



Exploitation workshop on
MOSES Robotic Container Handling System

Mirjam Huis in 't Veld, Frank ter Haar

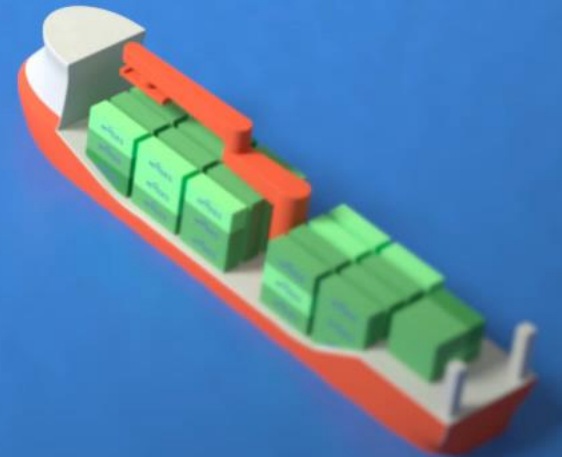
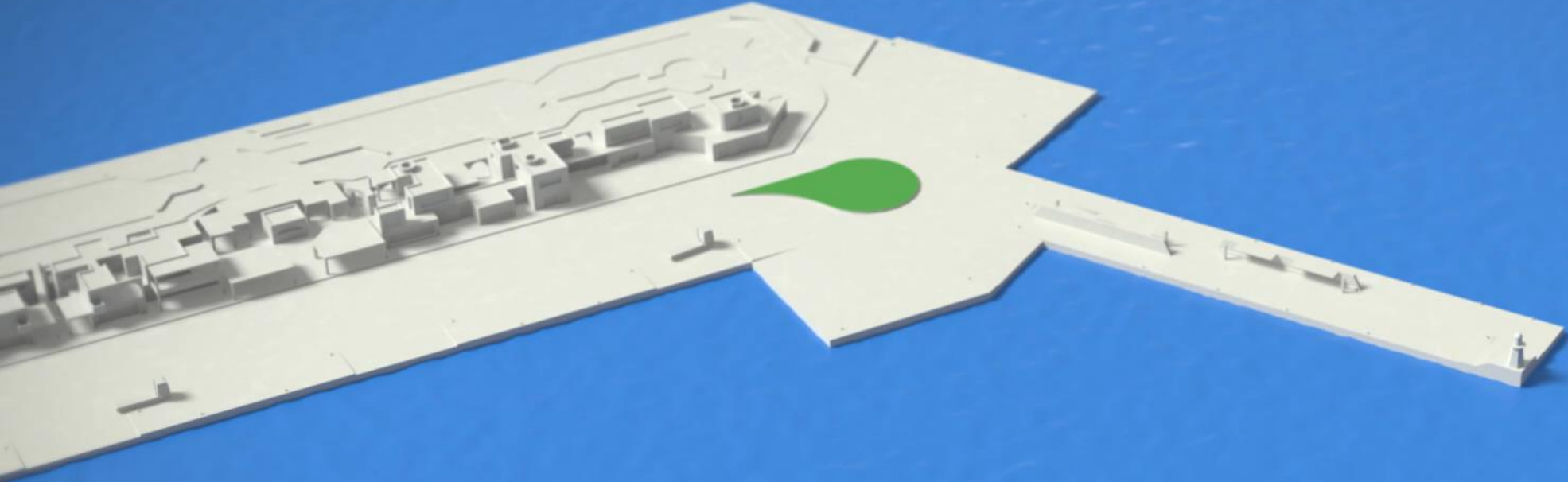
TNO

