DYNAMIC POSITION DETECTION AND COLLISION AVOIDANCE - RADAR IS THE SOLUTION

KYMATI

WAVES ARE OUR VISION

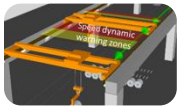
BUSINESS SEGMENTS – RADAR SOLUTIONS

INDUSTRIAL AUTOMATION

KY-RAY 1D

KY-RAY 3D

KY-LOC 1D



ANTICOL SW

CONTAINER TERMINALS

KY-LOC 2D

KY-OMNI SW

LARGE DRONES

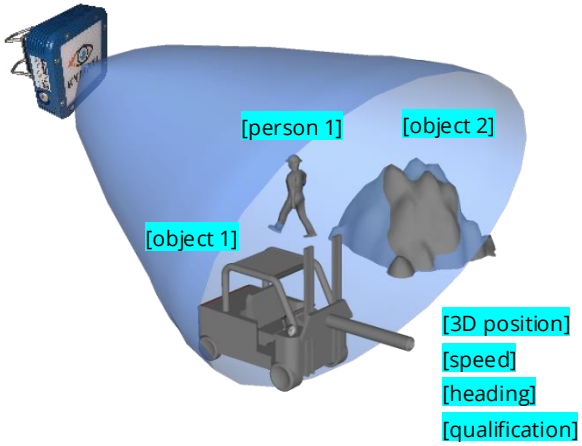
AVS / SRTS

MWOR

KY-OMNI SW

PRIMARY RADAR – HIGH RESOLUTION IMAGING

PRIMARY (IMAGING) RADAR – TARGETS DO NOT CARRY ANY DEVICE

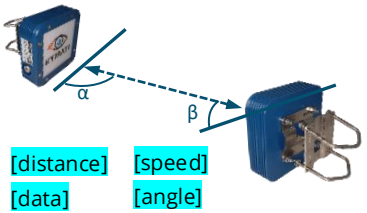


- **Detect**: Presence or absence of persons or objects.
- **Qualify**: Determine the type of objects seen, e.g. person, truck, bicycle, forklift, etc.
- **Count** qualified objects in view.
- **Position**: Determine 3D location (xyz) of all objects in the field of view.
- **Speed**: Doppler effect helps – precise speed and **Heading** reading of moving objects within a single measurement frame.

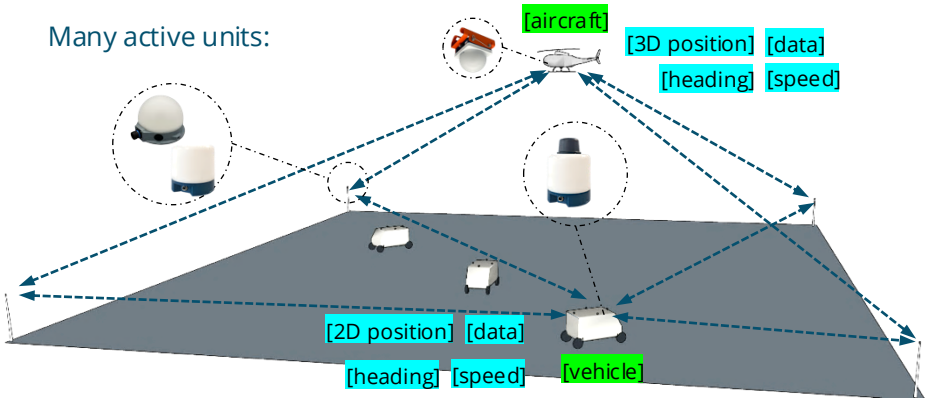
SECONDARY RADAR – DISTRIBUTED RADIO POSITIONING

MULTIPLE ACTIVE RADAR UNITS COMMUNICATE (TIME OF FLIGHT AND DATA)

Two active units:



Many active units:



- **Position**: Precise and dynamic measurement of 2D and 3D positions – independent of weather or dust, dirt and vibration. 2D and 3D position accuracy is increased by sensor fusion with on-board IMU and optional wheel encoder and steering angle information, applied with a geometric vehicle/aircraft model filter algorithm.
- **Data communication:** Radar sensors transmit data bidirectionally, simultaneously over the own Radar signal (no Wifi or 5G req´d).
- **Speed & Heading**: Precise speed and heading reading of each moving object.

