Logivations logistic & innovations

PIXEL ROBOTICS

Pixel PT

The intelligent, economical and sustainable pallet transporter for dynamic environments

Working permanently with the latest technologies

Product videos at the links below:

PixelRoboticsPT

Agenda

1. Company presentation
2. Real Time Localization & Recognition System
3. W2MO - Digital Twin powered by AI
4. Navigation with the Real-Time Digital Twin
5. Pixel PT
6. Fleet Manager
7. Use Cases
8. AI vs. traditional approaches
9. Profitability
10. Sustainability

1 Company presentation

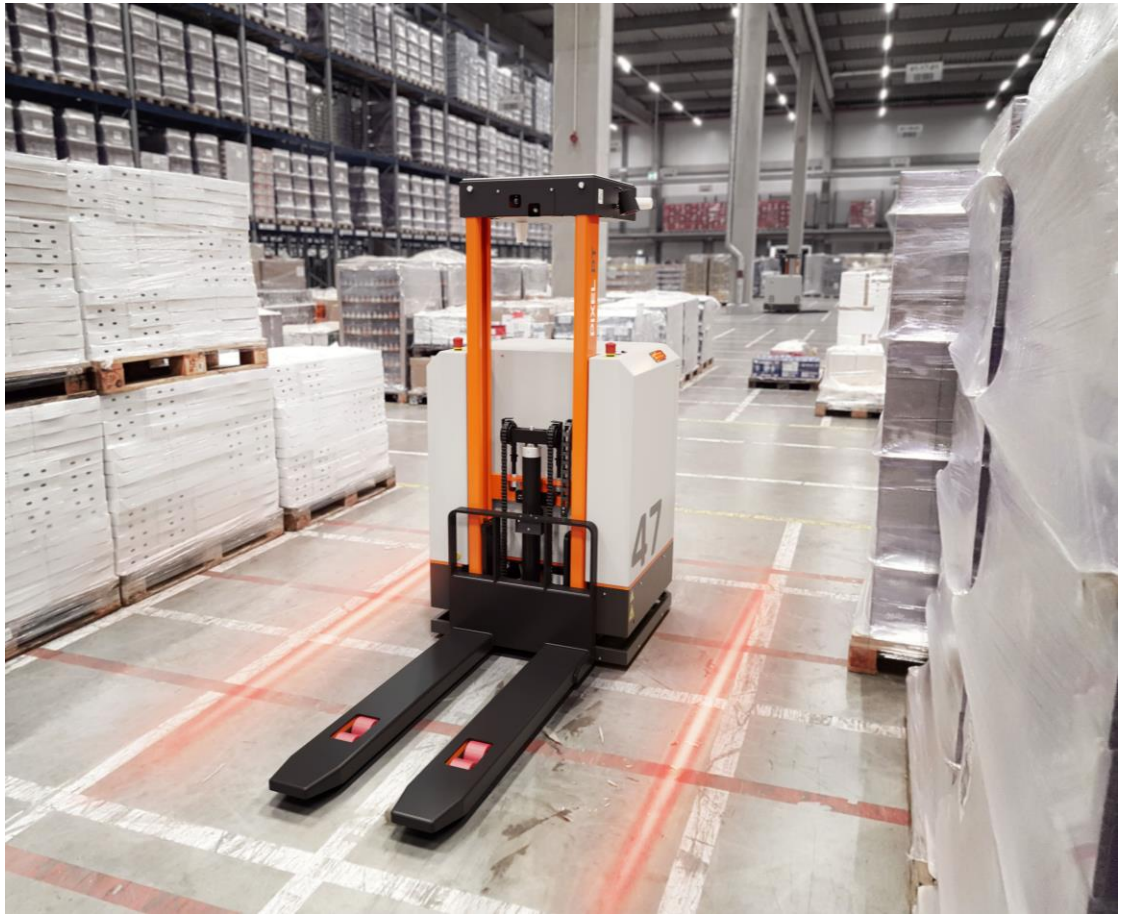
Pixel Robotics

AI-based mobile robots for transport in intralogistics since 2018

Customised solutions for logistics environments with high flexibility requirements and a high proportion of manual work

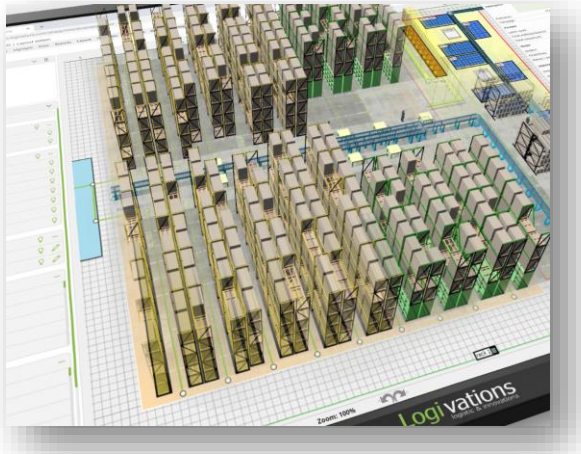
AI-based problem solving of human process errors for use in mixed human-robot fleets

Strategic partnership with Nvidia



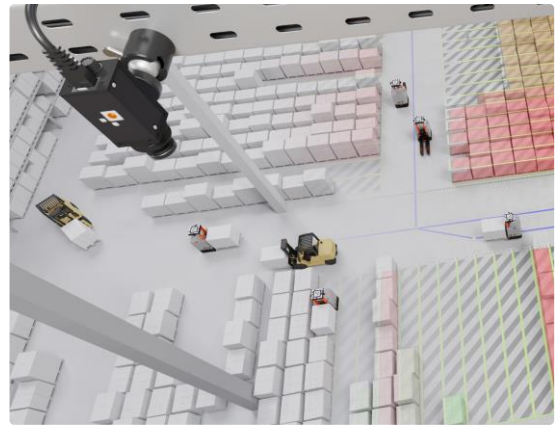
1 Company presentation

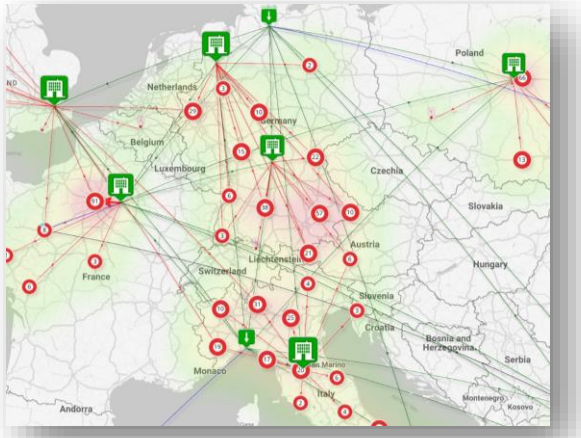
Logivations



Digital Twin & Real Time Digital Twin

- Design, Planning, Simulation & Optimization
- Algorithms: Slotting, Tour building, 3D cubing, capacity optimization + many more
- Process and Structure Optimization
- End-to-end Tracking of Goods and Transporters
- Touchless, Scanfree Warehouse with 100% stock accuracy
- Worker Safety
- Fleet Management





Supply Chain Engineering

- Center of Gravity
- Supply Network Planning
- Optimized Material Flow
- Interactive, Browser-based Optimization

AI-based Recognition

- Verified Identification
- Text reading and decoding
- Dimension Measurement
- Counting
- Identification Gates

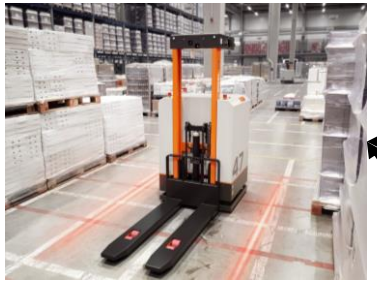
General Features

- Many reports, KPIs, analysis
- 200+ parameterizable interfaces
- Extrapolation, algorithmic data generation
- Scenario manager
- RESTful APIs, SAP, and database integration
- Excel-/CSV-Integration
- AI-based data consistency check

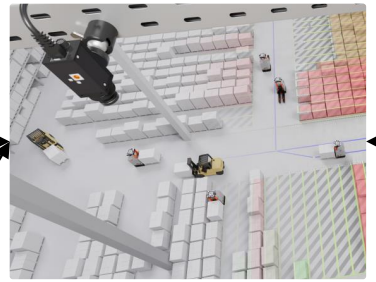
1 Company presentation

Cooperation between Pixel Robotics and Logivations

Mobile Robots

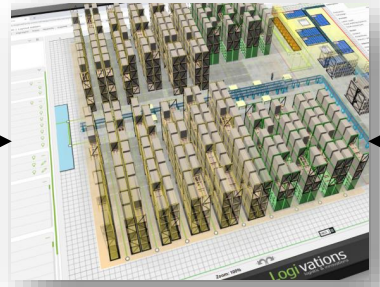


Real Time Digital Twin

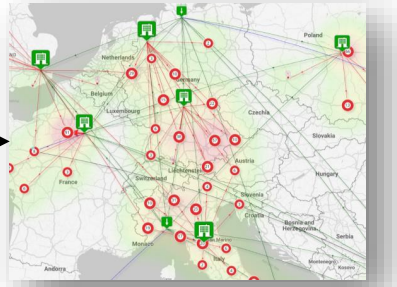


AI-based Recognition

Digital Twin



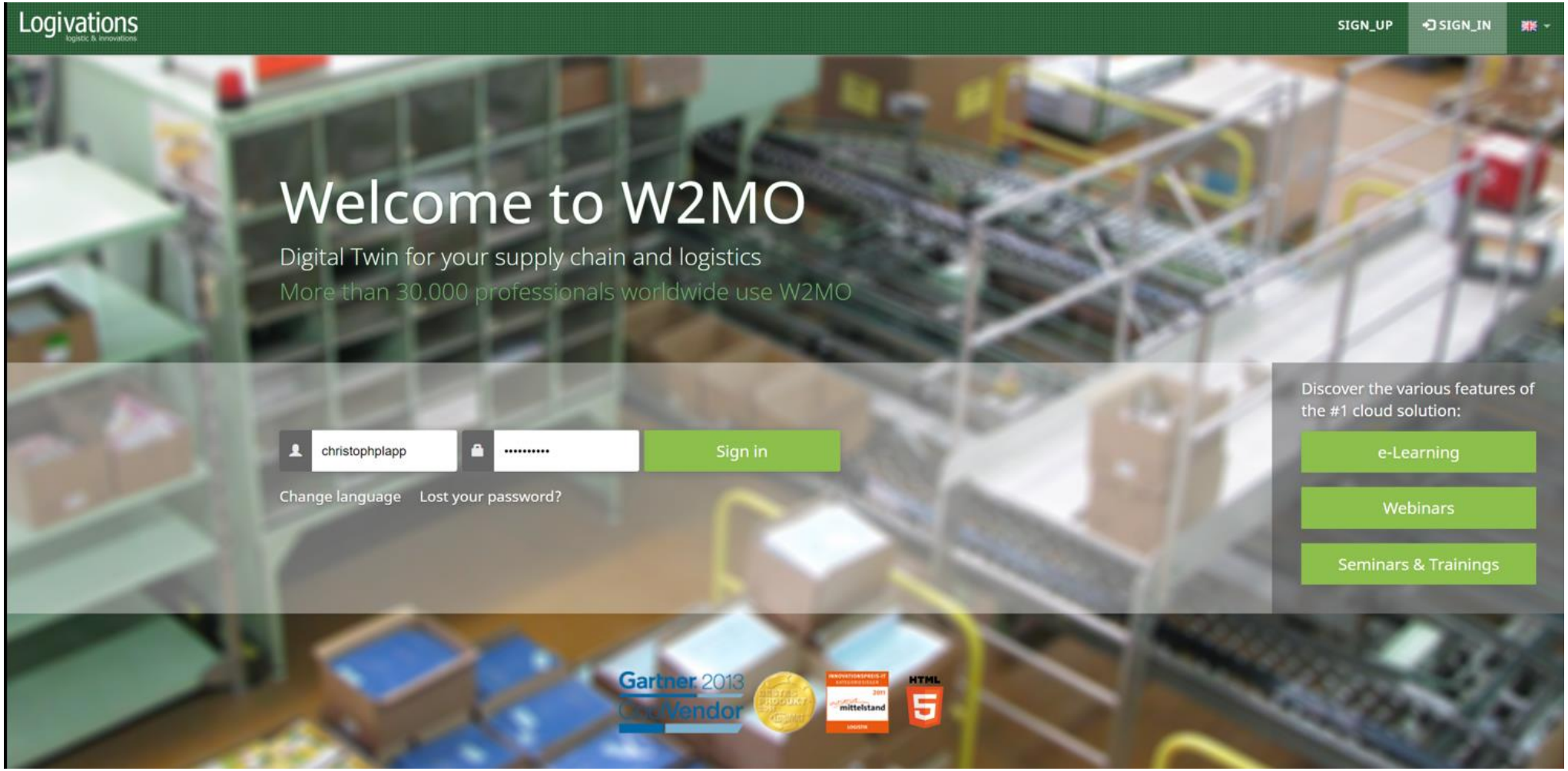
Supply Chain Engineering



1 Company presentation

W2MO – The Real-Time Digital Twin powered by AI

Please sign up for a free test account under: https://w2mo.logivations.com



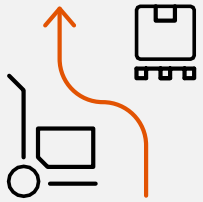
2 Real Time Localization & Recognition System