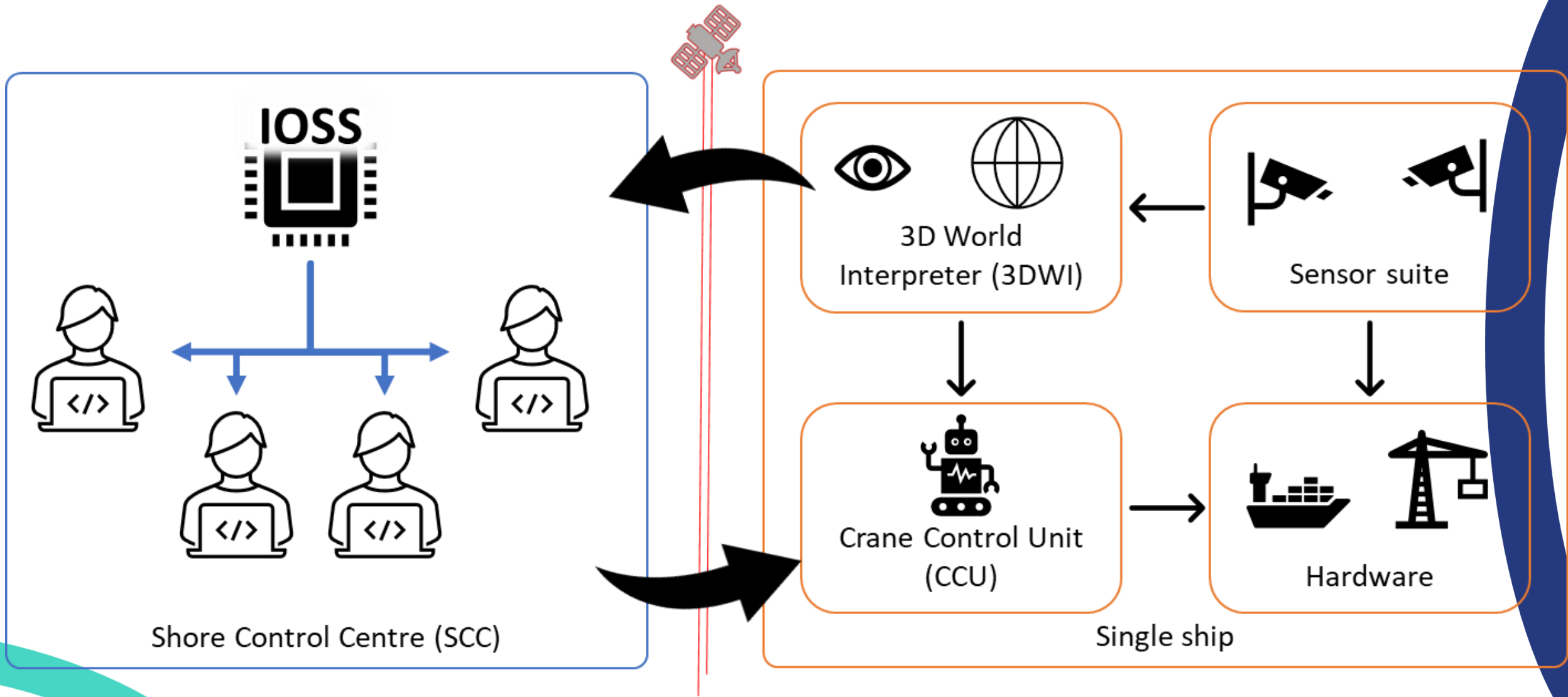
15.11.2023

Port of Rotterdam, NL

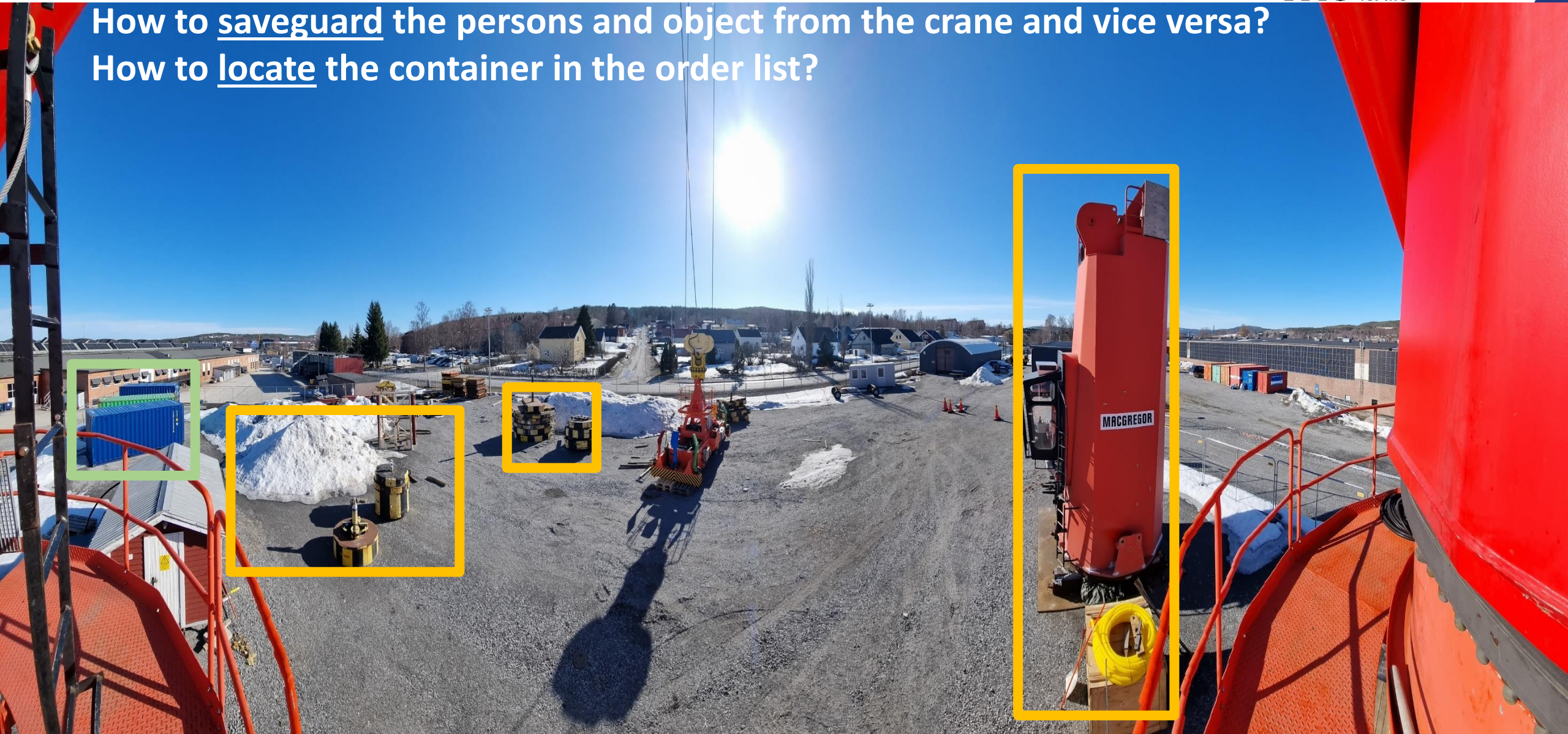


Port of Mykonos, Greece

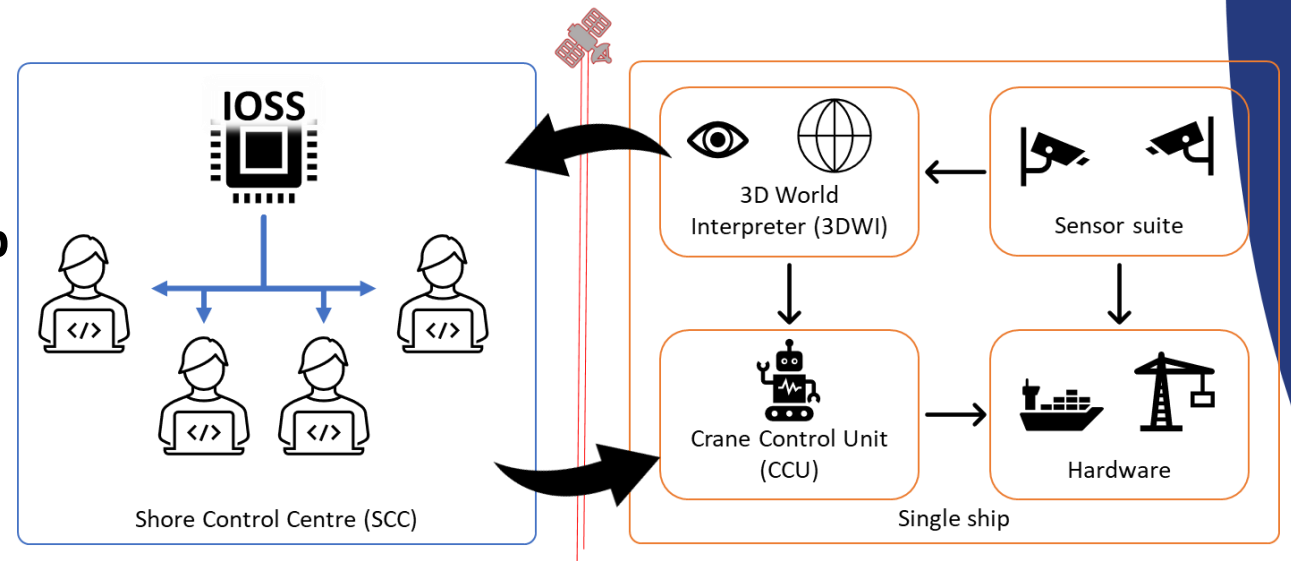




How to saveguard the persons and object from the crane and vice versa?
How to locate the container in the order list?



- **3D World Interpreter (3DWI)**
 - **F1: Sensor Suite Design**
 - **F2: 3D reconstruction and 3D Obstacles**
 - 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

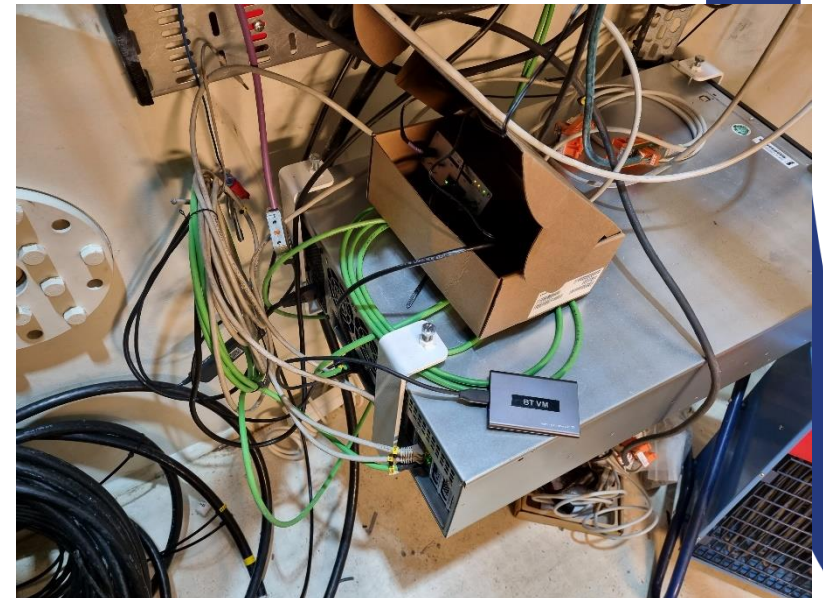
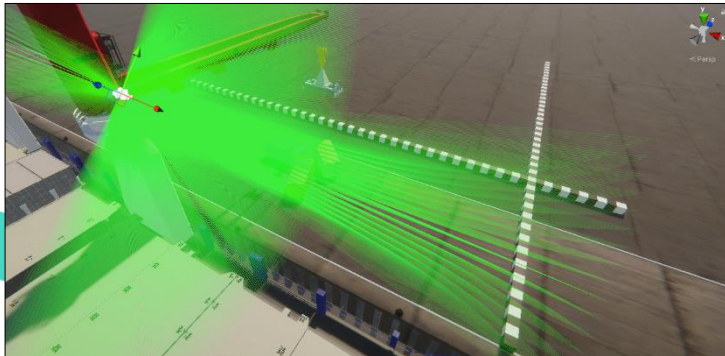
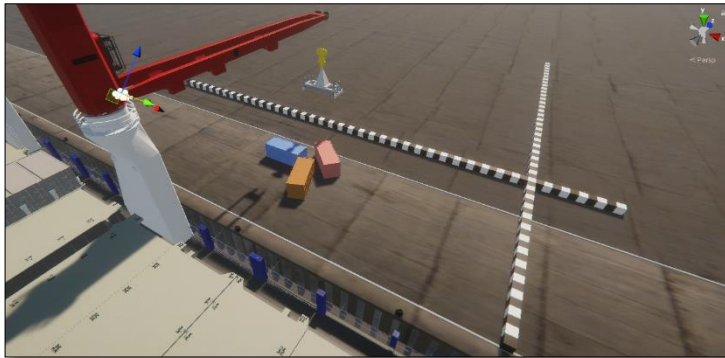