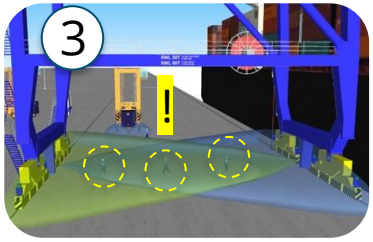
CONTAINER TERMINAL SOLUTIONS

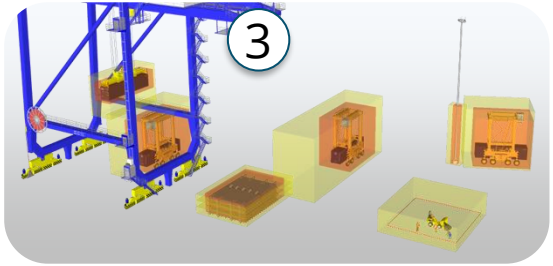
KYMATI

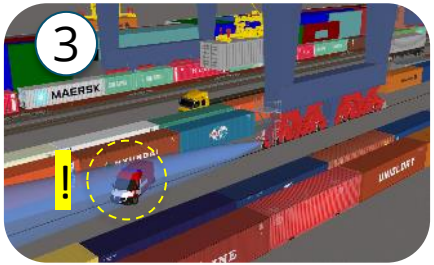
WAVES ARE OUR VISION

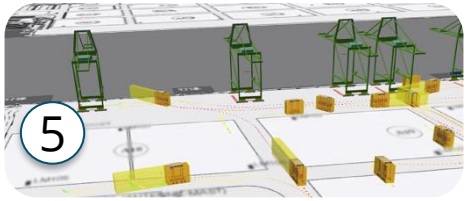
DYNAMIC LOCATION IS KEY
GNSS/GPS IS NOT SOLVING ALL ISSUES

1. **Container tracking** on yard
2. **Navigation and job assignment** for transport vehicles and cranes
3. **Collision avoidance** in 3D and no-go zones:
4. **Event creation** – exception tracking
5. **Dynamic 3D Visualization – Digital Twin** covering all different makes







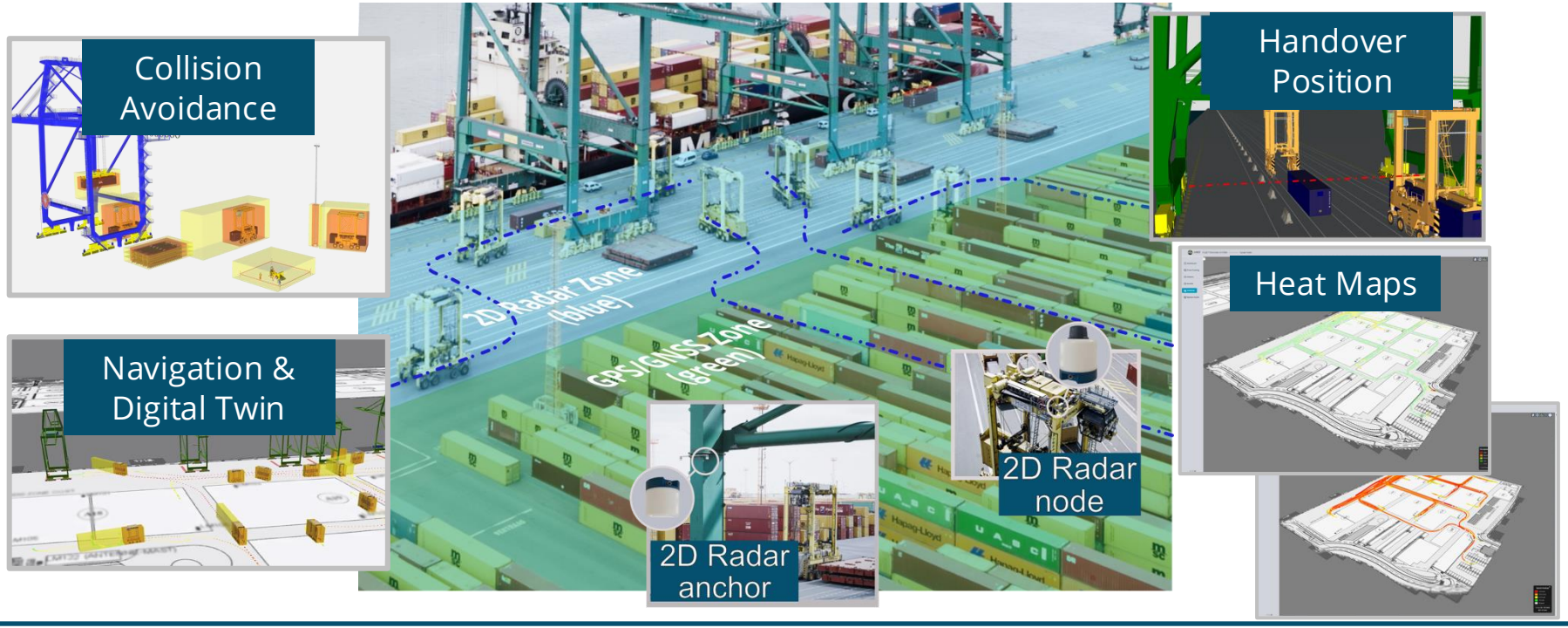


Due to signal reflections, GPS does not work reliable under and close to cranes...
... and some terminals already consider a complete independence from GPS for geopolitical reasons.