How it works: Cameras & AI connect reality with a digital twin

1

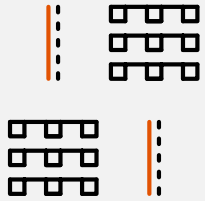
AI recognition units placed on the ceiling track everything in real-time

2



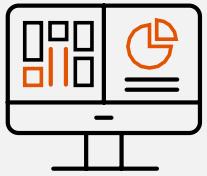
They analyze the shop floor for obstacles and vehicles

3



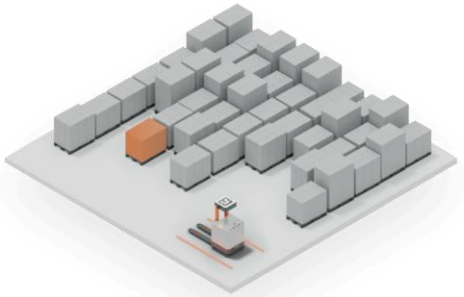
Determine the availability of target locations

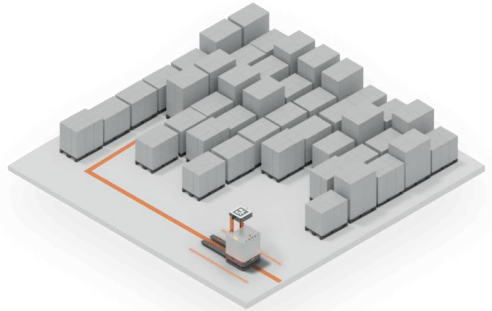
4



A digital twin is created and used for navigation and fleet management

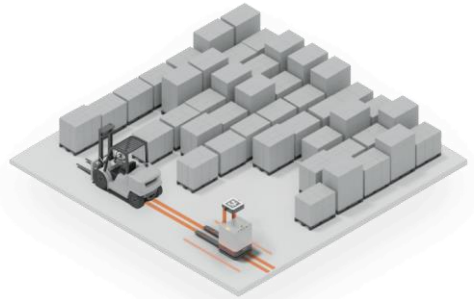
Flexible pallet pick-up and put-down without predetermined transfer points.





Forward-looking data of the digital twin enables flexible **avoidance of obstacles**

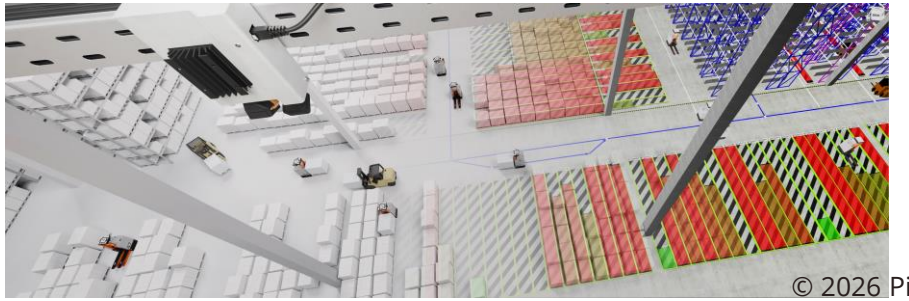
Intelligent and differentiated interaction between robots, people and forklifts **in hybrid environments**



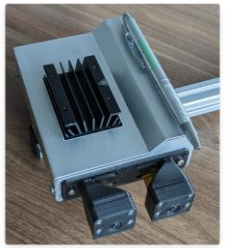
2 Real Time Localization & Recognition System

Recognition units: Commercial off-the-shelf

- Cameras
  - Resolution: 5MP, 120 degree viewing angle (other viewing angles optional)
- Industrial cameras directly connected to processing unit
  - NVIDIA AGX Orin Xavier
  - Processes 4, 8 or 12 camera inputs in parallel
  - Detection is decentralized, directly on the GPUsNo streaming of video - only transmission of position data
  - Can be upgraded independently of the cameras
- Area coverage depending on the accuracy of localization (1mm - 10 cm): 100m2 - 500m2
- Very fast: latency < 50ms
- Approx. 380 € per industry-camera

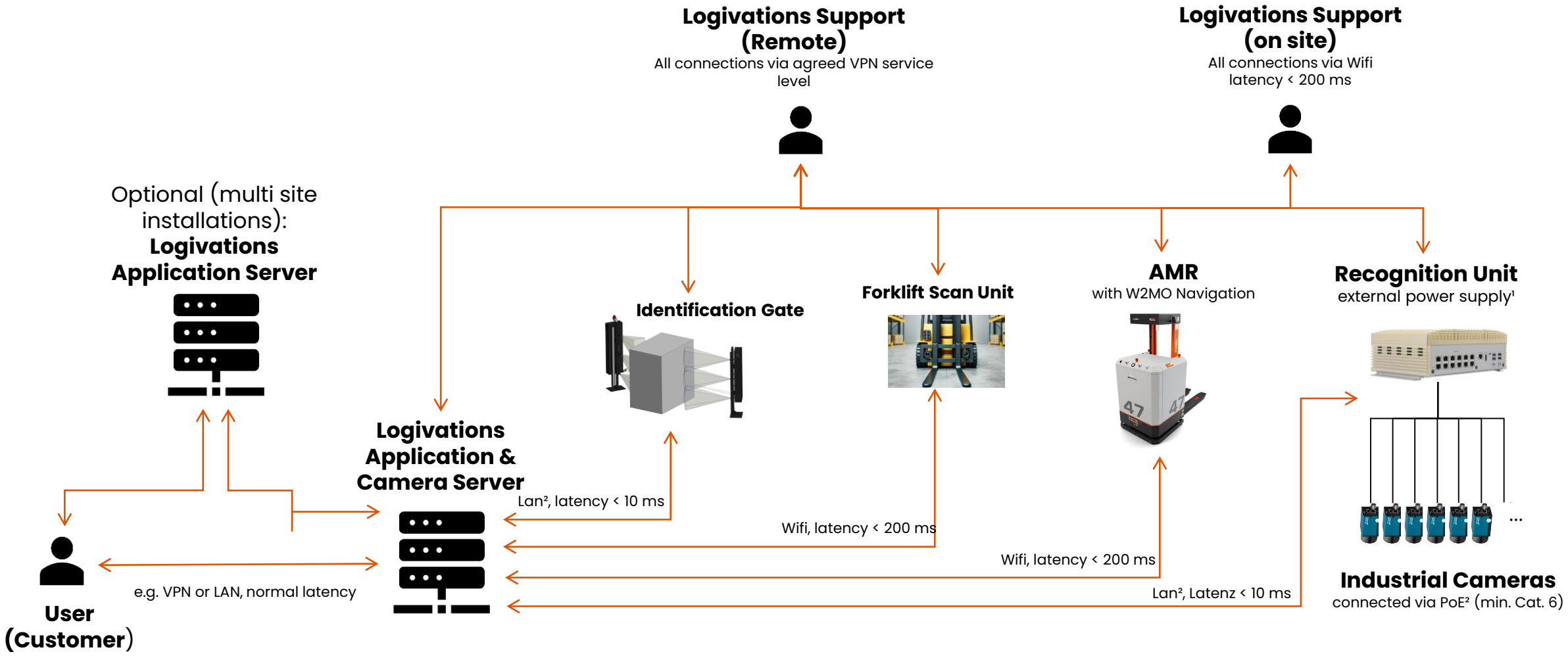


1. Generation (2018): 0.003 TOPS – **Raspberry PI with ML-Stick**
2. Generation (2020): 0.5 TOPS – **NVIDIA Jetson**
3. Generation (2023/24): 22 TOPS – **NVIDIA Orin** (in use)
4. Generation (2025/2026): **NVIDIA Thor planned > 100 TOPS**



2 Real Time Localization & Recognition System

Network Topology: Highly distributed & decentralized & parallelized software architecture

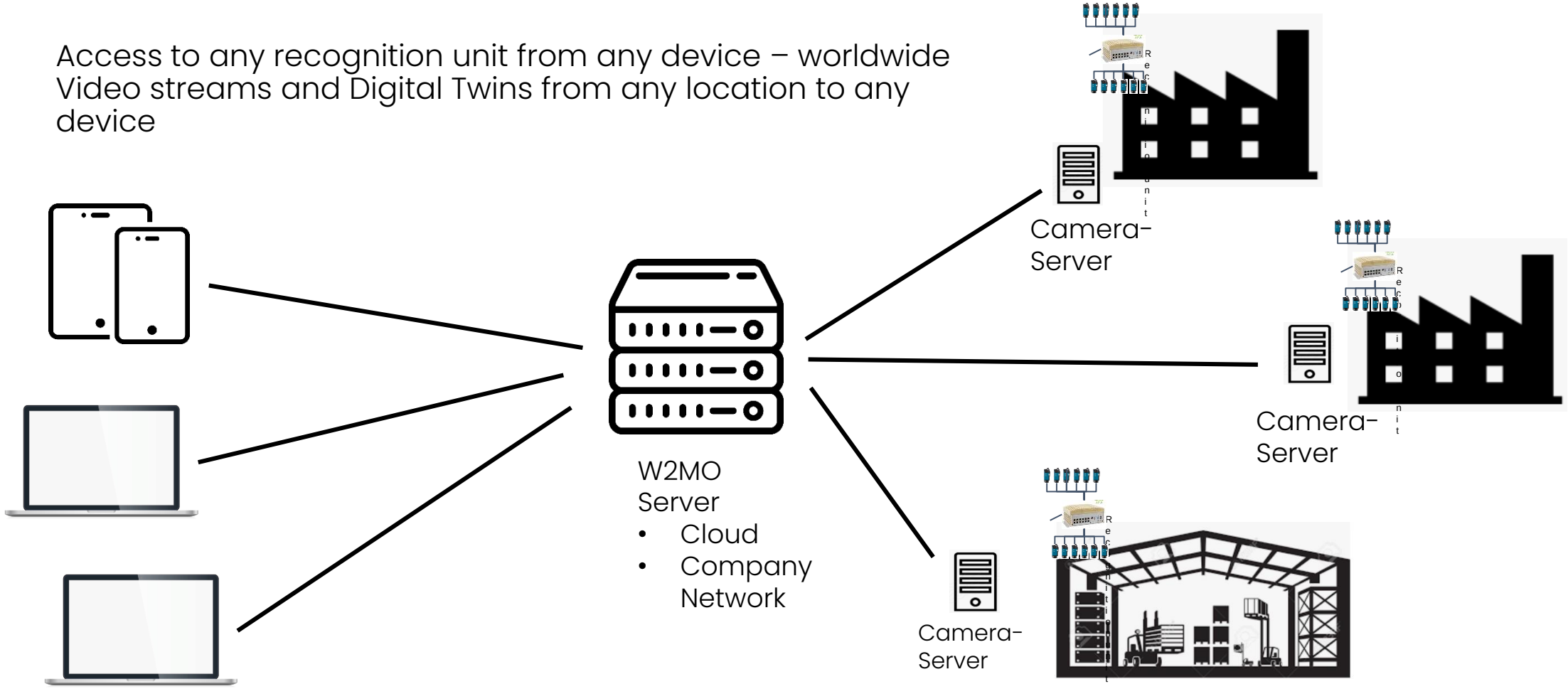


¹: External power supply: 24V DC or Standard 230V AC via power adapter
²: Max. Lan/PoE cable length for each connection: 100m

2 Real Time Localization & Recognition System

Network Topology: companywide access

Access to any recognition unit from any device – worldwide
Video streams and Digital Twins from any location to any device



3 W2MO - Digital Twin powered by AI

Aggregation and combination of all available information, fusing the real and digital world.