- **F1 Sensor Suite Design**

Design in Unity3D

Data acquisition pipeline

Mounting on Crane



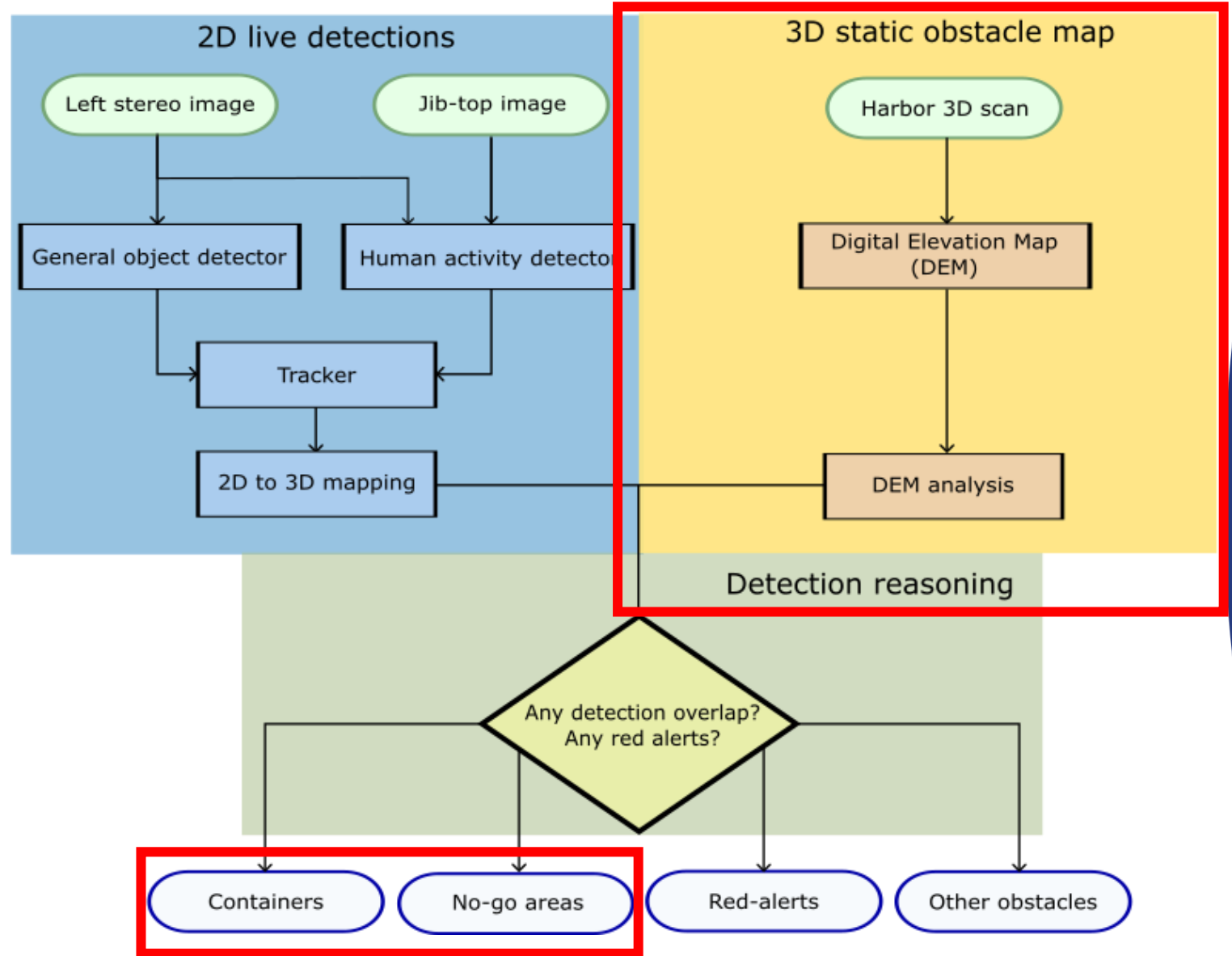
- **F2: 3D reconstruction and 3D Obstacles**