KYMATI @ MPET (ANTWERP, BELGIUM, 50% TIL, 50% PSA) SINGLE LARGEST TERMINAL IN EUROPE

35 STS, 240 STRADS (3HIGH AND 4HIGH) AS OF 2025 …AND EXPANDING

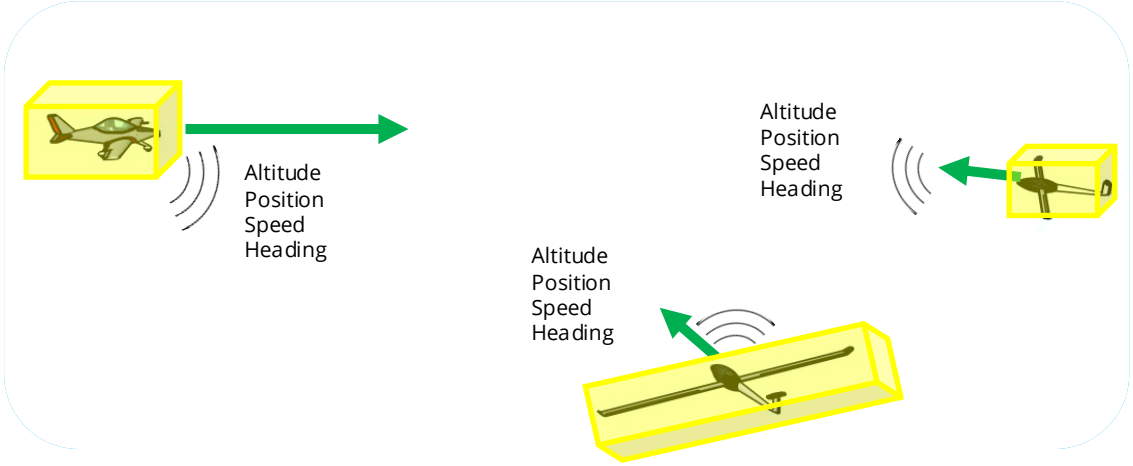
KY-LOC 2D: PRECISE GPS-DENIED POSITIONING CREATES SAFETY, AWARENESS AND COST REDUCTIONS



CRANES/VEHICLES CAN WORK LIKE AIRPLANES…

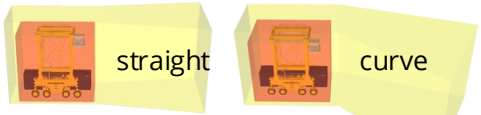
HOBBY PILOTS COLLISION AVOIDANCE

- Small aircraft outside commercial air traffic make use of a send/receive unit with GPS-based position, heading and speed to avoid collisions.
- All units continuously radio broadcast this data, without an established communication partner.
- All units listen in parallel, receive other aircraft´s broadcast messages when in receiving distance, and compute their individual collision risk, based on own position, speed and heading, as well as on the movement of those near by.
- Full 3D collision avoidance in any direction
- No central brain/server/operator involved.



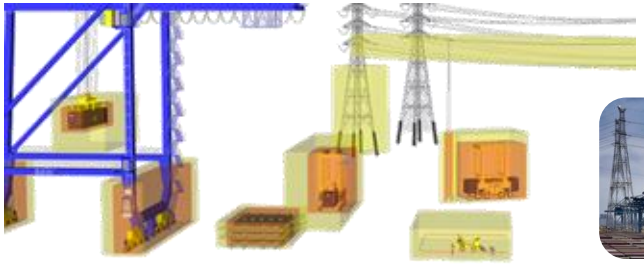
3D COLLISION PREVENTION ON TERMINALS

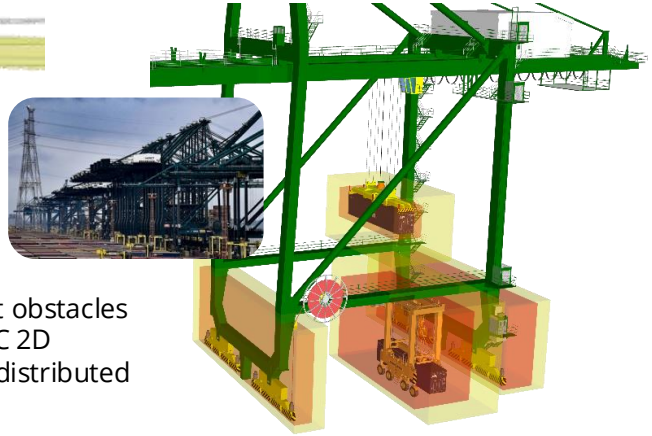
HIGHLY PRECISE COLLISION ANALYSIS – WARNINGS ONLY IF REQUIRED



Individual fixed collision shape
Individual, speed and heading dynamic warning shape

Overlap of dynamic warning shapes (yellow) and active movement prediction based on approach speeds:
=> warning will be triggered





