MICROTECNA engineering

AGV-based Solutions Overview

Novazzano (CH), 2023

V 1.7

ITMA2023 MILANO 8-14 JUNE, FIERAMILANO

ITMA 2019 20-26 JUNE 2019 FIRA DE BARCELONA GRAN VIA BARCELONA, SPAIN www.itma.com

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Qualified Partner 2022

BECKHOFF Solution Provider

Content

1. Who we are

Microtecna Engineering (MTE)

is a Swiss society specialized in the application development of innovative products and processes

Mission

Our mission is to support the client companies in the development and integration of new technologies for the achievement and the overcoming of the Industry 4.0 paradigms

Method

A strong connection between applied research, production technologies, automation models, industrial safety, computer systems/infrastructures, communication systems, with particular attention to cloud technologies and cyber-security

Teamwork

The expertise of Microtecna Engineering's team covers a wide spectrum of sciences and technologies and the experience gained in hundreds of completed projects guarantees the realization of innovative solutions and their maintenance throughout the life cycle

Customer Focus

Close collaboration with customers allows us to offer highly customized solutions that are 100% tailored to the specific needs expressed by the customer.

ENGINEERING APPLIED TO:

Embedded Systems

Embedded, IIoT, Vision Technologies

Industrial Automation

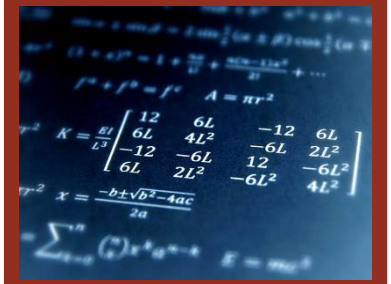
Machines, Robots and Plants automation

Industrial IT

Industry 4.0 solutions, MES, Web/Mobile Platforms

Modeling & Processing

Modeling & processing of complex systems



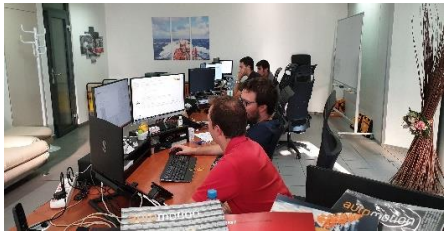
Field Layer

Automation Layer

MES Layer

R&D Layer

3. Areas of Expertise



AUTOMATED GUIDED VEHICLES (**AGV**)

BIG DATA MANAGEMENT

CLOUD COMPUTING & **WEB** SERVICES

EMBEDDED SYSTEMS

INDUSTRIAL INTERNET OF THINGS (**IIoT**)