Dock scan with LiDAR/Stereo

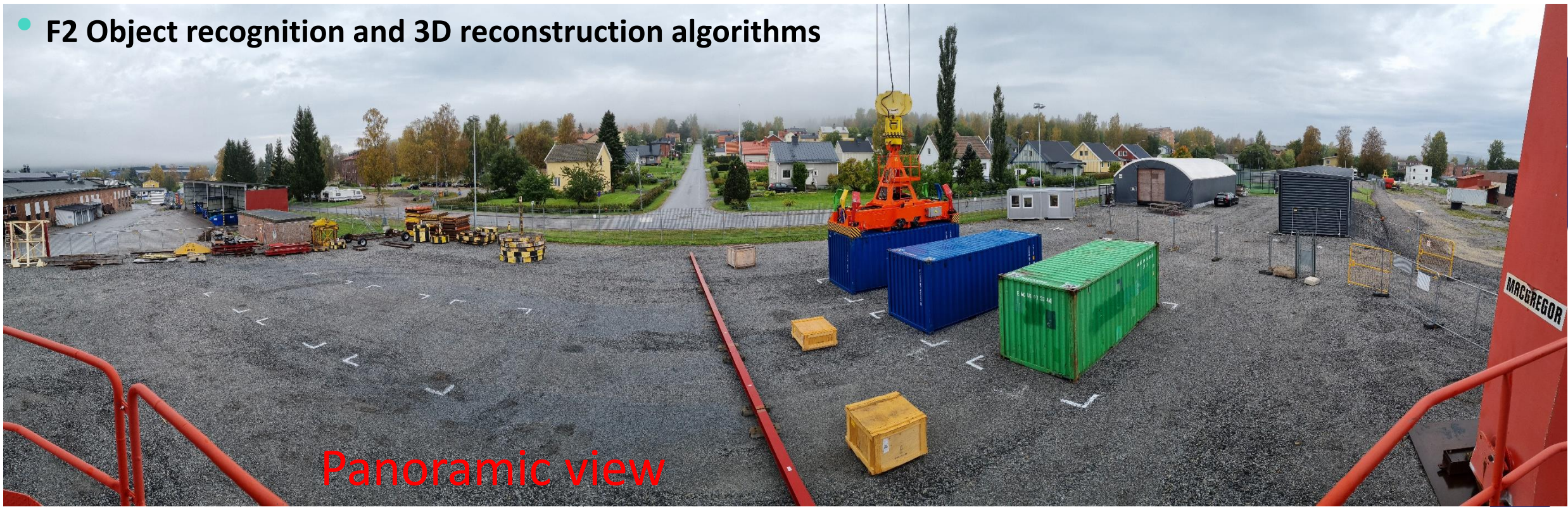
Digital Elevation Map

Containers

Other Obstacles



- F2 Object recognition and 3D reconstruction algorithms



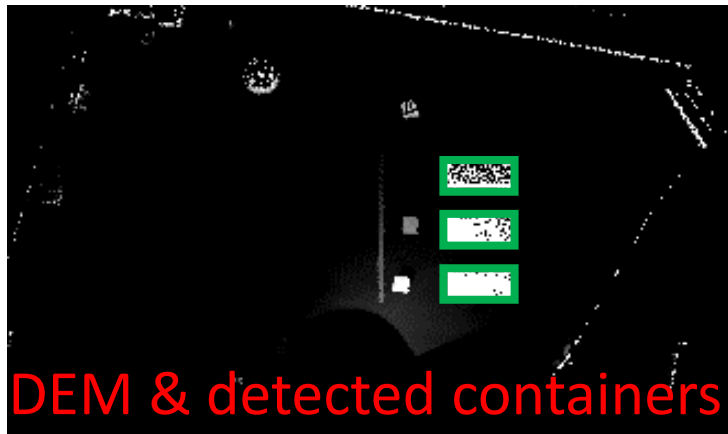
Panoramic view

3D Dock scan with LiDAR / Stereo

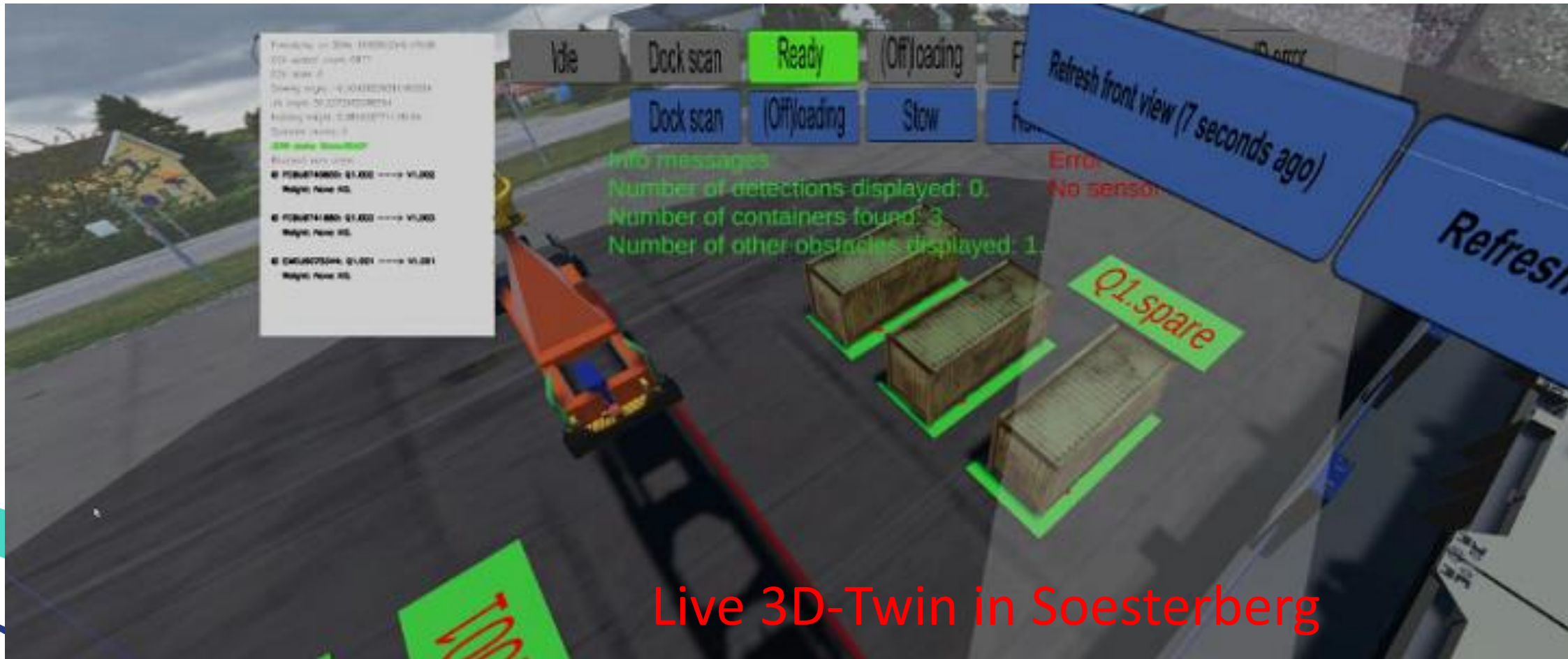


Topview for DEM





DEM & detected containers



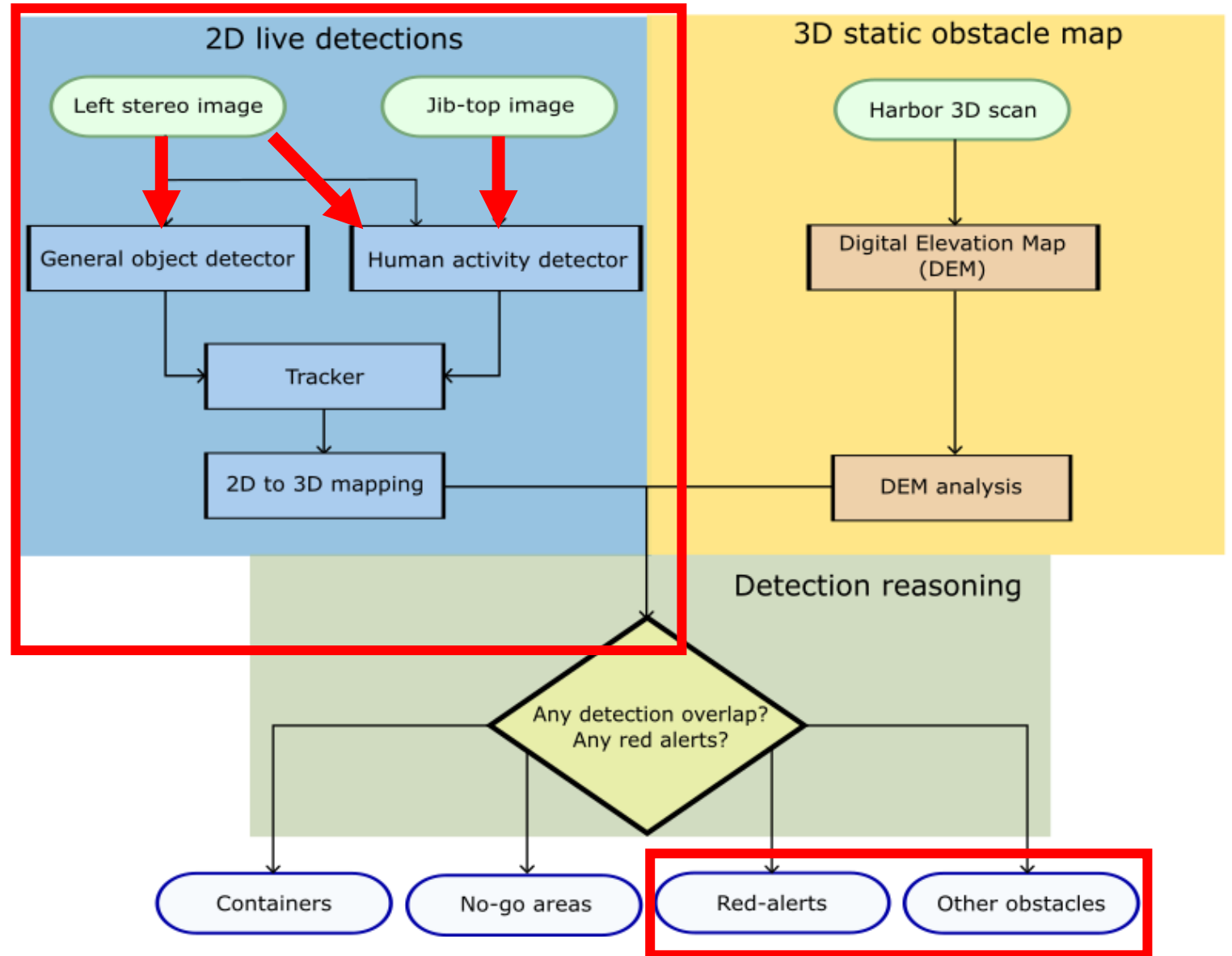
Live 3D-Twin in Soesterberg

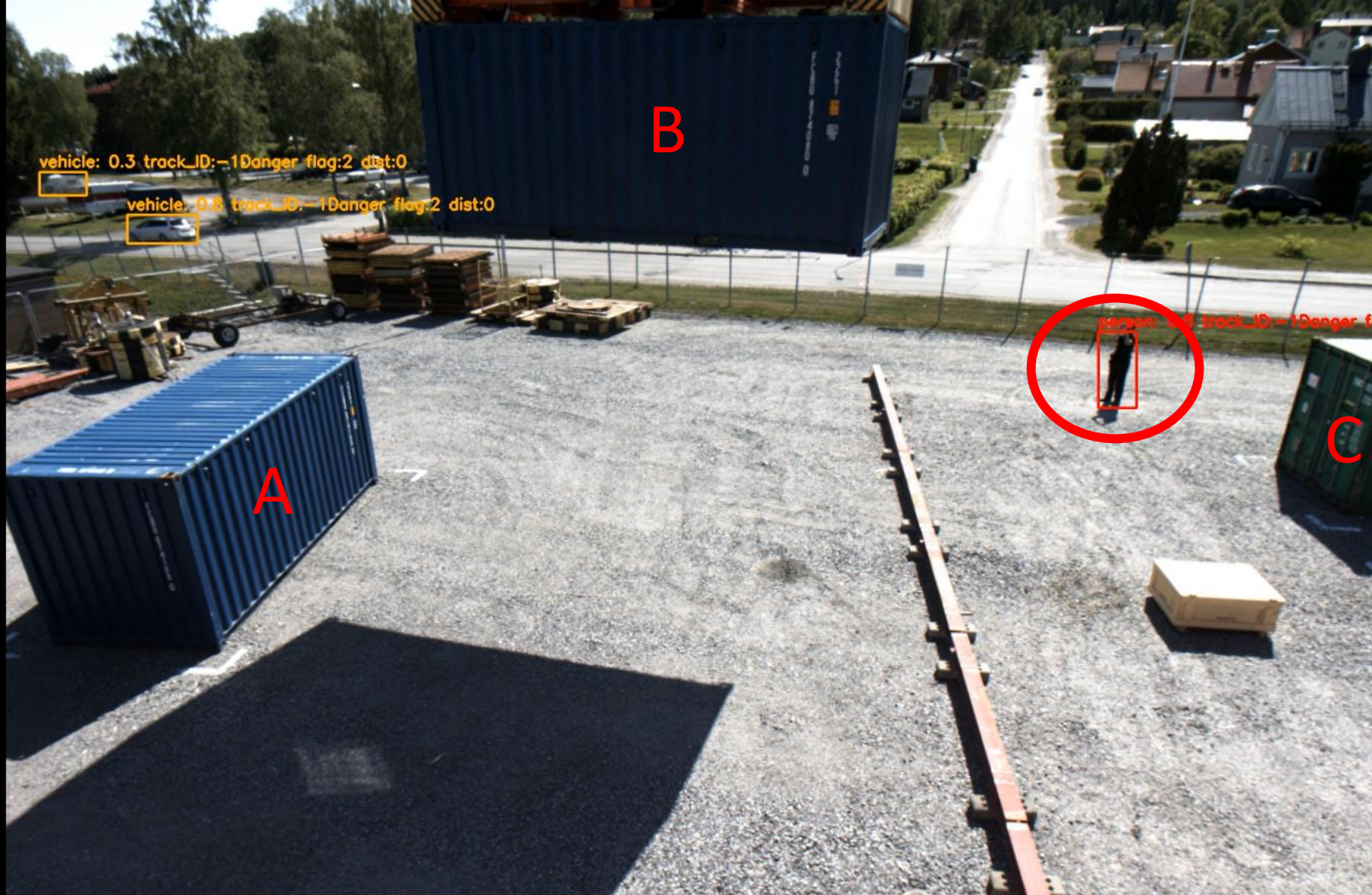