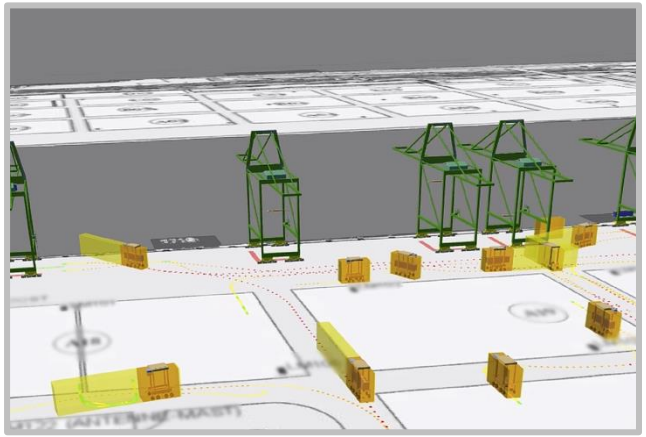
Positions of temporary alert zones (hatch covers, temp. work zones, silent monitoring zones) and permanent obstacles (buildings, light poles, power lines) are stored in the KY-LOC 2D database. Whenever there is an update, the database is redistributed to all CHE.

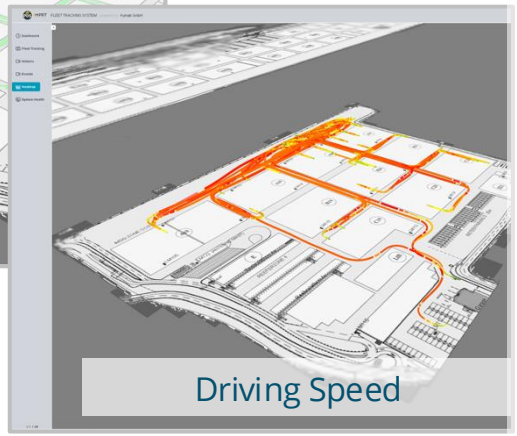
BENEFITS

- All CHE have precise position/heading and a collision radio to listen to near-by objects
- Each CHE calculates independent collision risk against other dynamically moving units (vehicles, cranes, containers) and static objects in their local database (updated when required).
- Safe and uninterrupted operation, no server, no central point of failure
- Warning precisely adjustable, only if really required => strong acceptance by operators/drivers

KY-OMNI - RECORDED MOVEMENT DATA ANALYSIS

KY-OMNI PROVIDES UNRECOGNIZED INSIGHTS INTO OPERATIONS





KY-OMNI data mining
Stats visualised:

- Occupany / time
- Speed / area
- Container sources / destinations
- Your criteria...

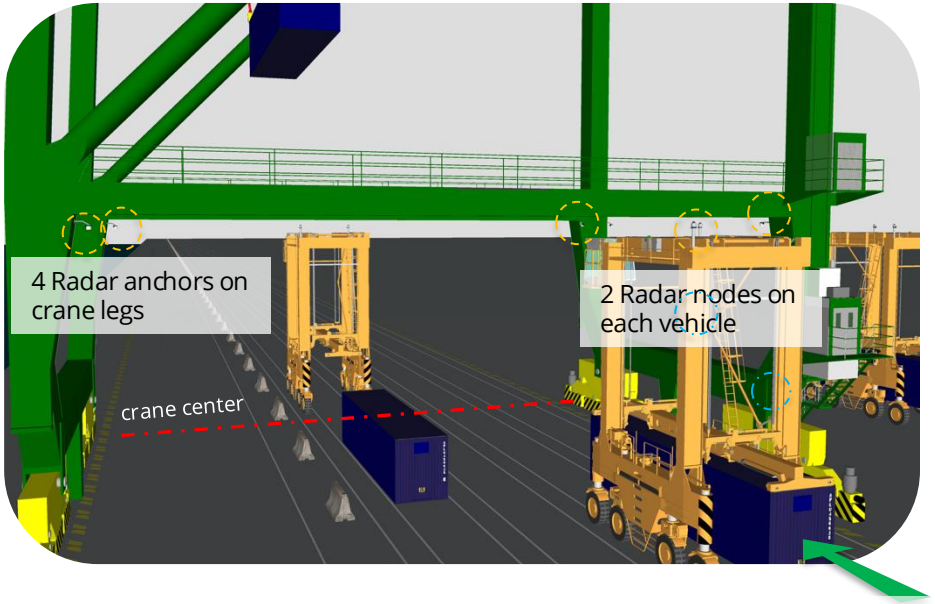
KY-OMNI Digital Twin
- All CHE displayed, independent of make and age
- **replay any scene,** any time, from any viewport