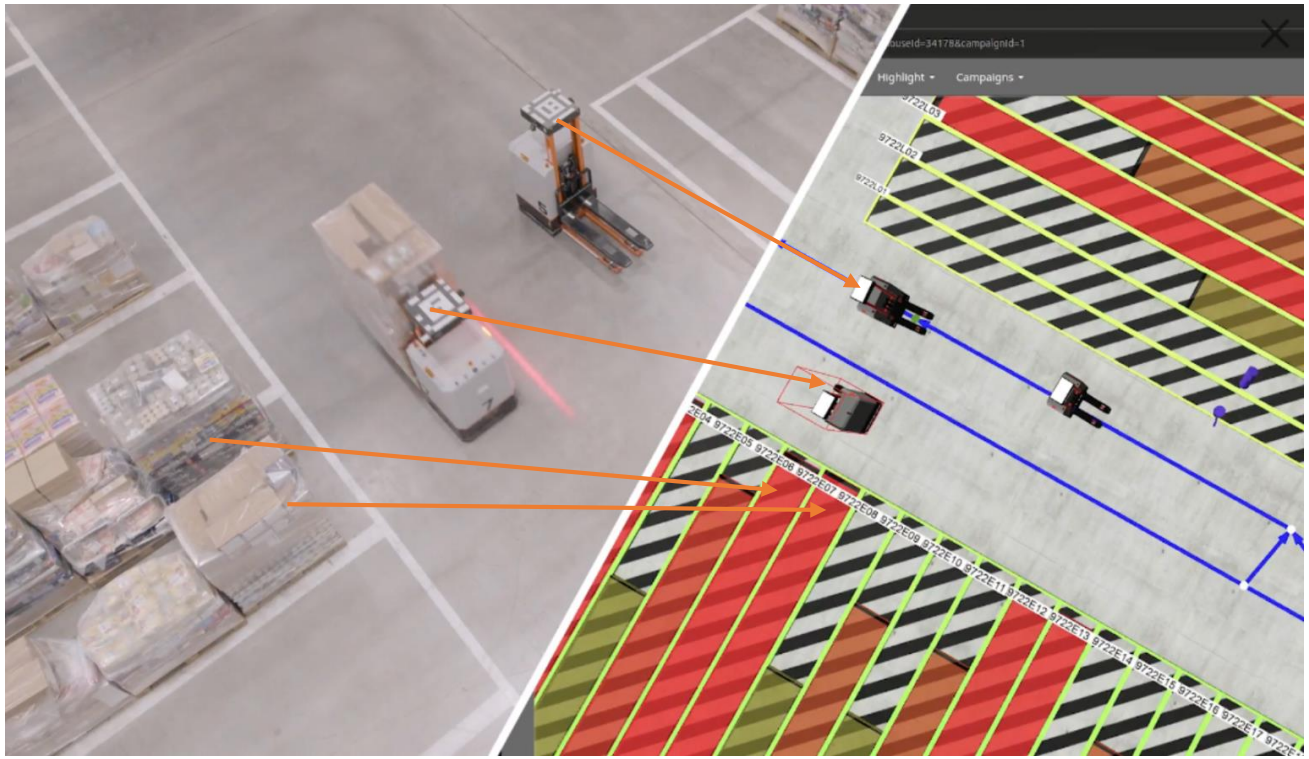
Drag&drop process modelling
Easy path and process (re)modelling

Real-time visualization
All traffic, goods to carry and obstacles in real time. We offer the best visualization in the market.

Web-based
Available anywhere on any device

Remote support
Access camera live view and control AMRs

Built-in WMS Integration
Connects to SAP and others

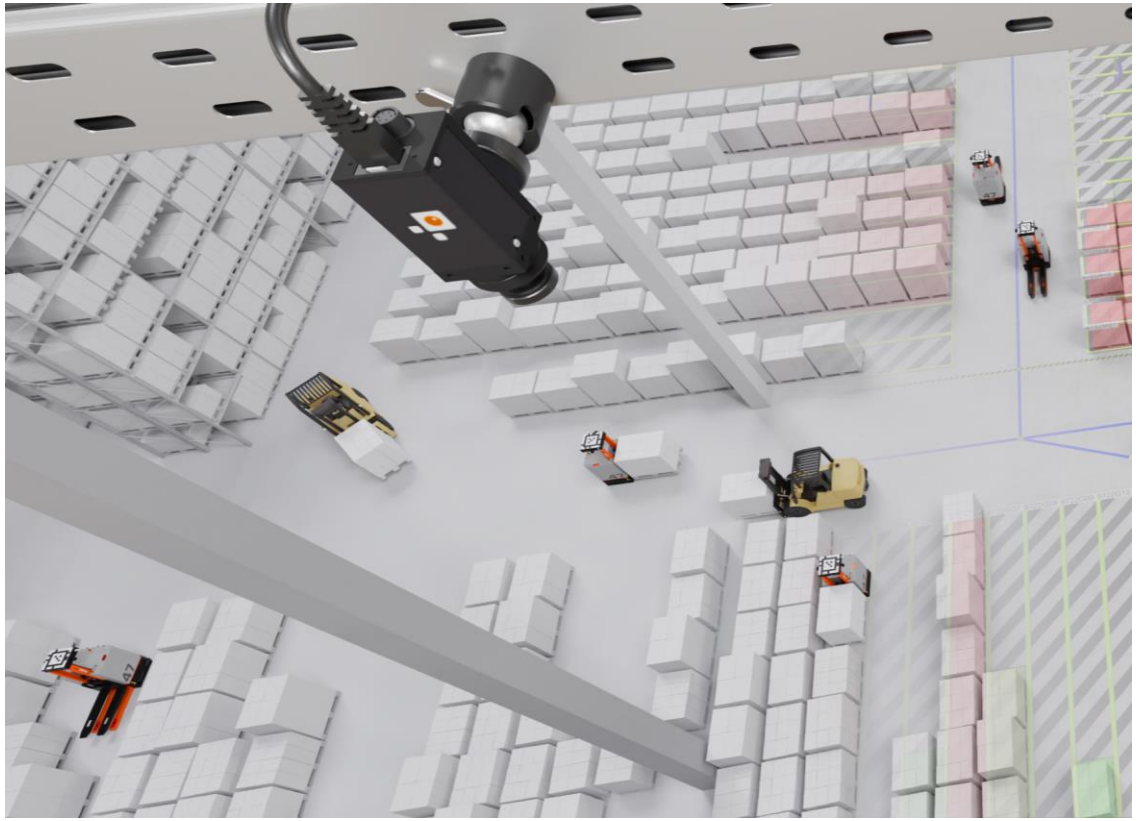


4 Navigation with the Real-Time Digital Twin

Visual AI navigation

Standard view

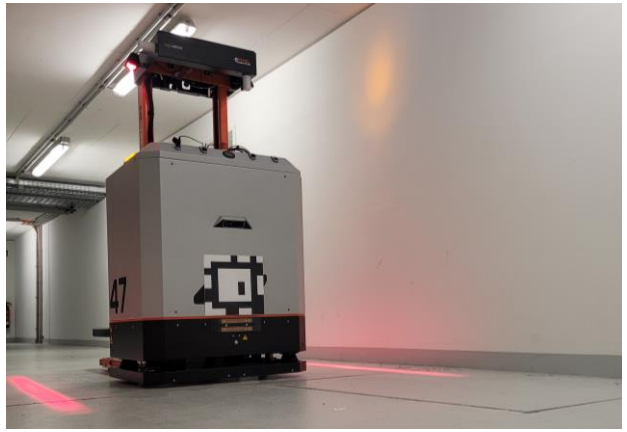
Hall height 3.5 to 14m



Particularly low hall height

Hall height up to 3.5 m

- Particularly in areas with little traffic or low ceilings (<3.5m), the number can be greatly reduced by using a flat camera orientation (range 20 - 40 m)
- The AMR receives an additional AprilTag on the front
- The AMR can travel intermediate distances (approx. 5 - 15m) without camera coverage via odometry



Real-Time Digital Twin determines the exact position

4 Navigation with the Real-Time Digital Twin

Driving without ceiling cameras

Odometry

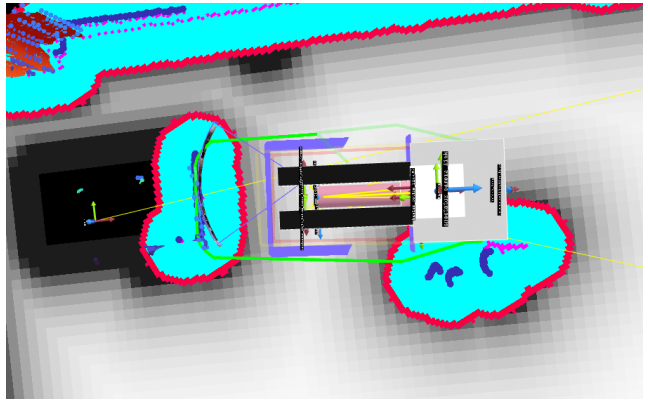
- Position determination based on the steering angle and wheel rotations
- Regular position calibration via ceiling cameras or SLAM

AprilTags

- Detection of April Tags with vehicle cameras
- Very precise and absolute positioning possible
- E.g. when transferring to platforms

SLAM

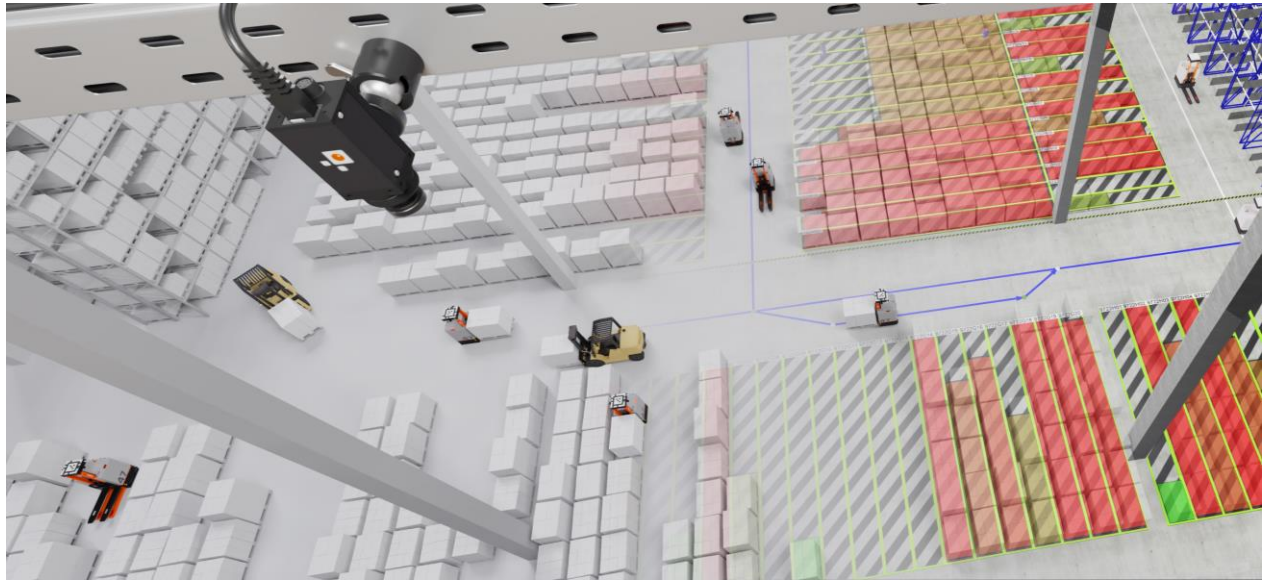
- Recognition of environmental features with safety LIIDARs and vehicle cameras
- Position estimation via comparison with map from the Real-Time Digital Twin