- **F3 Safeguarding crane and humans**

Real-time analysis of sensor data

2D detections to 3D alerts

Continuous update of 3D-Twin





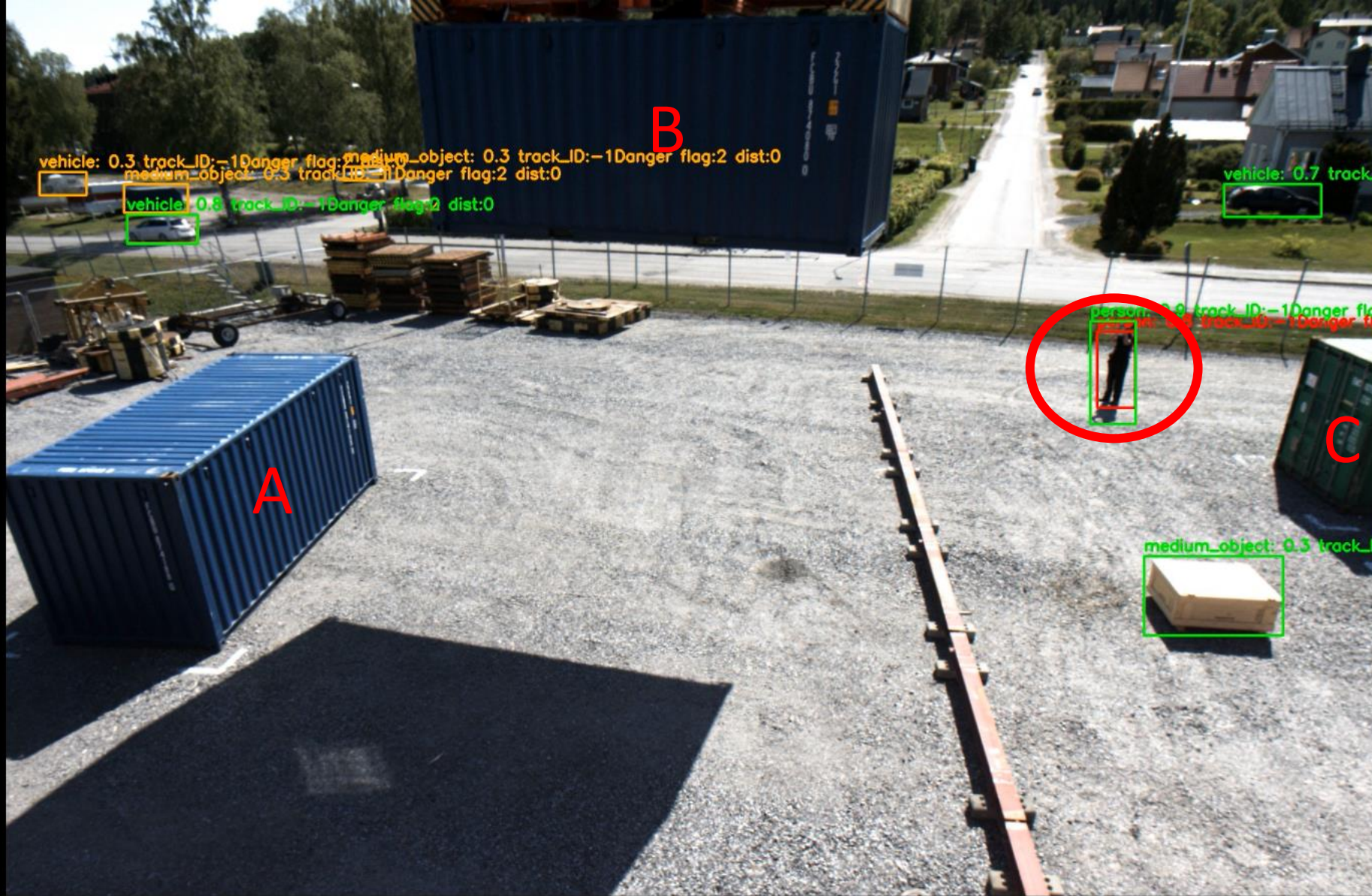
00:00:06

00:00:36

1530_000

Human activity detector





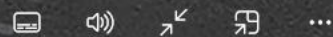


00:00:06

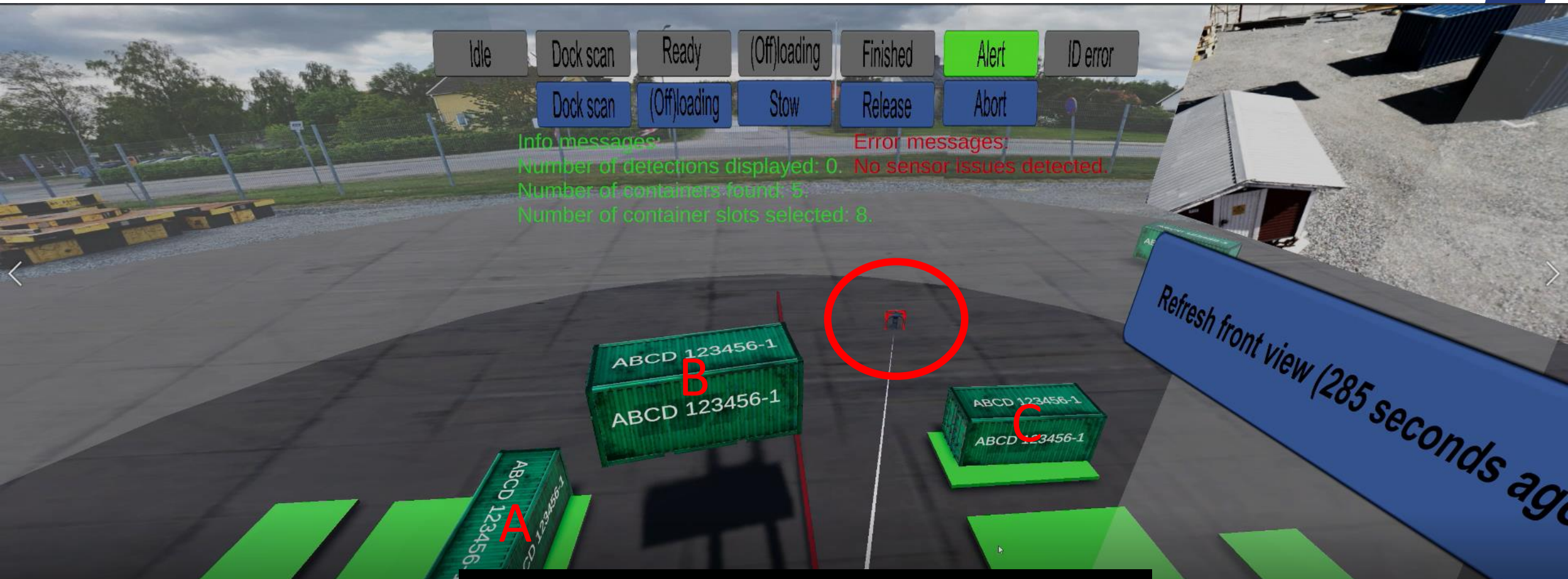
00:00:36

1530_000

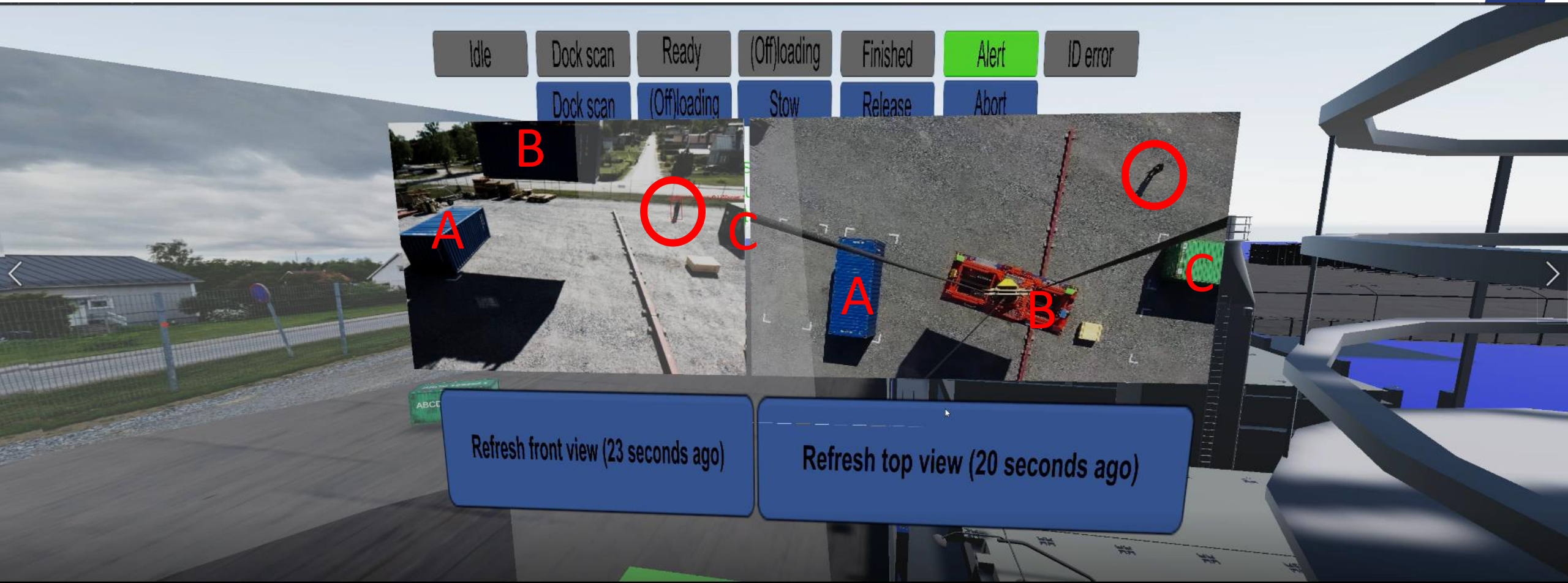
Jibtop Human Activity Detector



3D-Twin with the interpreted objects for remote SA

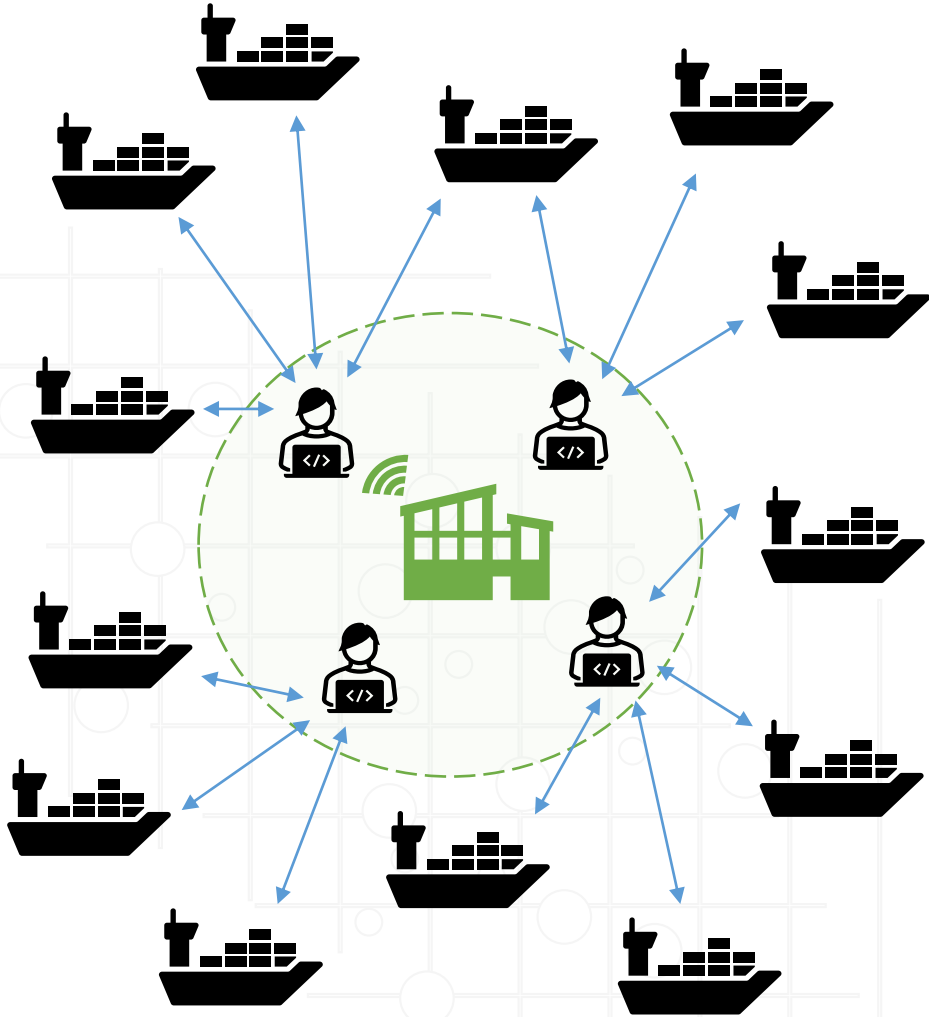