PRECISE HANDOVER POSITION UNDER CRANES

GUIDANCE FOR DRIVERS OR AGV OPERATION

BENEFITS

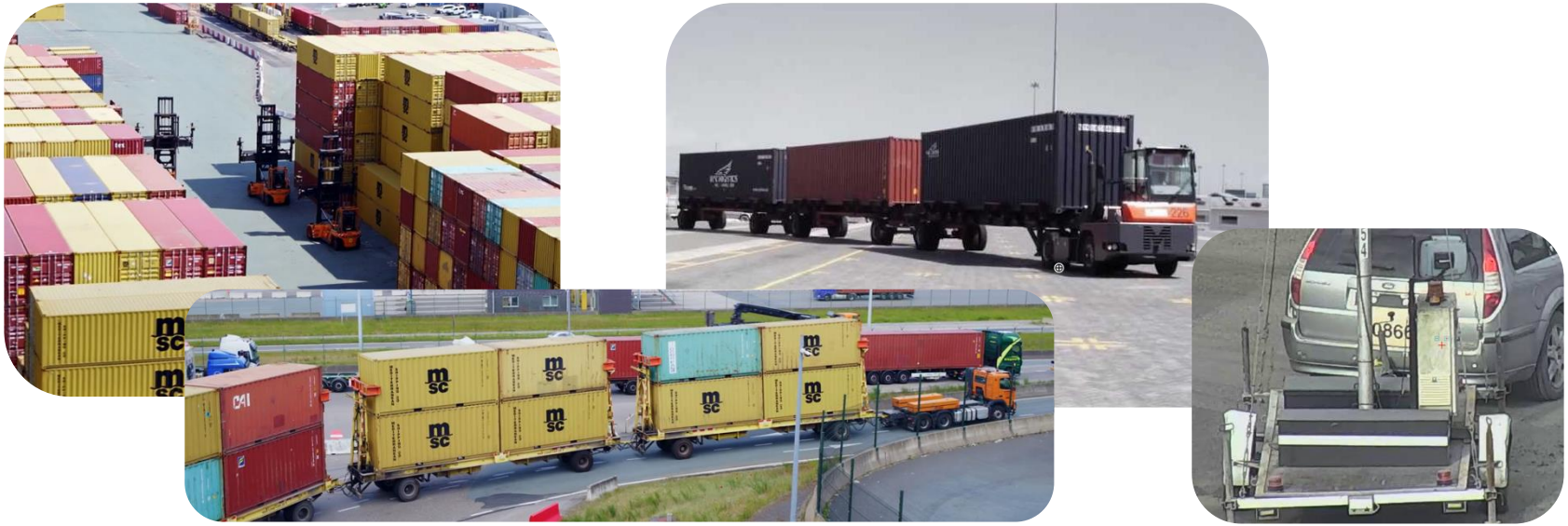
- Position detection allows precise vehicle position in GPS/GNSS denied areas under and next to the crane.
- Several stopping points for CHE can be preconfigured per each crane, depending on the container size under spreader, crane type and vehicle make (individually).



- Driver gets optical ‘car wash-like’ position indication (visual and audio) on cabin display
- AGV control receives continuous position in GPS/GNSS format or local coordinates.