4 Navigation with the Real-Time Digital Twin

Areas with a lot of activity - high traffic volume

- Predictive obstacle detection - intelligent avoidance and bypassing of obstacles
- Best multi-AMR behavior - optimal control of the «swarm»
- Mixed operation
- Dynamic routes - free navigation
- Fill level detection, automatic order generation
- Tracking of all goods movements
- Fleet management of mixed fleets
- Additional safety through person recognition of ceiling cameras

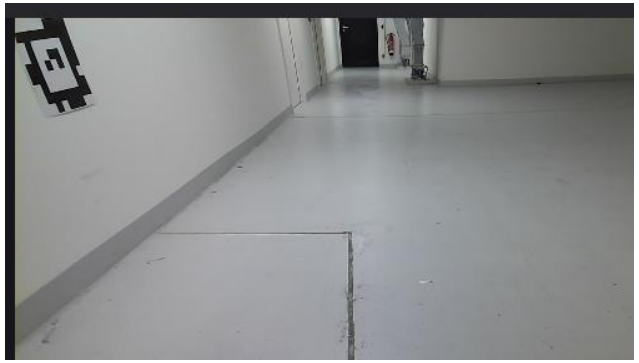


Full camera coverage: all functions

4 Navigation with the Real-Time Digital Twin

Areas with little activity - low traffic volume

- Obstacles are only detected when the AMR is in front of them
- Fleet management only for the AMRs
- Traffic situations with AMRs and forklifts can only be controlled with simple rules (position and movement of the forklifts is not known)
- Safety only via the safety scanners and on-board cameras
- AMR drives via odometry and calibrates the position with SLAM



View from the AMR camera

No camera cover:
Fewer functions

5 Pixel PT: Hardware and safety concept

Our hardware and safety concept is modular and cost-efficient

- Autonomous mobile robot based on a **LEAN, modular and robust hardware concept**
- Combines **proven parts of industrial trucks**
- Particularly safe due to **double safety technology**: Camera/AI object recognition and CE-compliant laser safety scanners
- 3-wheel geometry and slim design allow **navigation in tight spaces and narrow aisles**

Max. Speed:	1.5 m/s
Max. Lifting Weight:	1,300 kg
Lifting Height:	250 mm | 500 mm | 900 mm
Dimensions:	1,980 x 800 x 1,740 mm Fork length can be adapted to the load on request
Turning Radius:	1,650 mm
Min. Aisle Width:	1,000 mm
Weight:	550 kg

5 Pixel PT: Hardware and security concept

A robust vehicle for logistics - developed from practical experience

Simple operation: On/Off, emergency stop, brake release, manual operation - everything else is automatic

Bumper and sturdy housing. Easy to repair if a forklift truck runs into it

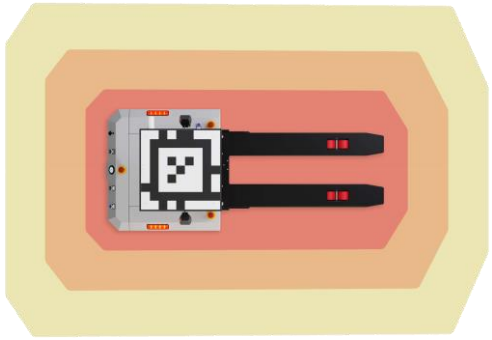
With a drive wheel diameter of 28 cm, even larger expansion joints are no problem for the PIXEL PT

5 Pixel PT: Hardware and safety concept

Low maintenance, safe and cost-effective

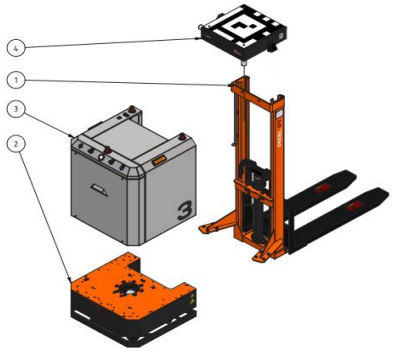
Battery concept

- **LiFePO4-battery** with BMS, battery cells are exchangeable and recyclable
- Continuous **operating time of up to 18 hours in real operation**
- Maximum operating time per day approx. 20 – 21 h
- **Automatic charging** and charging control
- Fully **charged in 2h**



Safety

- Full safety in human-machine operation
- SICK laser safety scanners **with 360° coverage** and Flexisoft safety controller
- **3D-cameras** for obstacle detection
- Distance Sensors
- Emergency stop buttons
- **CE-Declaration**



Maintenance and operation

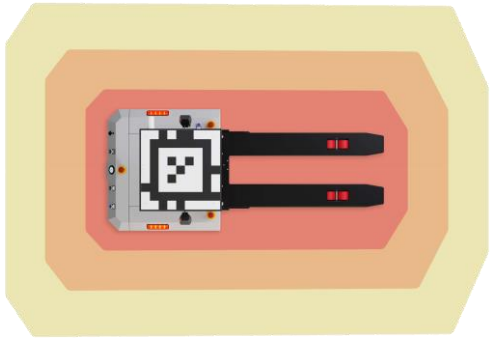
- Sensors installed protected
- Robust housing and proven components of industrial trucks
- Maintenance / repair / replacement of components can be carried out by the customer's workshop or local service providers

5 Pixel PT: Hardware and safety concept

Advantages

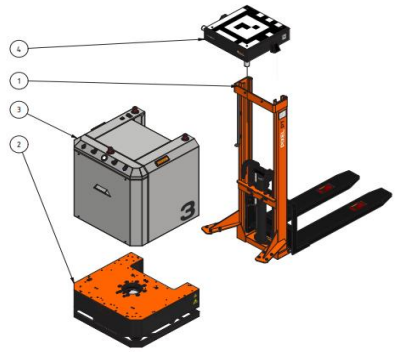
Battery concept

+ No intermediate charging necessary during the shifts -> Up to **10% more productivity** per AMR
+ Centralization of charging stations possible -> **Lower infrastructure costs**
+ **Sustainability:** Repairable batteries - replacement possible in 5 minutes



Safety

+ No blind spots -> standard-compliant driving in narrow **block storage lanes** with a width of up to 1m possible
+ **Integrated obstacle detection** for obstacles close to the ground such as forks
+ **Standard safety technology** from market leader **SICK**



Maintenance and operation

+ **Modular design:** More than 95% of components can be replaced in under 30 minutes
+ **Inexpensive maintenance** through extensive remote diagnostics and predictive maintenance

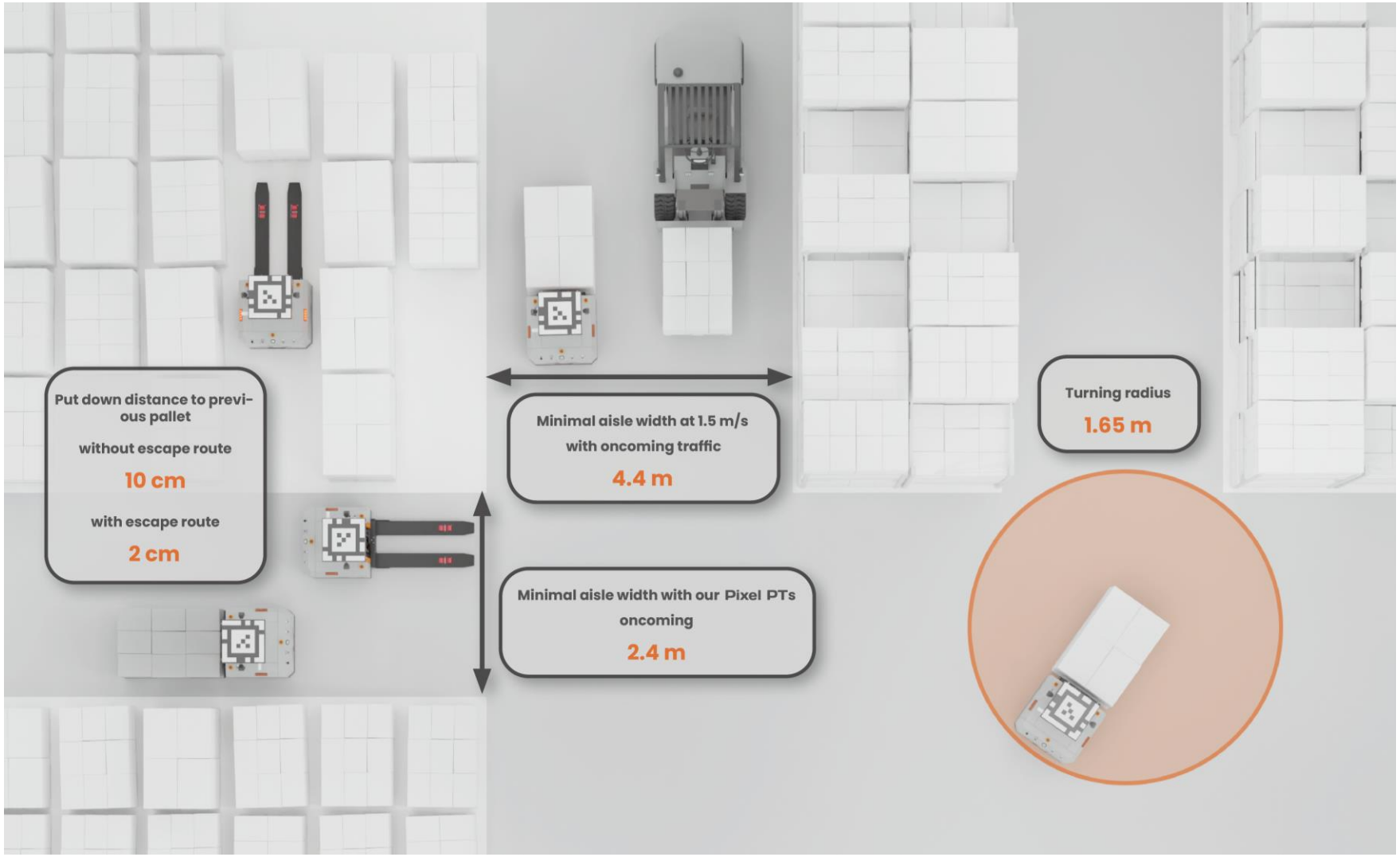
5 Pixel PT: Hardware and security concept

Fork detection

- The innovative, AI-based fork detection recognizes forklift forks - on the ground or in the air.
- Detected forks are avoided with sufficient safety distance.
- In contrast to conventional 3D cameras, the detection is robust against uneven ground.