3D-Twin with access to camera footage



Final 3D-Twin for Operator SA – spreader, container ID, task list

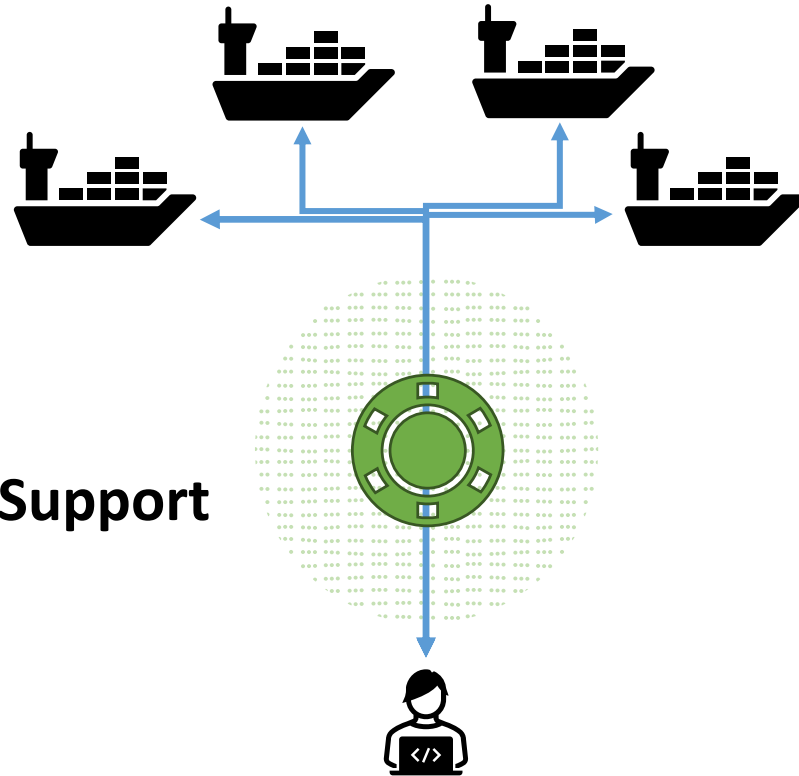




How to support remote operators in the supervision of dozens of autonomous operations in the maritime industry?

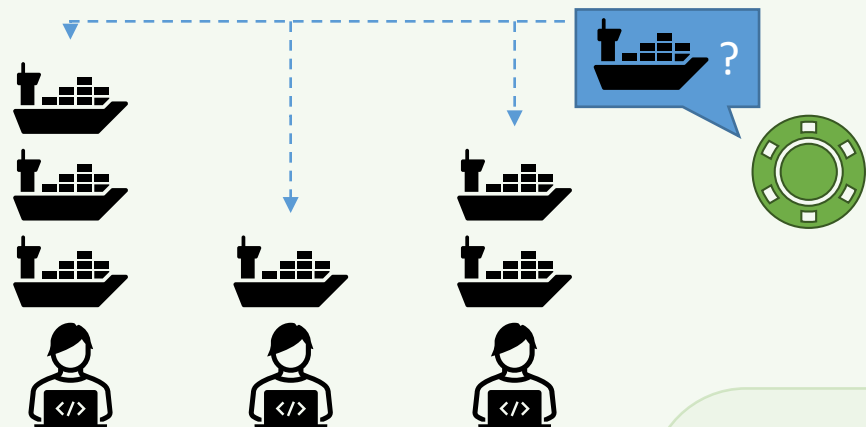


Intelligent Operator Support

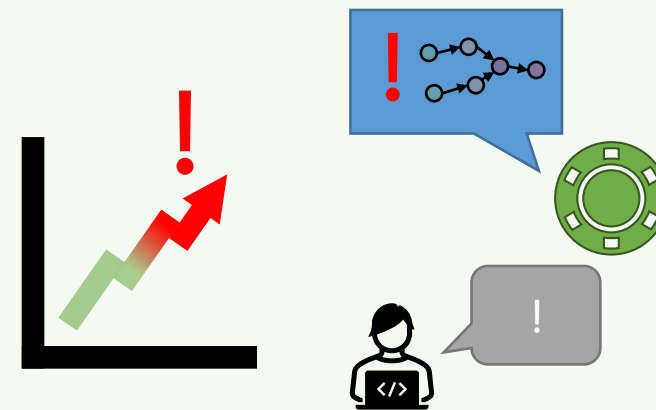


Support functions

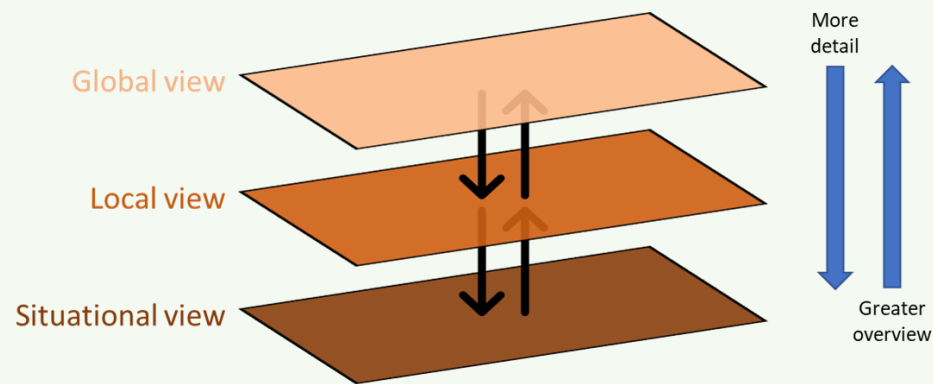
Dynamic Allocation of Operations to Operators