OTHER CHE INCLUDED IN TRACKING AND COLLISION AVOIDANCE @ MPET

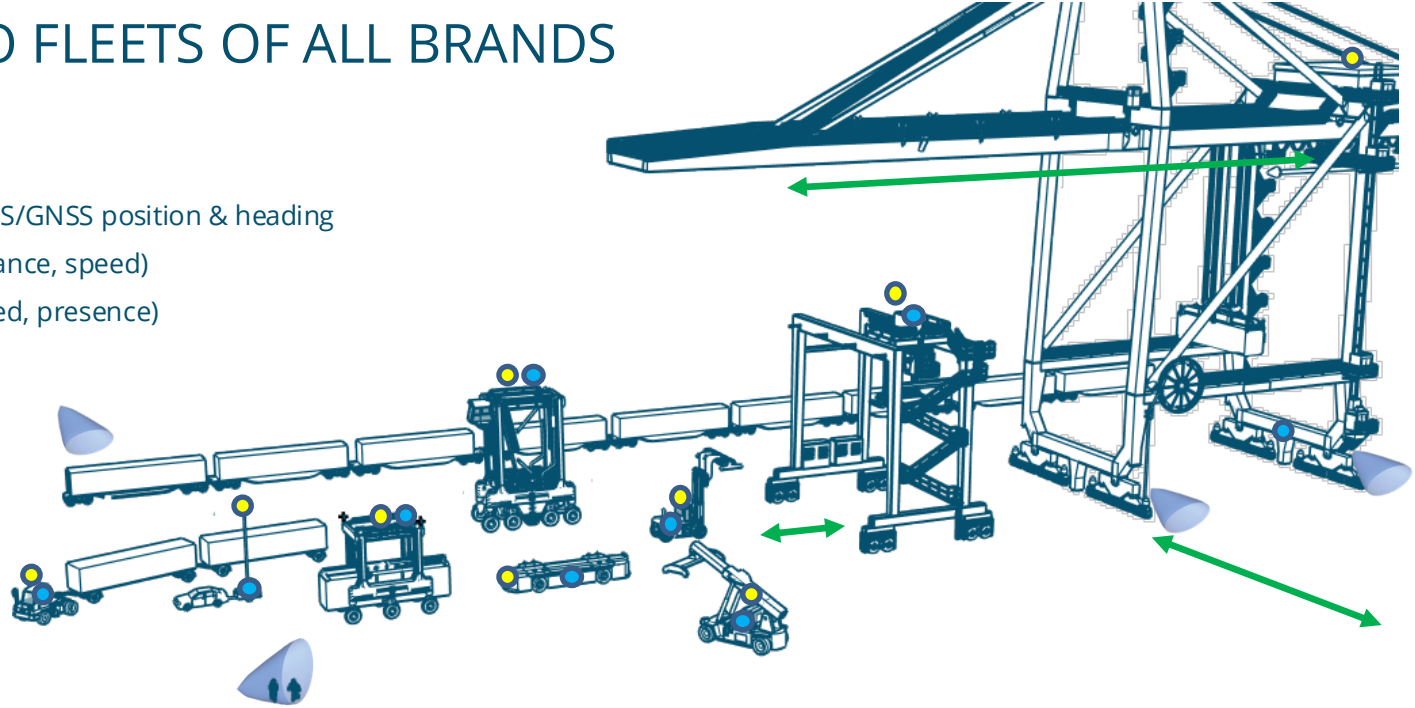
EMPTY HANDLER, TERMINAL TRACTORS + TRAILERS, CARS



KY-LOC 2D - FOR ALL CHE* TYPES

APPLICABLE TO FLEETS OF ALL BRANDS

- Kymati 2D Radar & GPS/GNSS position & heading
- Kymati 1D Radar (distance, speed)
- Kymati 3D Radar (speed, presence)
- navigation hub

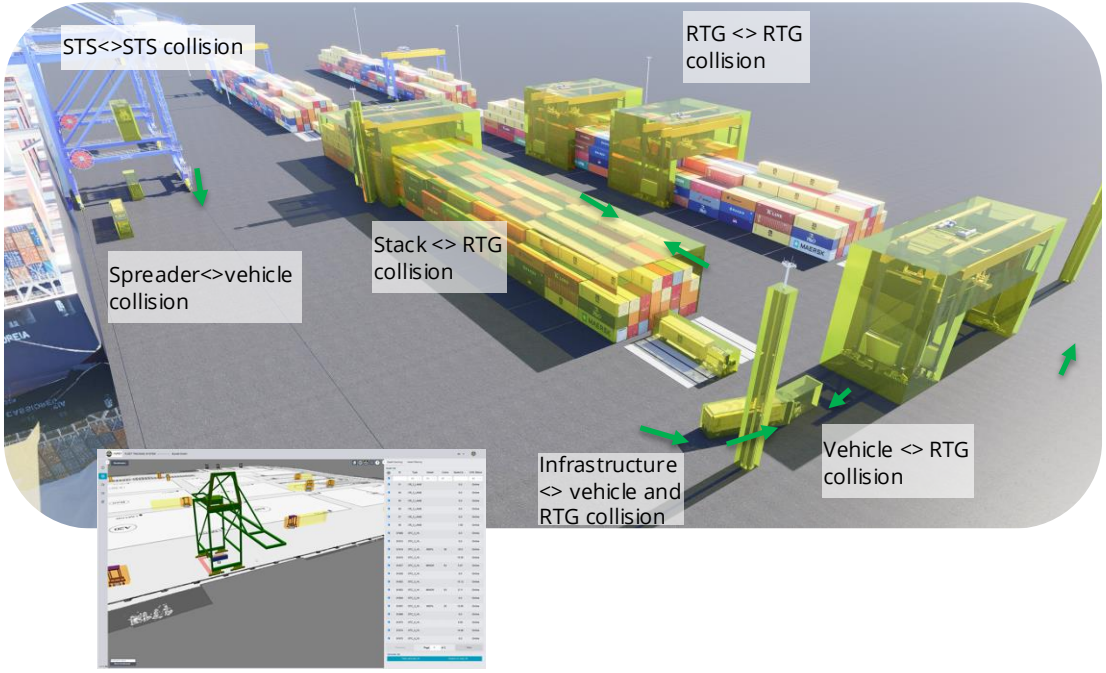


*) CHE=Container Handling Equipment

KY-LOC 2D: RTG CONTROL & COLLISION AVOIDANCE

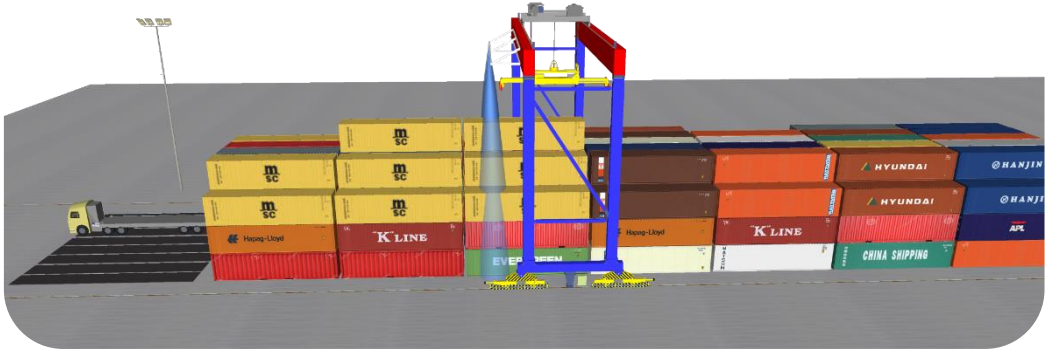
RTGs <> STS SPREADER & CONTAINER <> TERMINAL TRACTORS - ONE SYSTEM FOR ALL

- With only the precise position measured, all static (lightpoles, buildings, stacks) and dynamic objects (all CHE) can be protected in all three dimensions.
- With all vehicles, RTGs and STS cranes, a full digital twin in 3D, dynamically representing all movements and positions of equipment in real time is provided by the optional web-based KY-OMNI application.
- Collision avoidance does not require any server or network connection