5 Pixel PT: Space requirements

For transportation of 1,200 x 800 pallets (EPAL)



5 Pixel PT: Space requirements

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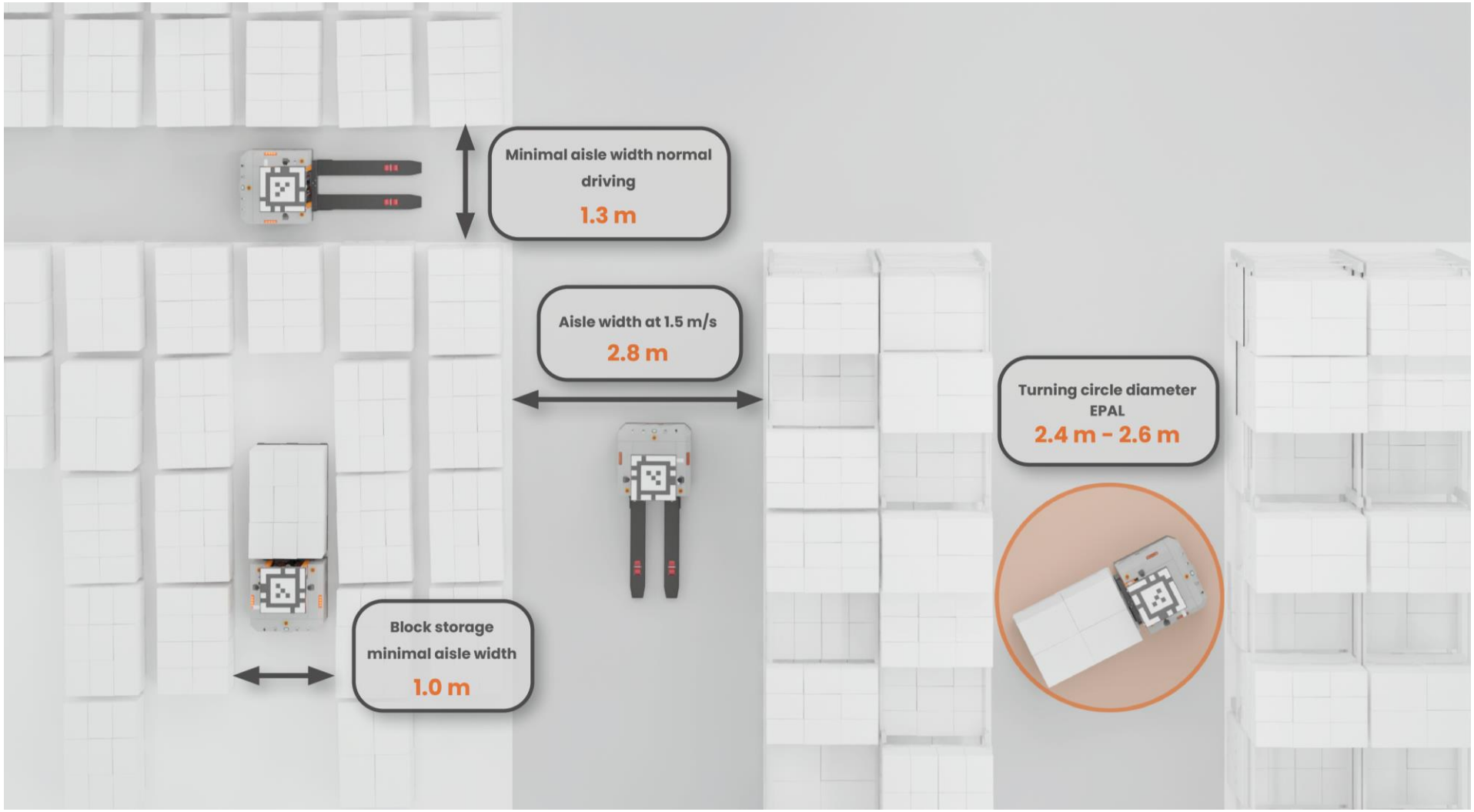


6 Fleet Manager

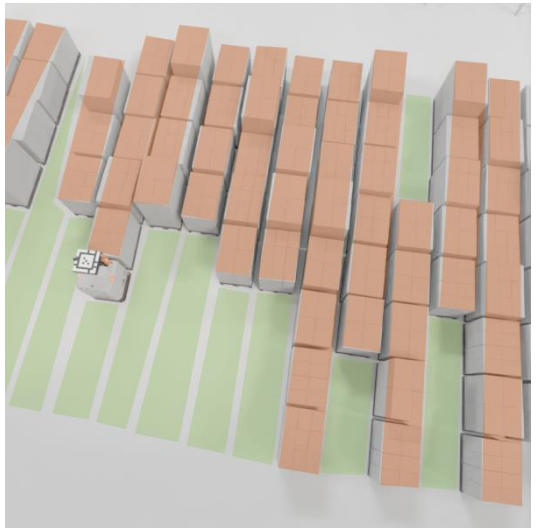
Flexible and automatic generation of transport orders using innovative AI approaches

Automatic order generation with

April tags

Order generation using fill

level detection & estimation



Automatic order generation via interfaces:

(RESTful API, SAP, WMS; VDA 5050…)

Manual order generation via

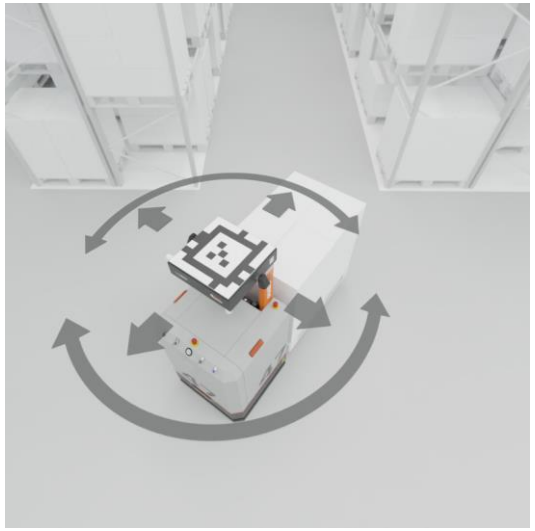
Desktop UI / App

6 Fleet Manager

Real-time fleet monitoring and management

Charging management

Teleoperation



Analytics

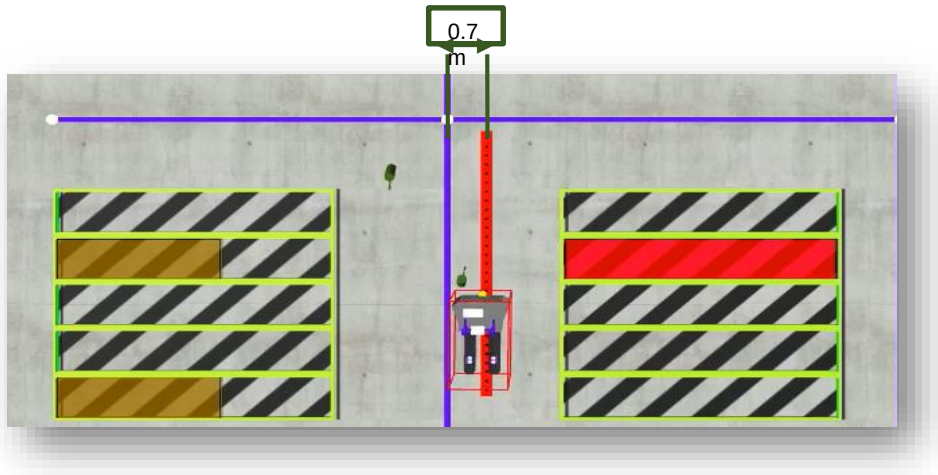
Automatic
push notifications
per email or phone

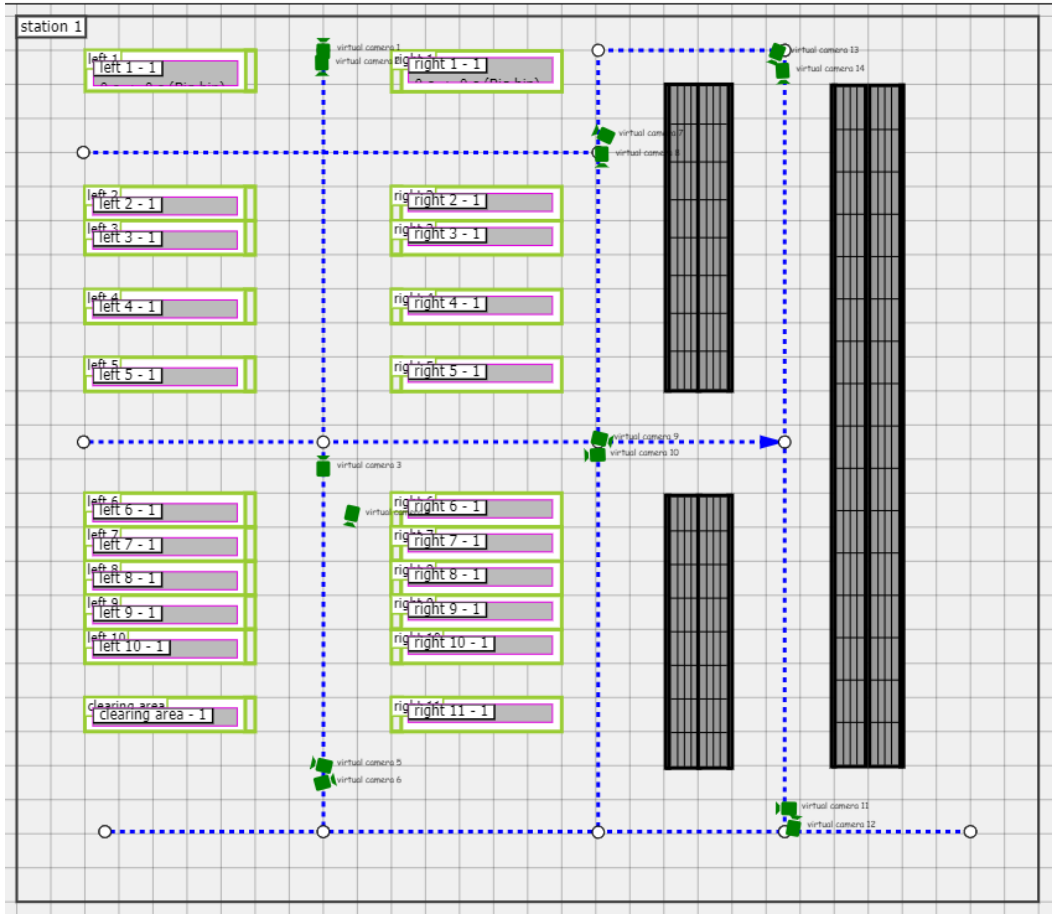
6 Fleet Manager

Interactive Configuration

Configurations in the digital twin:

- Restricted areas (areas that must never be driven on)
- A process network of routes that are preferred (optional)
- One-way paths, right-hand traffic, maximum speeds
- Waiting areas and home areas