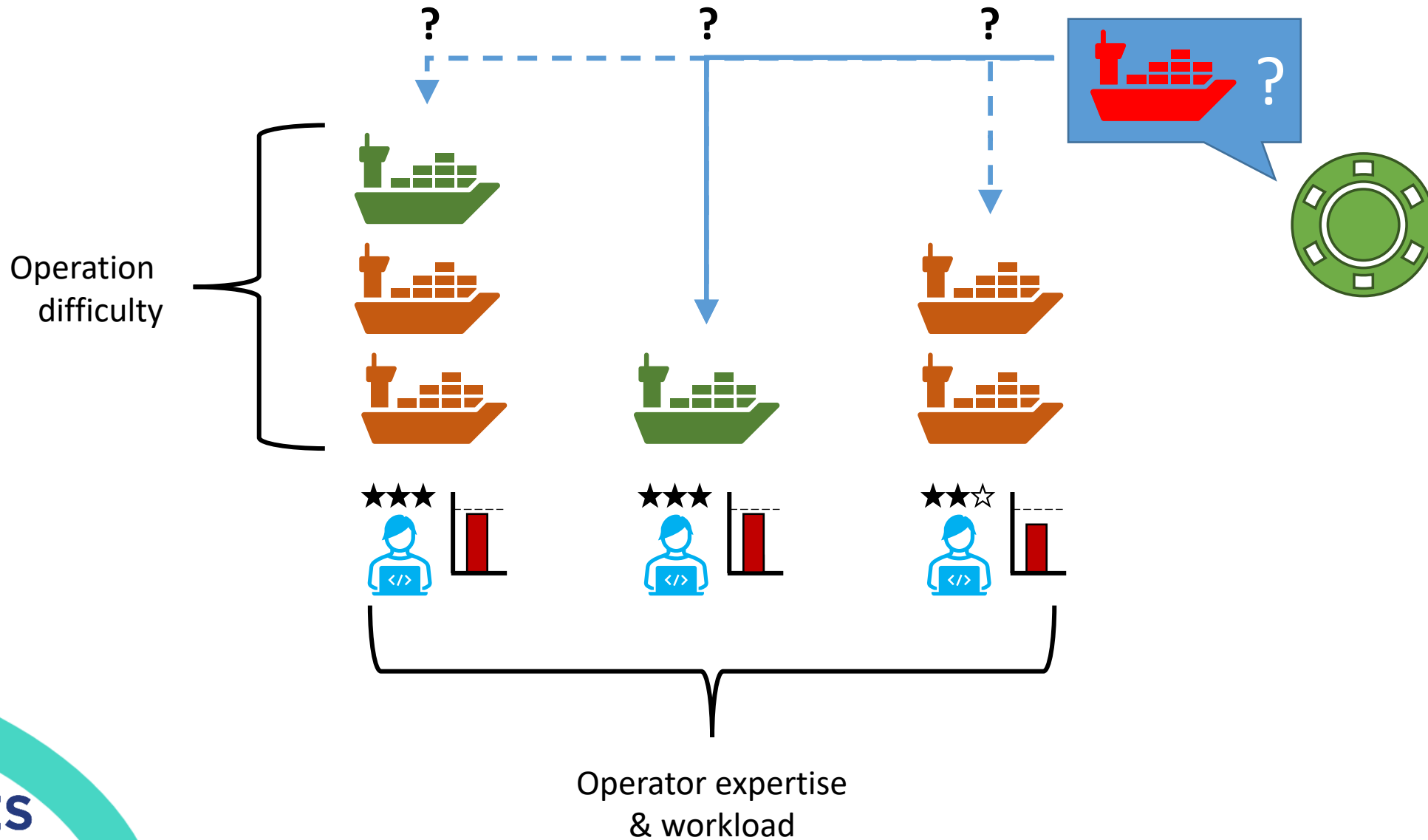
Continuous Interpretable Risk Assessment



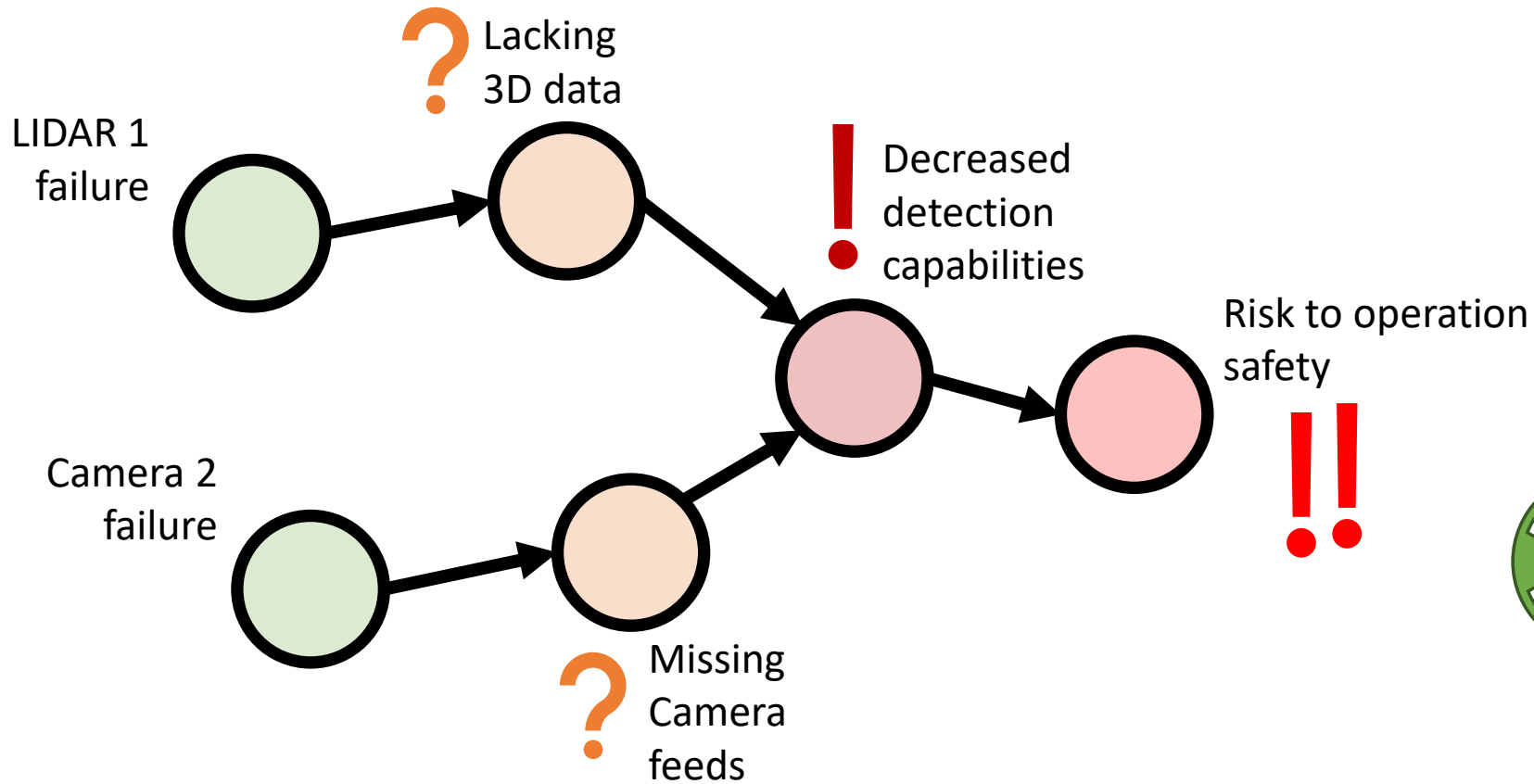
Progressive Disclosure



Dynamic Task Allocation; Who does what?

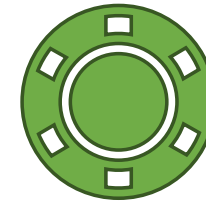


Risk Assessment: Timely and interpretable notifications

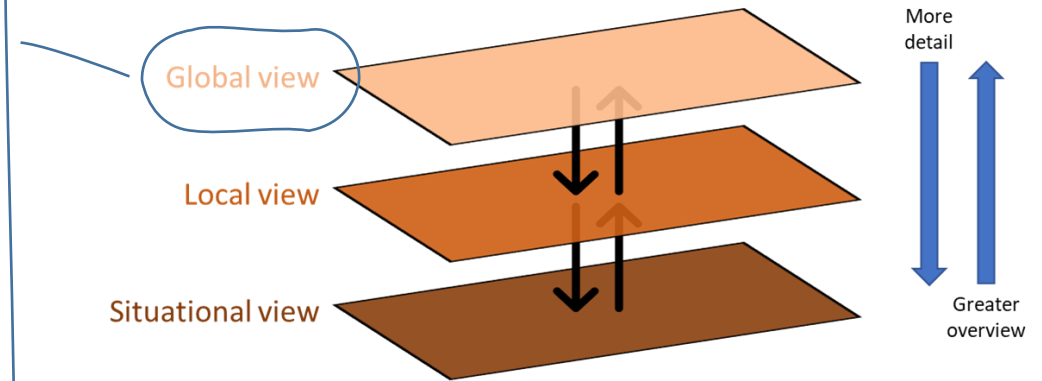


Higher risk to physical harm due to decreased detection capabilities caused by several sensors failing.