CONTAINER TERMINALS – STACK PROFILING

ACTUAL STACK PROFILE MEASUREMENT

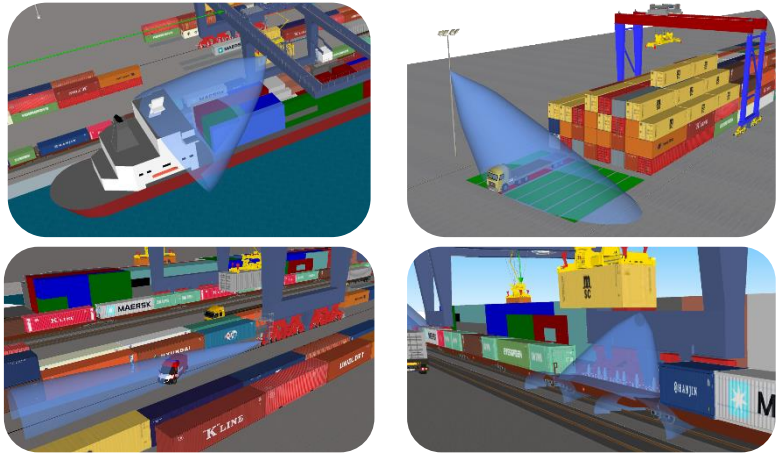


BENEFITS

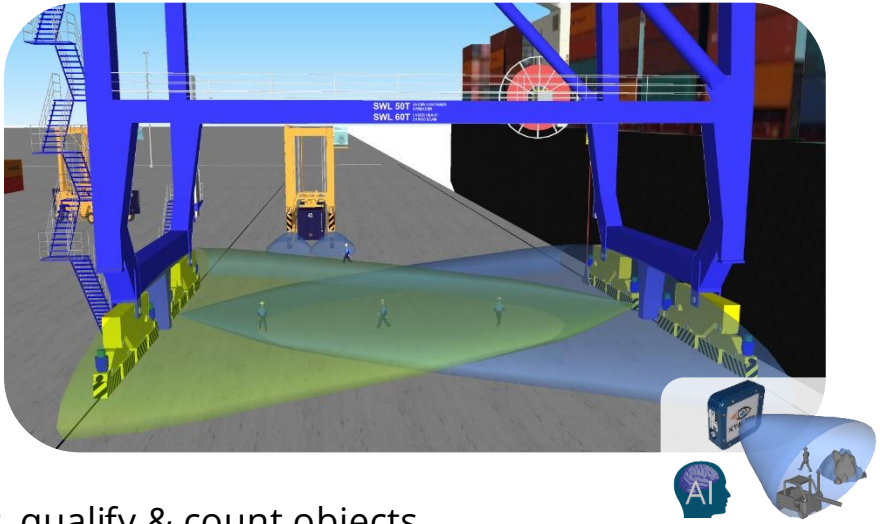
- Only 4 sensors for 8 rows required to get complete shape data
- No maintenance, no re-adjustment or cleaning, no interruptions for installation
- High reliability for operational safety and TOS data.

CONTAINER TERMINAL – ABSENCE & PRESENCE

OBJECT DETECTION

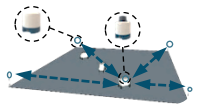


PERSON DETECTION



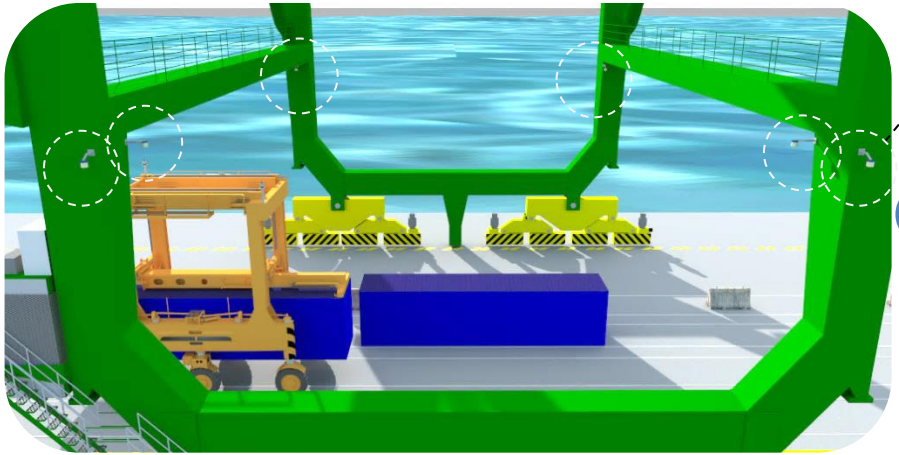
BENEFITS

- High resolution radar can detect, qualify & count objects
- No maintenance, no re-adjustment or cleaning, no interruptions for installation
- High reliability for operational safety and automation of processes