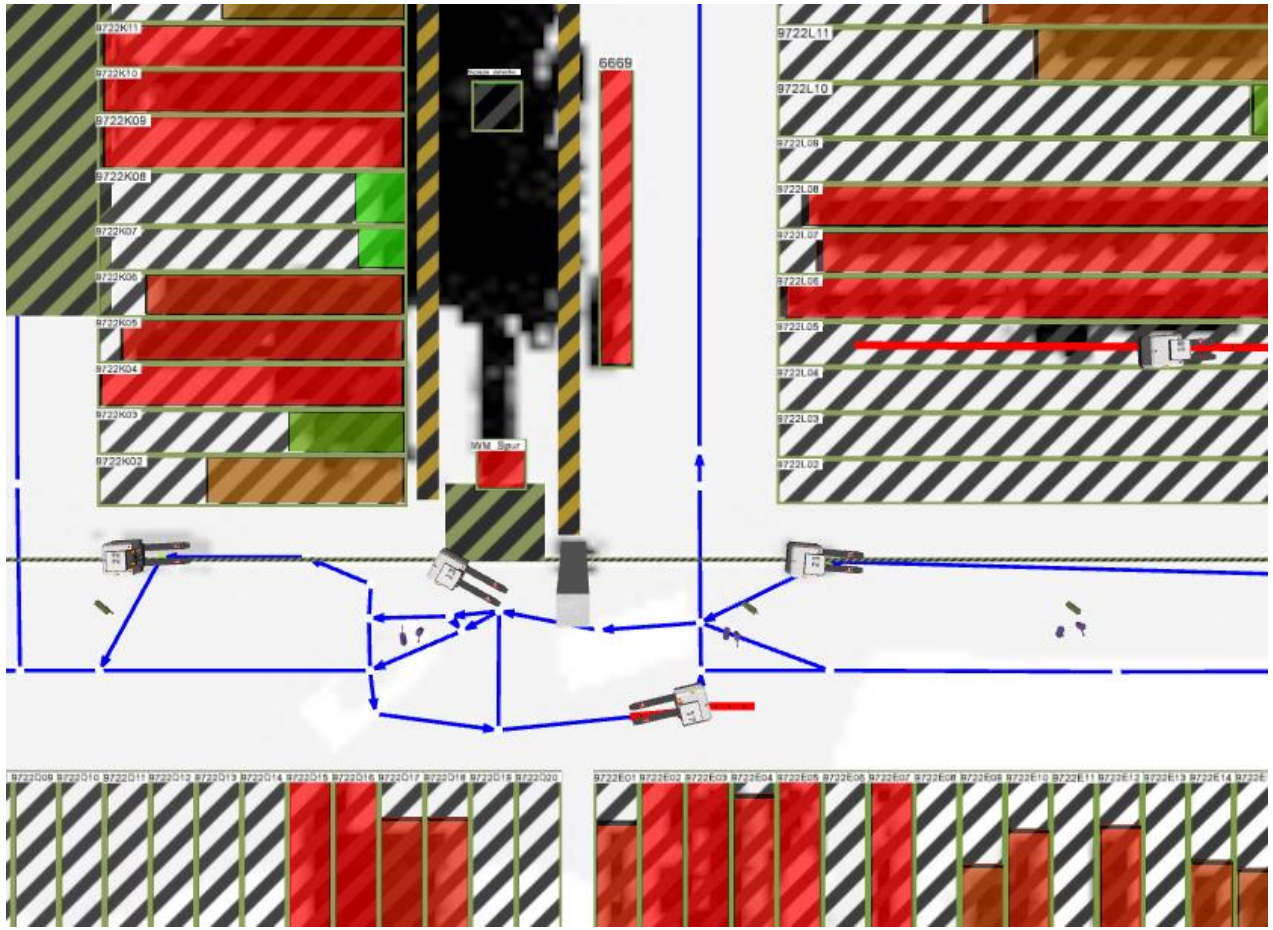




6 Fleet Manager

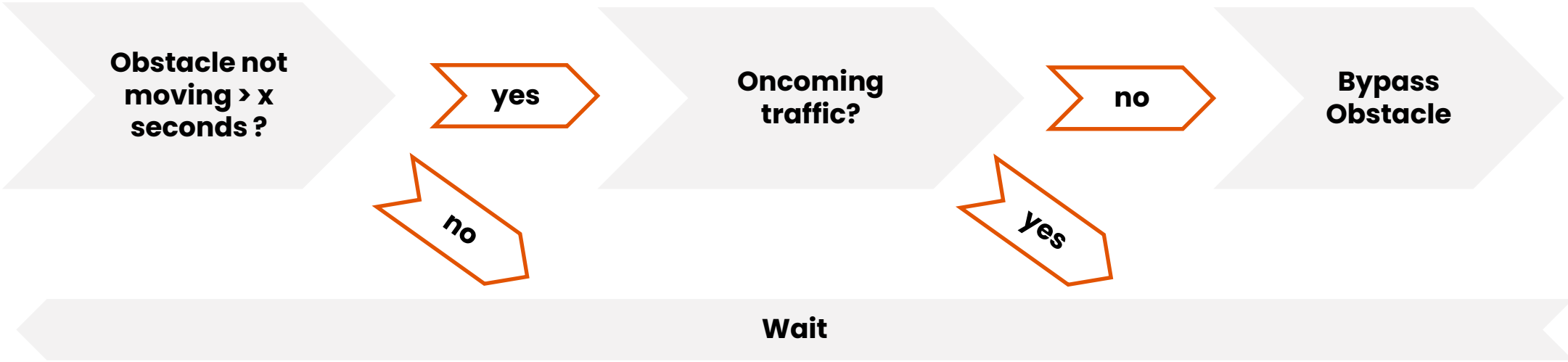
Multi-AMR technology

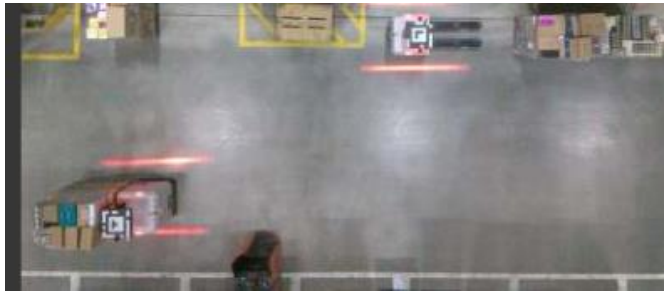
- Coordination of large fleets of freely navigating AMRs in interaction with forklifts on highly frequented routes
- Ceiling cameras recognize the traffic situation
- AMR behavior can be adapted to the traffic situation, e.g.
  - AMRs should not actively try to avoid moving forklift trucks.
  - AMRs should not attempt to drive around other active AMRs.
  - AMRs should avoid inactive road users.
- Definition of congestion zones and priority rules



6 Fleet Manager

Autonomy according to rules - Optimized obstacle avoidance





6 Fleet Manager

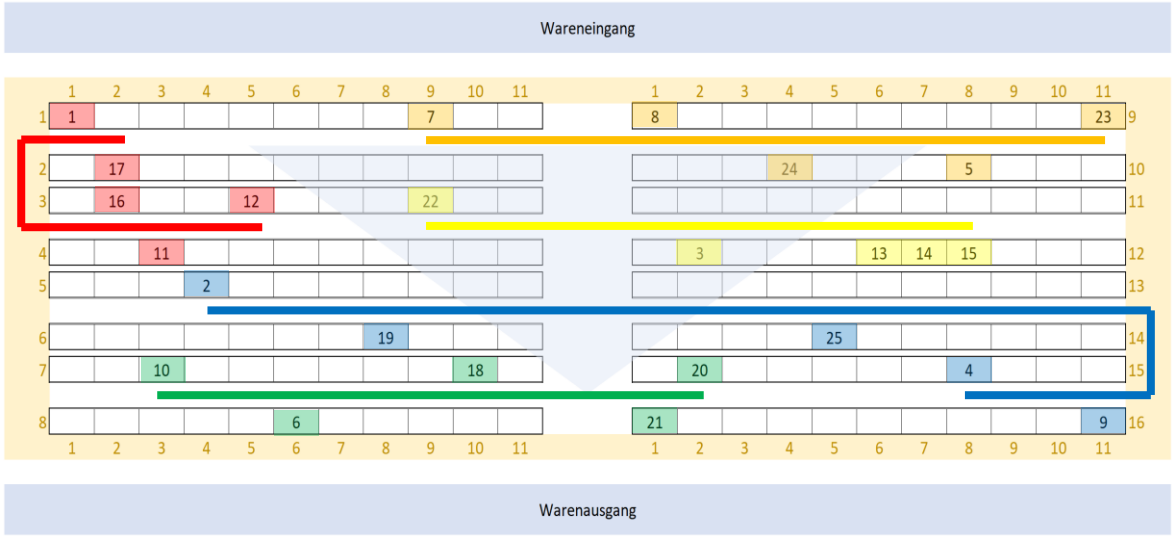
Optimization of the fleet

Fleet management uses a variety of mathematical algorithms from W2MO to optimize the process. The entire fleet of vehicles is optimized (AMRs and other integrated vehicles, e.g. forklifts or other AMRs via VDA 5050):

- Order sequence and assignment. Which vehicle handles which order and which process?
- Charging management. When is the best time for which AMRs to charge?
- Route optimization. Thanks to the ceiling cameras, the system knows the status of all paths before the vehicles arrive (like traffic jams in Google Maps). This means that areas can be avoided early and over a wide area, or orders can be put on hold.

Optimization is online, i.e. the system reacts continuously to changes.

Manual prioritization of orders / creation of special trips is possible



Example: Combinatorial optimization of the assignment of orders to AMRs

6 Fleet Manager

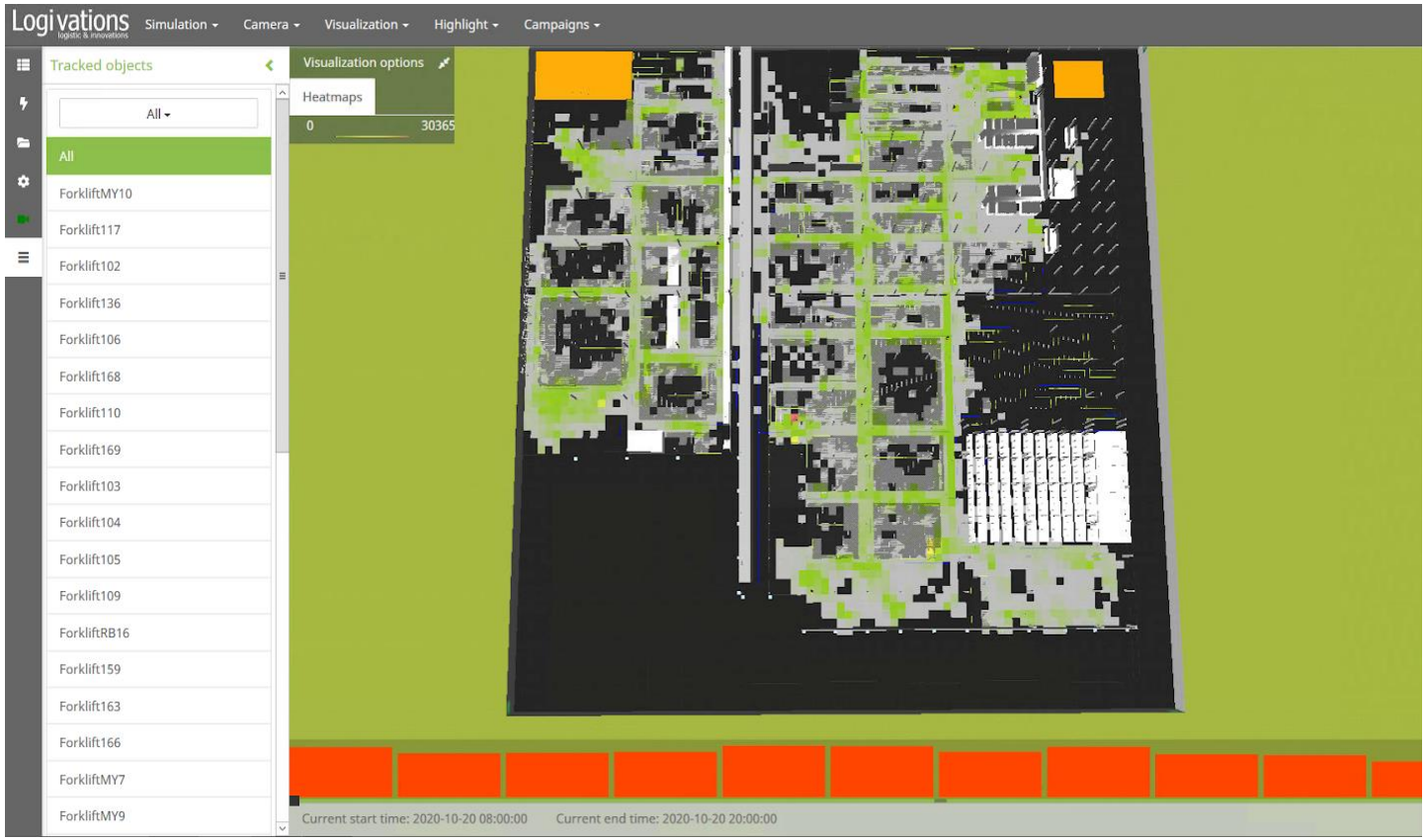
Interactive Visualization

Our interactive heatmaps in the 3D view allow the visual representation of large amounts of data and KPIs, e.g. on:

- **speed**
- **error frequency**
- duration of load handling
- collisions and “near-misses”

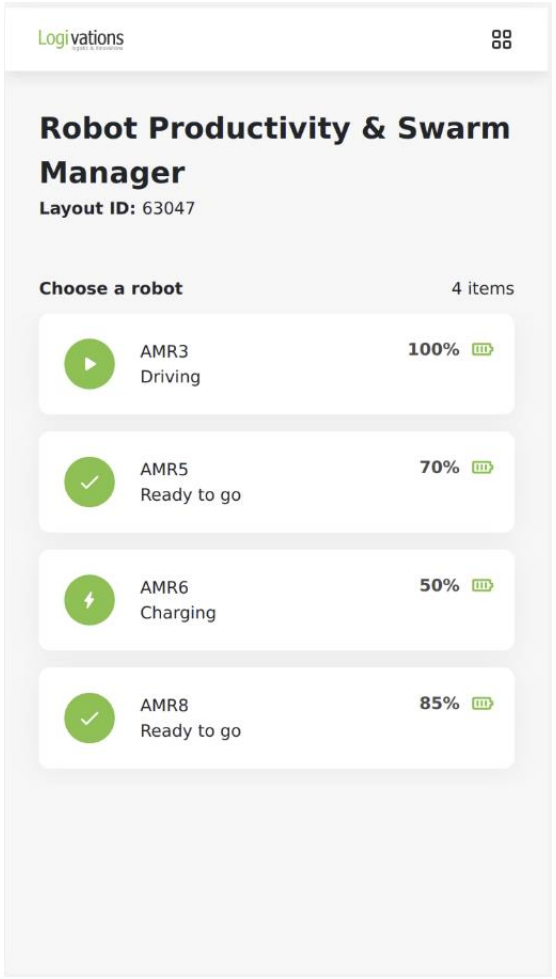
The observation period can be selected interactively.

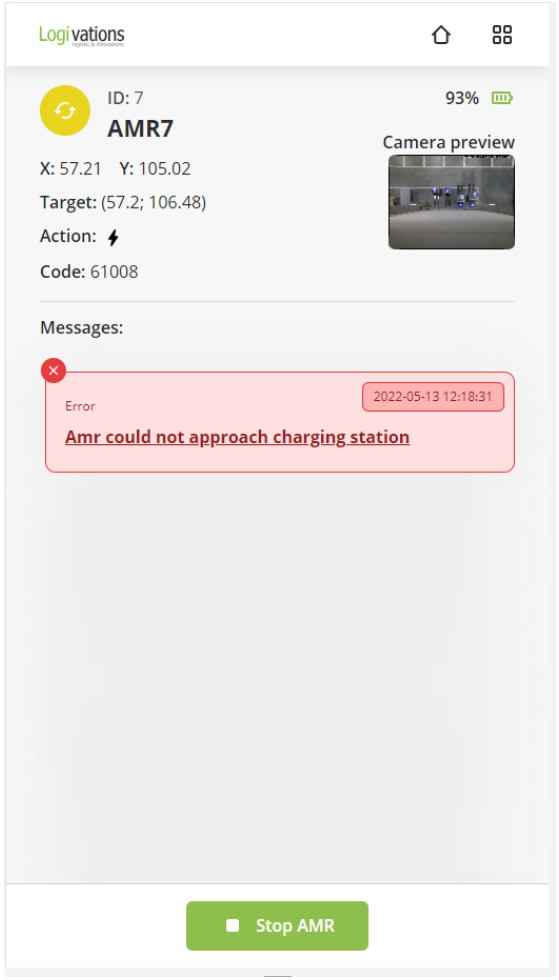
Thanks to the powerful **in-memory database**, millions of data points can be analyzed in real time.

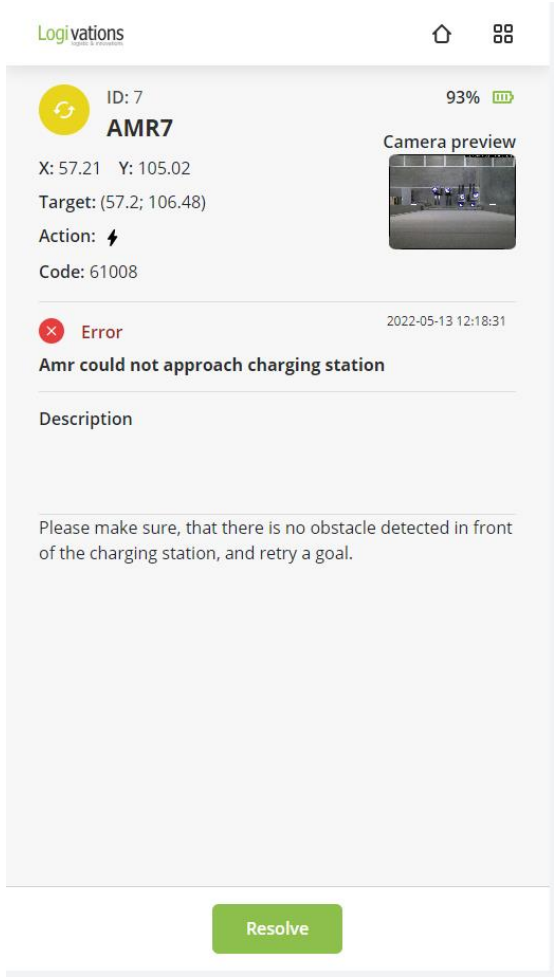


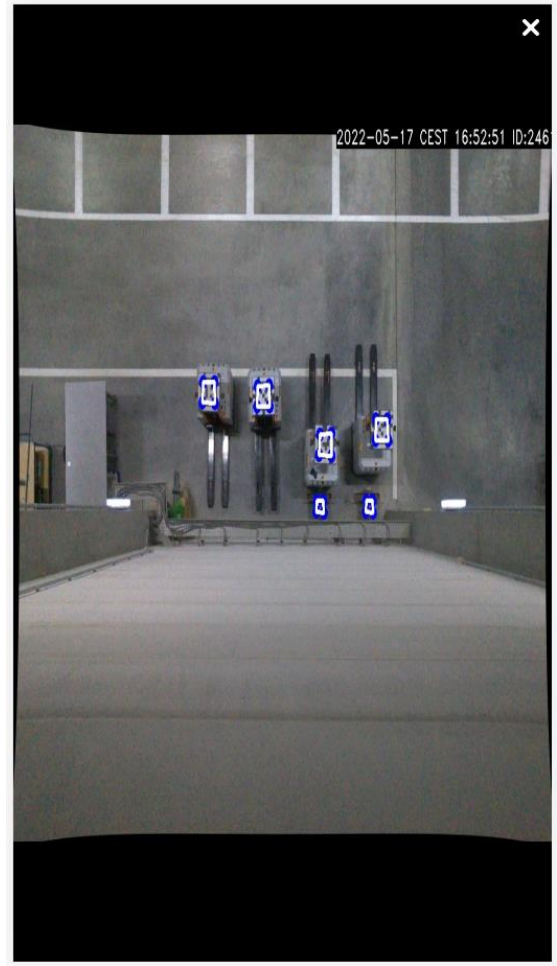
6 Fleet Manager

Mobile App







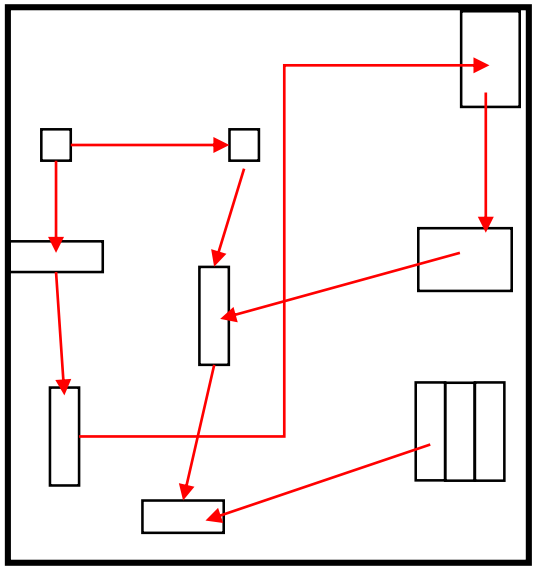


7 Use Cases

Suitable for all logistics and production environments

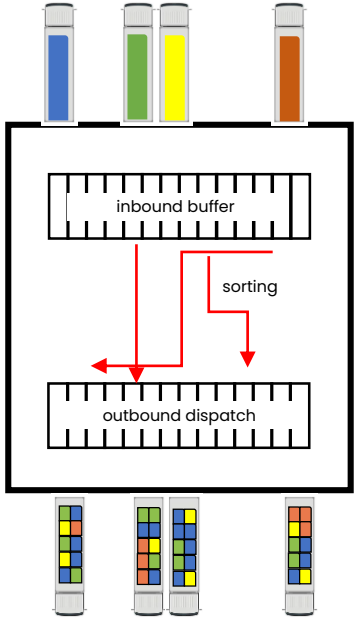
Anywhere to anywhere

Automation of all horizontal pallet transports



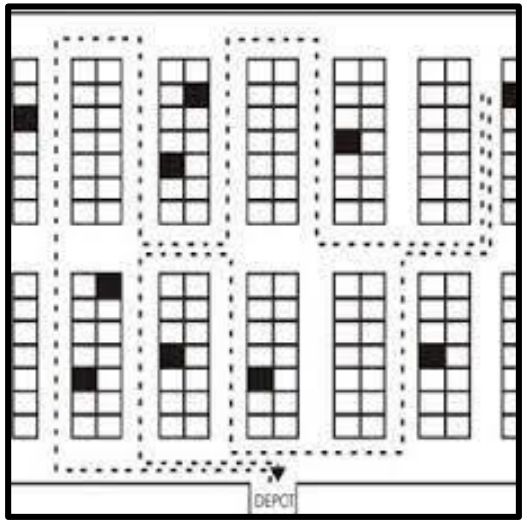
Cross-Docking

Automatic identification and sorting of goods



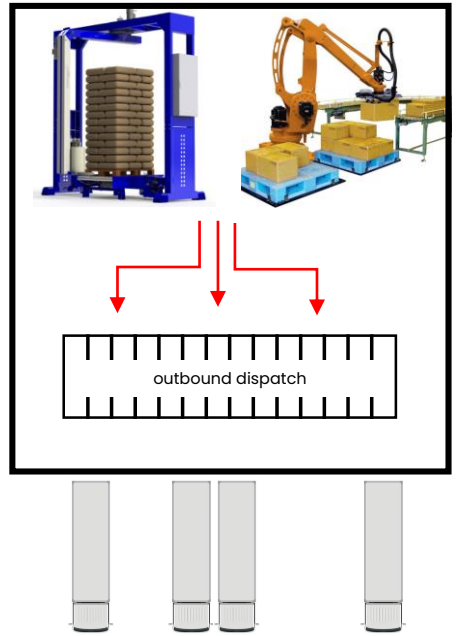
Picking

Consequences of the order picker and autonomous driving distances



Inbound / Outbound

Transport from/to high bay storage or palletizer to dispatch lines and vice versa