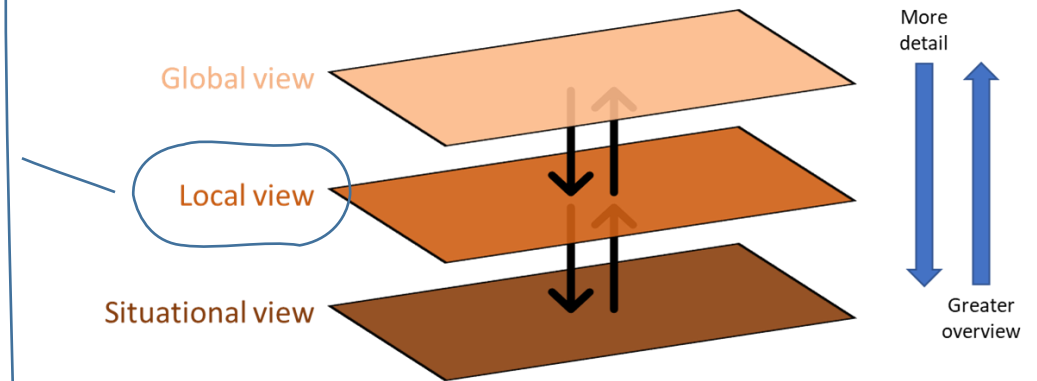
At next port, contact the local port authorities to review LIDAR 1 and Camera 2.



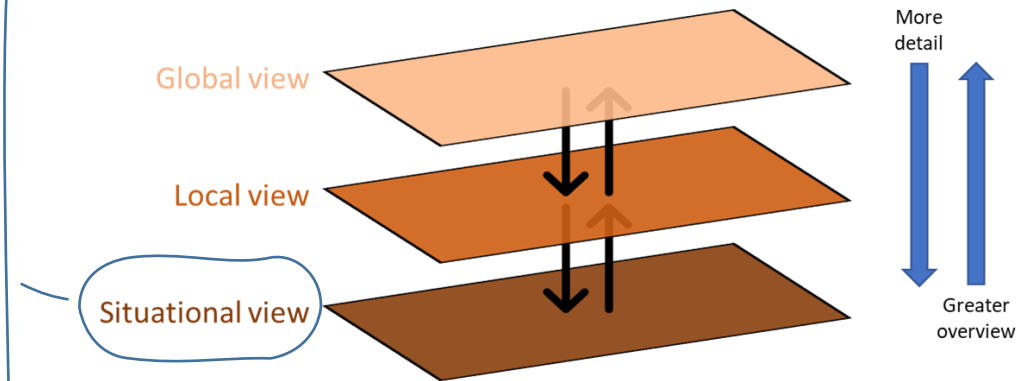
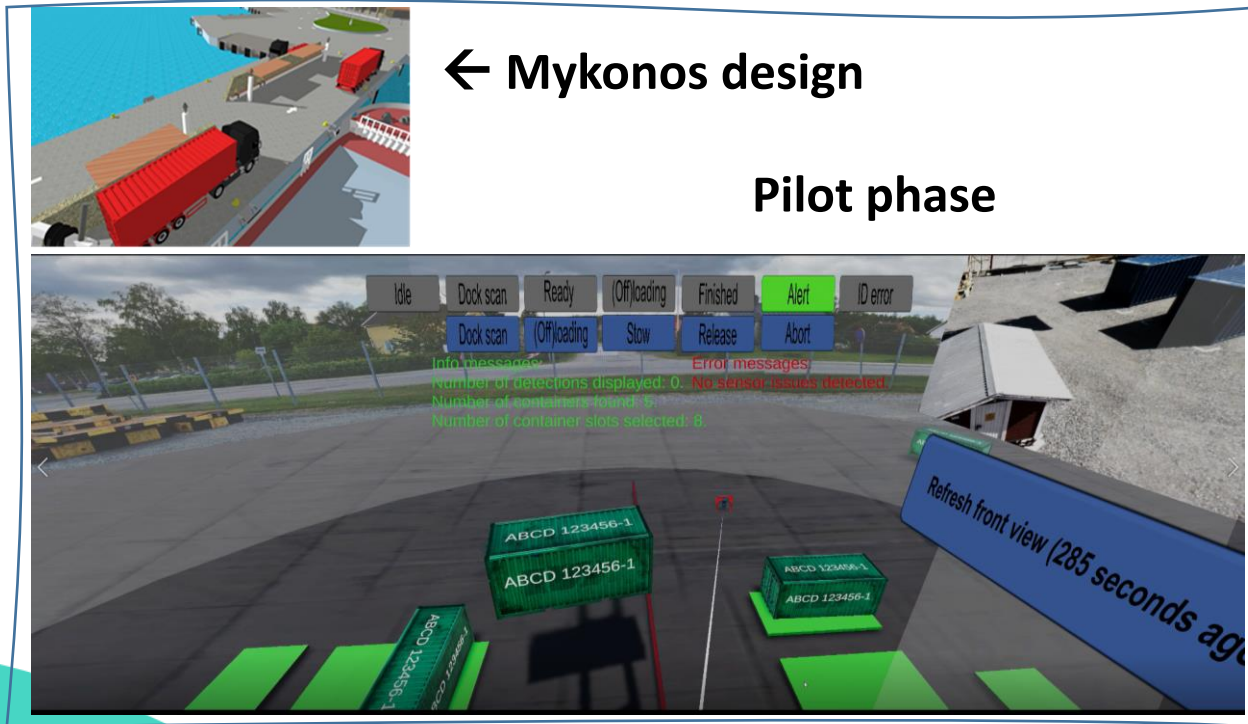
Progressive Disclosure; What to show when?

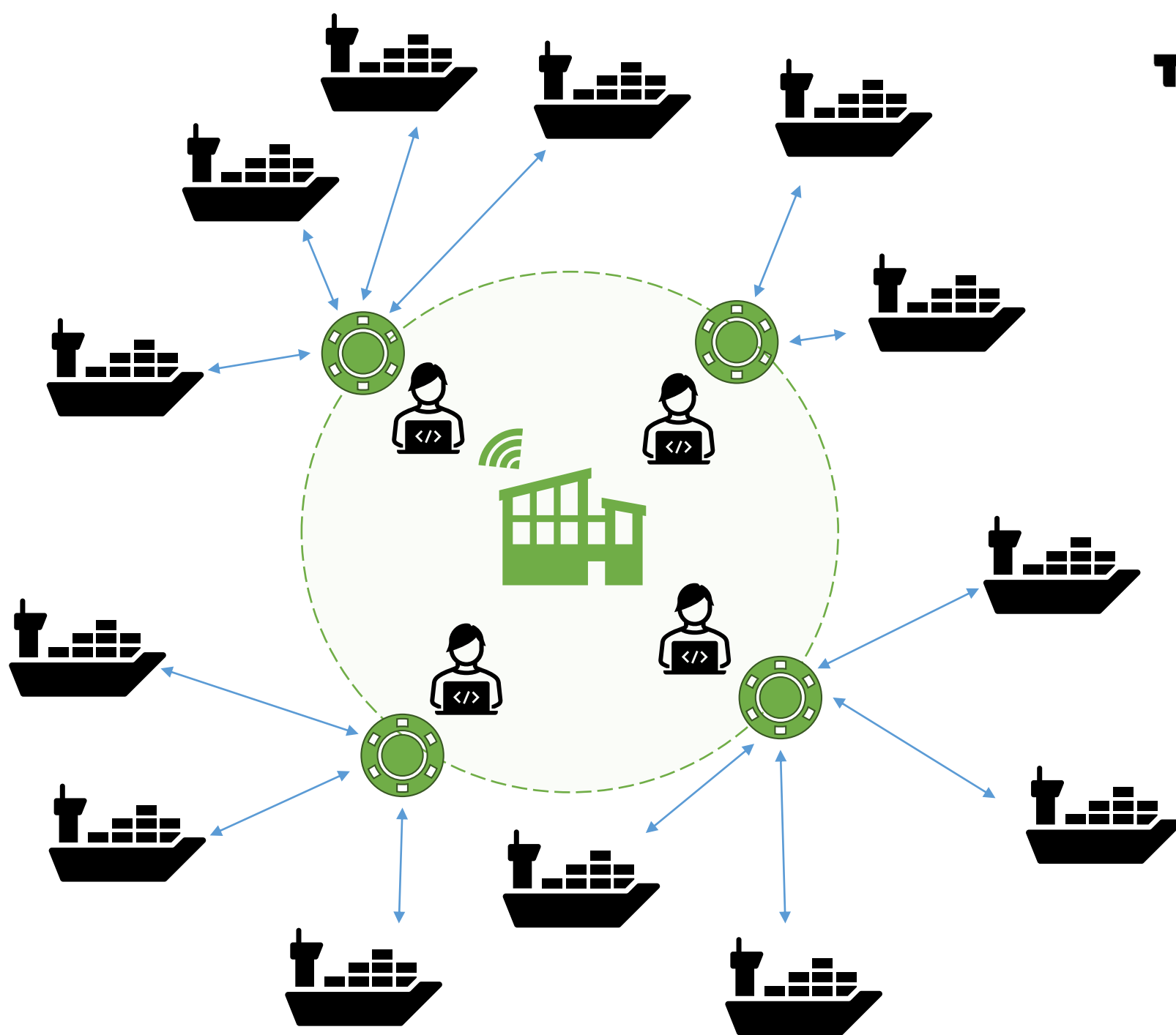


Progressively Disclosing Interactions; When to show what?



Progressively Disclosing Interactions; When to show what?





MOSES

Thank you for your attention!

TNO innovation
for life

Mirjam Huis in 't Veld, Frank ter Haar,

TNO

MOSES@tno.nl



 www.moses-h2020.eu

 MOSES project2020

 @mosesproject20

 MOSES Project



This project has received funding from the European Union's horizon 2020 research and innovation programme under grant agreement No. 861678.