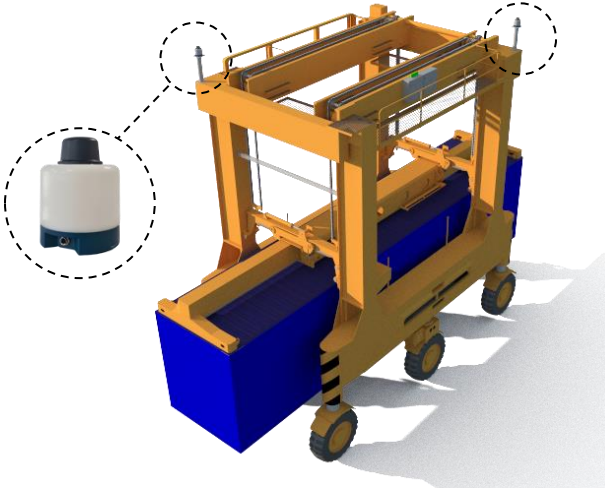
KY-LOC 2D FOR FULLY AUTOMATED 1OVER1 STRADS

AUTOMATED 1OVER1 STRADDLE CARRIER POSITION



A KY-LOC 2D anchors under quay crane and on last row of lightpoles

N KY-LOC 2D nodes on straddle carrier (2D Radar & GNSS)



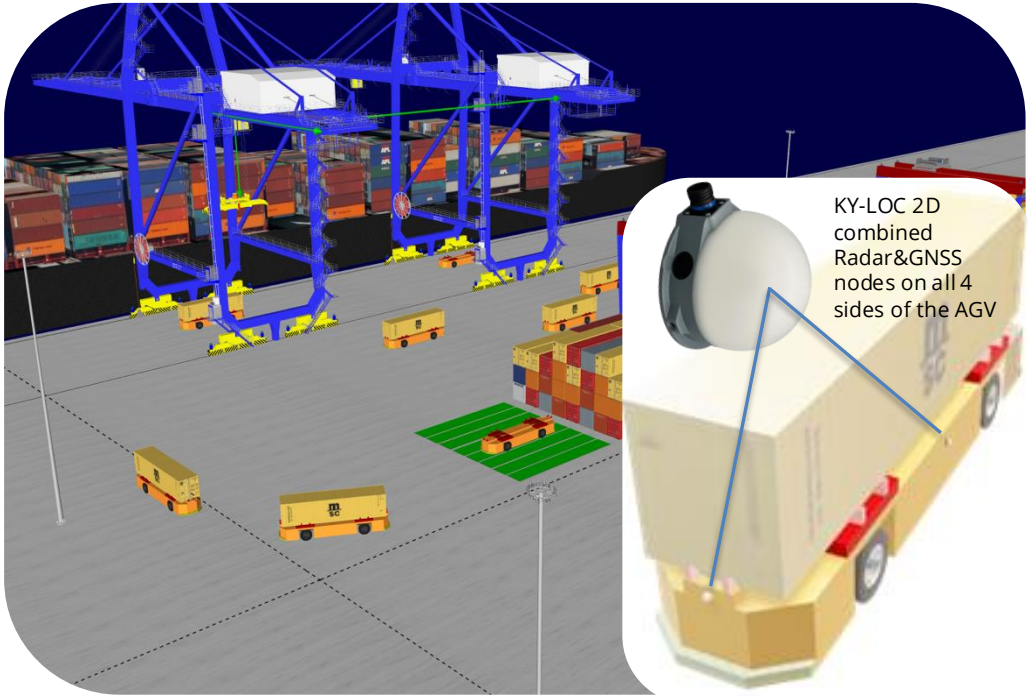
BENEFITS

- Highly reliable and precise position in GNSS denied areas
- RTK-GNSS used in yard areas – no infrastructure required
- Maintenance-free – no moving parts, not affected by weather or dust
- 2D accuracy ±3cm with built-in redundancy, for high SIL/PL level of automation

HORIZONTAL TRAFFIC - FLATBED AGV

PRECISE 2D POSITION, WITHOUT GPS/GNSS UNDER CRANES AND IN HANDOVER ZONES

- Distance/angle receiver on all four sides of AGV allows precise position and heading measurement to a single reference unit under crane or in the yard
- RTK GPS/GNSS receiver is included in 2D radar nodes. The nodes use Radar and RTK-GNSS simultaneously and fuse position and heading results.



GET IN TOUCH

KYMATI

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