7 Use Cases

Outgoing goods example

Challenge

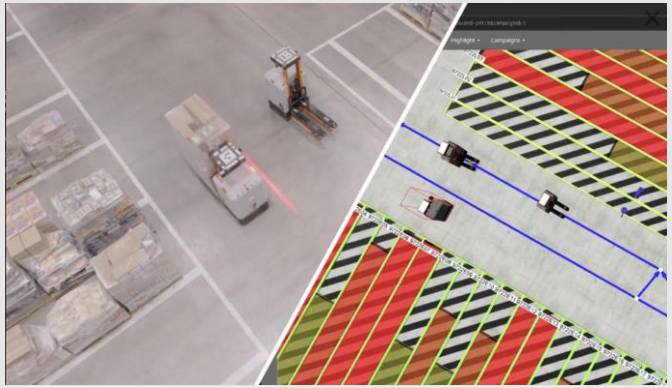
- Very flexible and dynamic surroundings with narrow tracks
- 150+ target options in block storage
- Foiled pallets
- Combined operation
- Obstacles
- Limited support possibilities

Solution

- Automatic order generation via fill level detection
- Automatic scanning of pallet label with determination of target lane via WMS connection
- Automatic obstacle avoidance (including fork tines)
- Dynamic multi-robot fleet management compatible with manual material handling equipment
- Easy fleet monitoring and remote support via digital twin
- Easy hardware maintenance via modular concept

Customer added value

- **Personnel:** Reduction of personnel requirements and costs
- **Quality & Safety:** Reduction of error rates and accident numbers
- **Costs:** FTE reduction, lower energy consumption



8 AI vs. traditional approaches

We know the important features for logistics

	Pixel Robotics	Old style
Navigation, sensors	14 to 18 cameras onboard, ceiling cameras to monitor everything, NVIDIA AGX Orin	LIDAR, various other sensors
Recognition, e.g. label reading of transported goods	optional	not available/ Third-party product
Transport of foiled pallets	included	not available
Full area monitoring and verification of lanes, buffers	included	not available
Integrated Digital Twin	included	not available
Fleet management, tracking & steering of manual vehicles or third-party AGVs	included or optional	Customized developments
People tracking / fully monitored security area	included	not available

9 Profitability

Overview of prices

Hardware		Price per unit
Robot Pixel PT		**39.900 €**
Options:	Lifting height 55 cm (1,000 kg max.)	3.900 €
	Lifting height 90 cm (750 kg max.)	5.900 €
	Onboard cameras for pallet detection and label reading	2.100 €
Infrastructure		
Industrial camera		340 €
NVIDIA 12 Port		3.400 €
Charging station		3.900 €

Software purchase OR monthly software rent		For the first license	For license 2 to 5	For license 6 to 20	From 21 licenses
Pixel AI Robot Operation System including: - Navigation of the robot with onboard cameras and area recognition units - Integration in digital twin - Fleet management for the Pixel Robots - Standard order entry via API		**42.000 €**	**37.800 €**	**33.600 €**	**29.400 €**
		2.394 €	**2.155 €**	**1.915 €**	**1.676 €**
Options:	Order generation via April tags	1.800 €	1.620 €	1.440 €	1.260 €
		103 €	92 €	82 €	72 €
	Order generation via area monitoring	1.800 €	1.620 €	1.440 €	1.260 €
		103 €	92 €	82 €	72 €
	Pallet recognition and label/barcode reading	2.500 €	2.250 €	2.000 €	1.750 €
		143 €	128 €	114 €	100 €

Software maintenance is 19.5% per year (maintenance is only required for purchased licenses)

Options:
a) Bug fixes (4% per year) - problems with the software are fixed, but the customer does not receive any new, additional features

b) Full maintenance - annual performance & feature update (15.5% per year) in addition to bug fixes option

If you choose the "rent" option, the software maintenance is already included in the rent. With a fixed rental period of 12 months, only 10 months are charged.

10 Sustainability

Economic comparison between Pixel robotics AMR and a conventional forklift

Productivity	- An autonomous Pixel PT achieves between 50% and 100% of the productivity of a forklift driver - Influencing factors are: long/normal fork, driving distances, possible driving speeds
Daily working hours and output	- About 21 hours a day (the remaining 3 hours are needed for charging) - If the possible daily working time is used, a robot can provide at least a 30% higher daily output
Energy consumption	- Since the Pixel PT drive slower overall and each optimizes acceleration and braking, the energy consumption is at least 50% lower
Floor requirements	- A Pixel PT can be operated on all logistics floors on which a conventional pallet truck can be operated
Wear	- Since the Pixel PT accelerates and brakes more smoothly and optimized overall, wear on the ground and vehicle is significantly lower
Repairs & Maintenance	- The Pixel PT uses standard components that can also be found in commercially available forklifts - A repair team that can maintain the truck fleet today can also maintain and repair the pixel PT's mechanical components - The onboard computers and cameras can be controlled and maintained remotely by Pixel Robotics / Logivations

9 Profitability

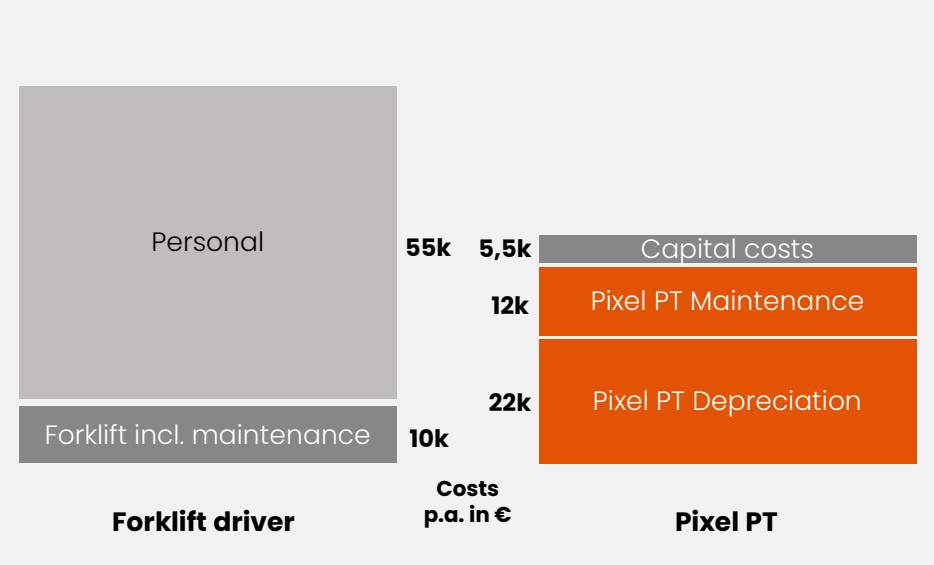
Case study Swiss reseller: 60% cost reduction for the automation of horizontal transports

Forklift driver

1.700 working hours / year

- Salary and social costs: ~55,000 € p.a.
- Forklift and other equipment pro rata: ~ 10,000 € p.a.
- In addition: management overhead

➔ **Annual costs 65,000 €**



Pixel PT

- 16 operating hours per day on 240 working days = 3.840 h/ year
- Investment approx. 110,000 € (AMR + infrastructure + own costs
- Capital costs: 5,500 € p.a. (5%)
- Depreciation: 22,000 € p.a. (5 years)
- Maintenance: 12,000 € p.a.
- In addition: overhead for technical monitoring

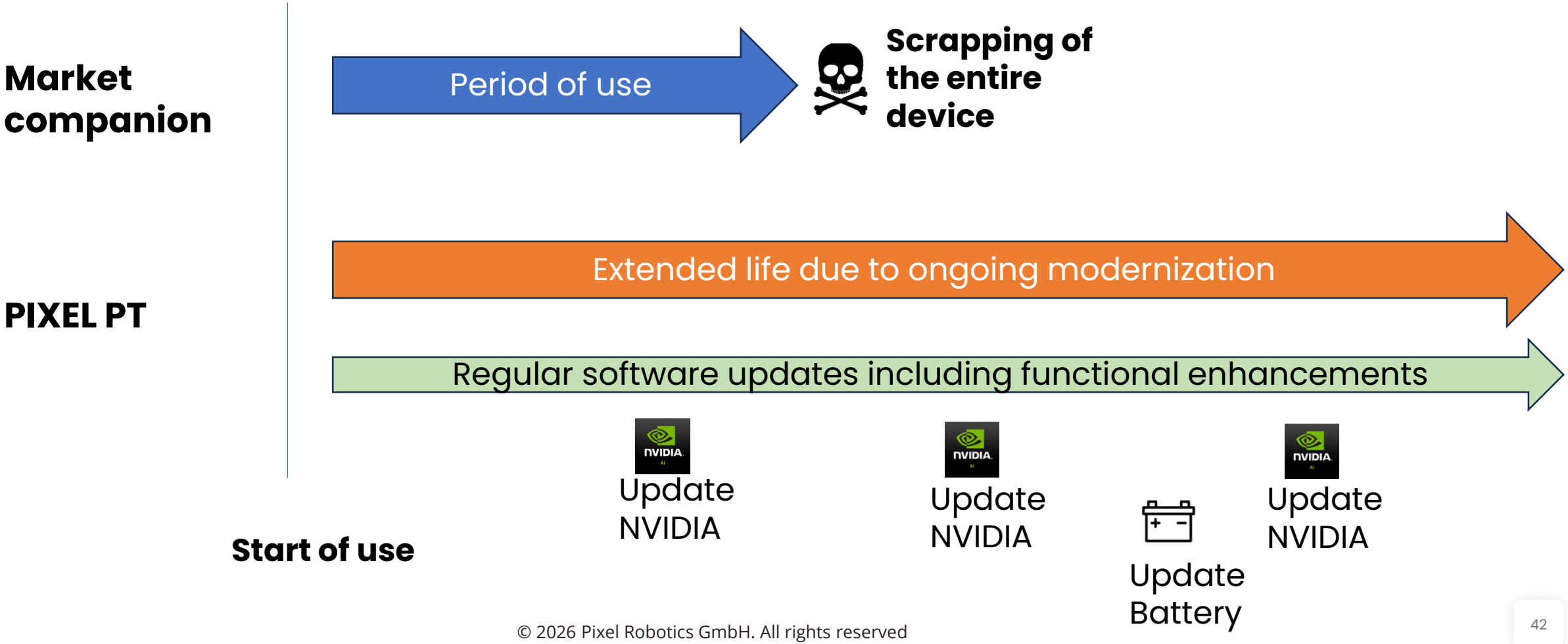
➔ **Annual costs 39,500 €**

- An employee is approx. 1.5 to 2 times faster than the robot, but the robot can work about 2.2 times the hours per year.
  ➔ **One robot thus replaces approx. 1.5 employees.**
- Automation of transportation enables a significant reduction in personnel costs.
  ➔ **The cost of a robot is only 66% of a manual driver**.

➡ **Thus, Pixel Robotics and Logivations offer a cost reduction of approx. 60%.**

10 Sustainability

Continuous updates of the technology components ensure that the Pixel PT is always at the cutting edge of technology



10 Sustainability

Exemplary comparison with horizontal pallet movements (95% of movements)

Pixel PT

Own weight: 0.55 t

Motor power: 0.8 KW

Consumption/h: 0,3 to 0.45 KWh

Jungheinrich ETV 216i

Own weight: 3.4 t

Engine power: 8 KW

Consumption/h: 3.5 KWh

- Regular consumption of the Pixel PT, taking into account the higher productivity of the forklift: 0.68 KWh/h to 0.9 KWh/h
- The Jungheinrich consumes at least 9,984 kWh more electricity with the same transport performance for e.g. 3,840 h/year (two shifts)
- With an electricity price of €0.5/kWh, using one of the most modern forklifts in the Jungheinrich fleet for ground transport is at least €5,000/year more expensive.
  With older forklift models, additional costs of over €10,000 should be taken into consideration.

Contact

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