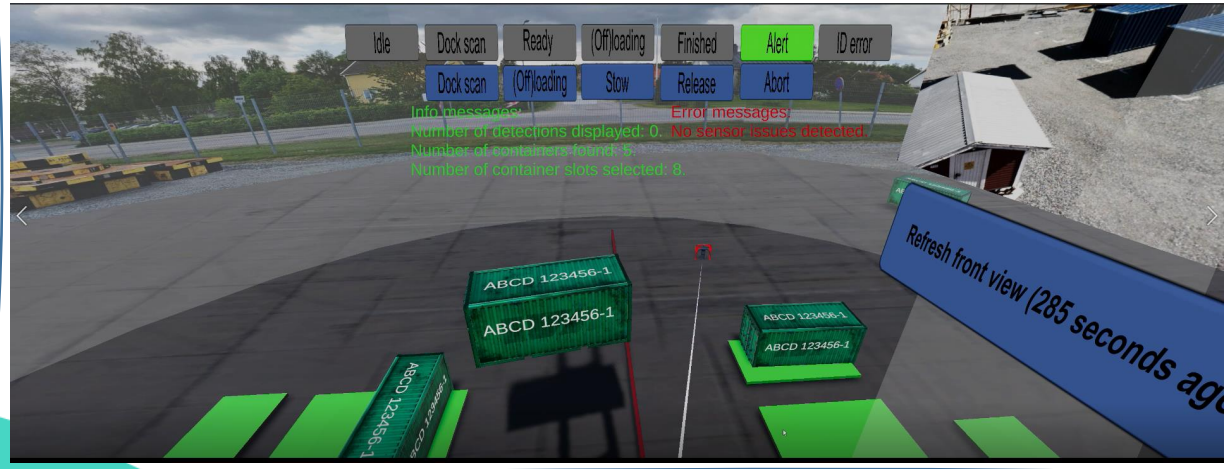



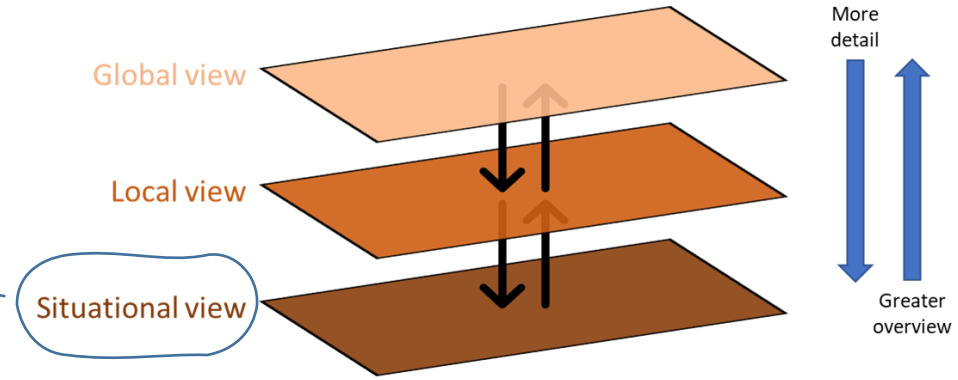
# Progressively Disclosing Interactions; When to show what?

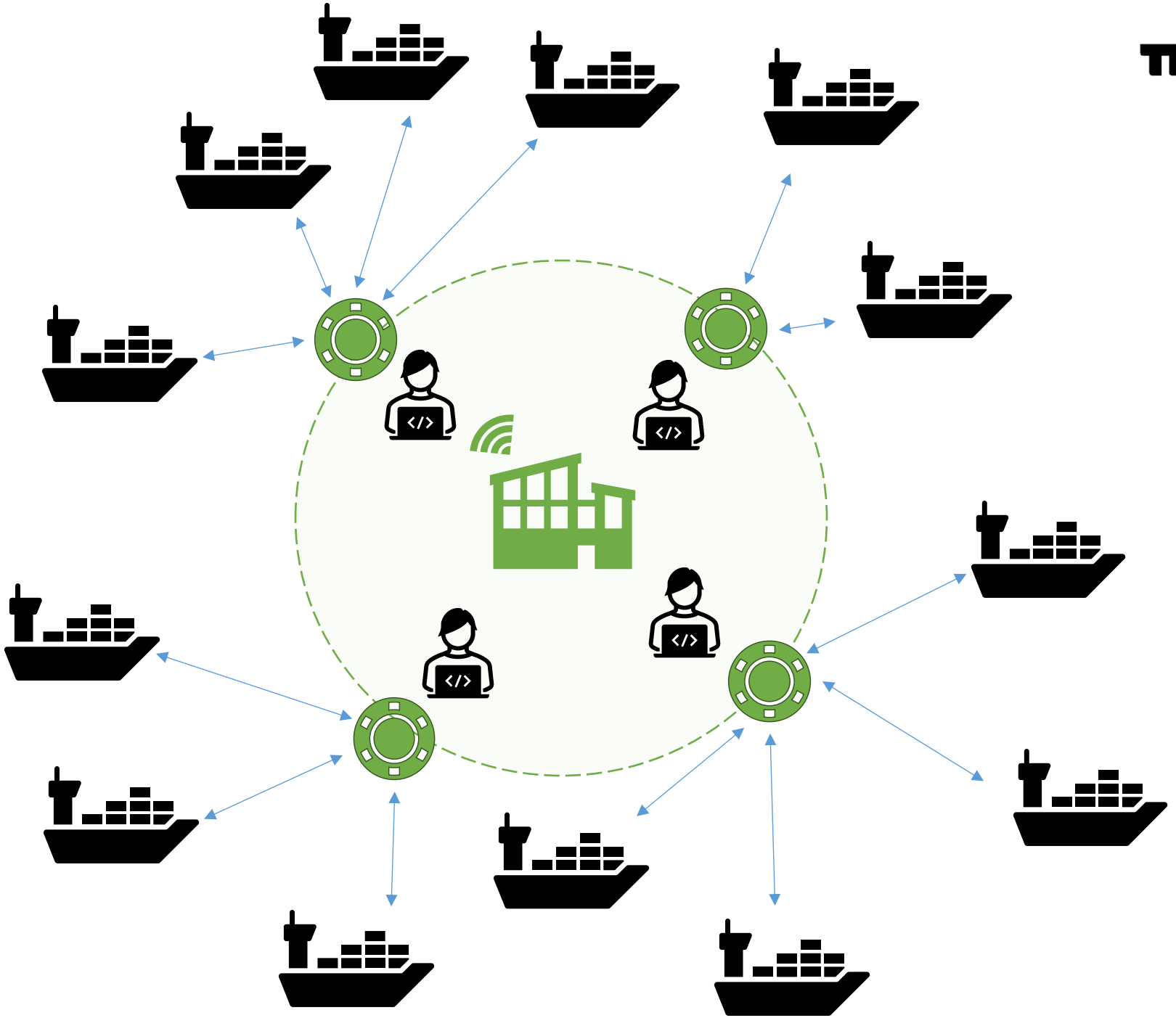


← Mykonos design

**Pilot phase**



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# Thank you for your attention!

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