INFORMATION SYSTEMS AND **MES**

MACHINE ENGINEERING & CONTROL

MEASURING & SENSOR SYSTEMS

REAL-TIME COMPUTING

OPTIMAL **CONTROL & OBSERVATION**

SAFETY & HIGHLY RELIABLE ARCHITECTURES

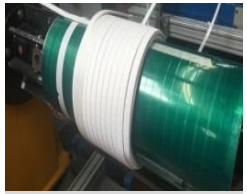
4. Industries

Aerospace

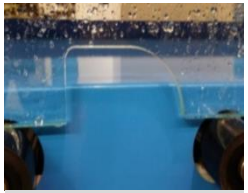
Automotive

Coating

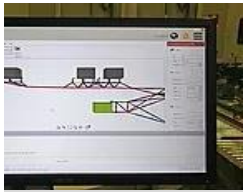
Construction



Electromech



Glass



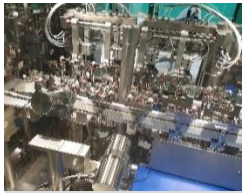
Logistics

Mechanical

Metallurgical

Naval

Packaging



Pharma

SEMI

Textile

Wood & Paper

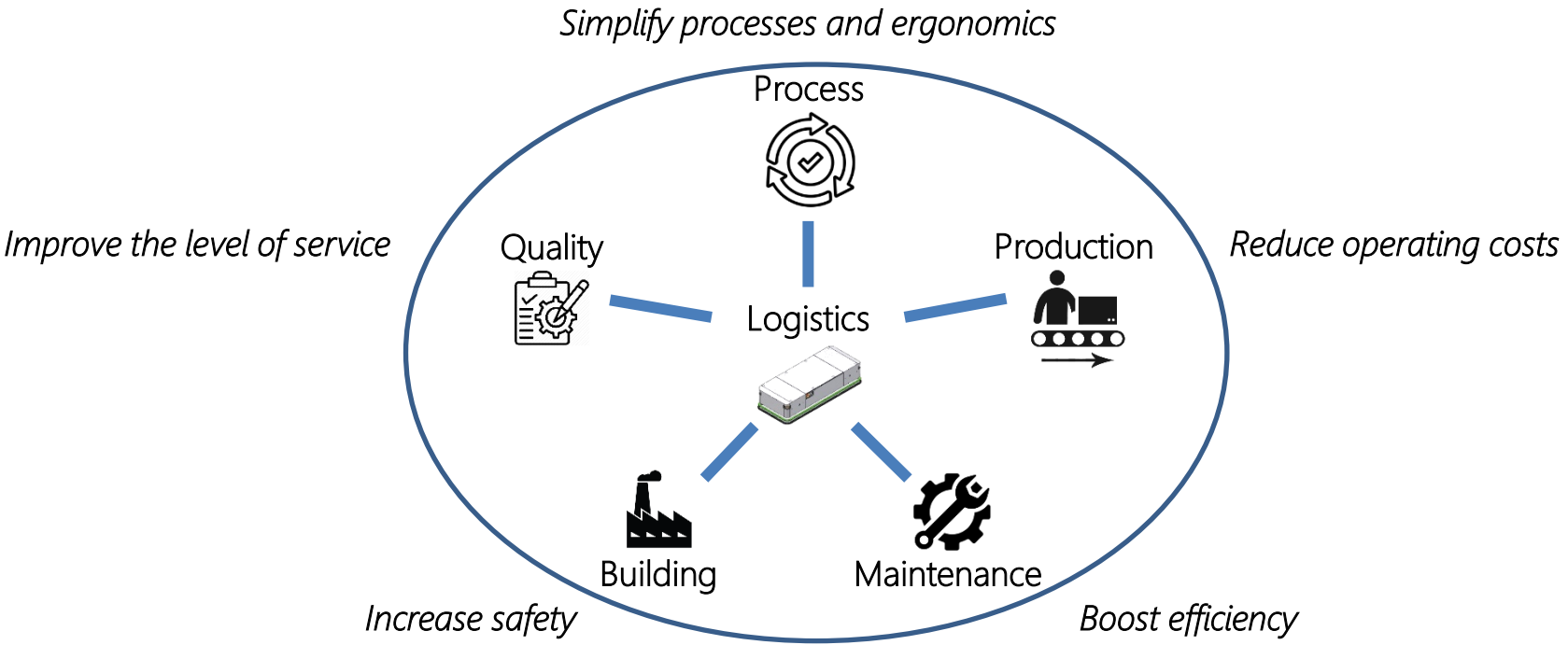
We have experience in various industrial contexts including critical ones

5. Solutions

We build turn-key industrial solutions to meet your needs

MTE Services	Customer Types: Startup	OEM	End User
Engineering + R&D Modeling & Simulation Requirement, Functional & Technical Analysis System & Software Design Project lifecycle management (Formal/Critical)	✓	✓	✓
Lines / Machines / Plants In collaboration with mechanical/electrical partners	✓	✓	✓
Software Embedded / Firmware / Vision/ Robotics PLC / HMI / DCS PC / DB / Web / Mobile	✓	✓	✓
Deployment & Service On-site and remotely (Microdesk)	✓	✓	✓

WHY automate industrial logistics processes?



In most cases the best solution is custom built through careful integration of your company's properties and requirements

WHAT is an AGV-based logistics platform?

Overall Components

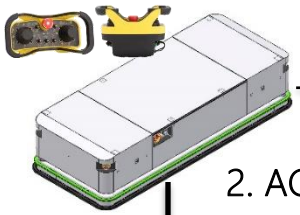
Data / Process

Functional Safety

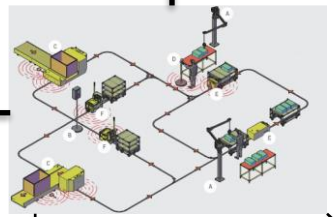
Work Stations

interfaces

3. Control Station

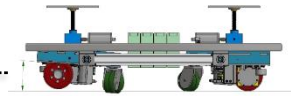


2. AGV



1. Layout & Maps

Warehouses



Payload Interfaces

Payload

Recharge Stations

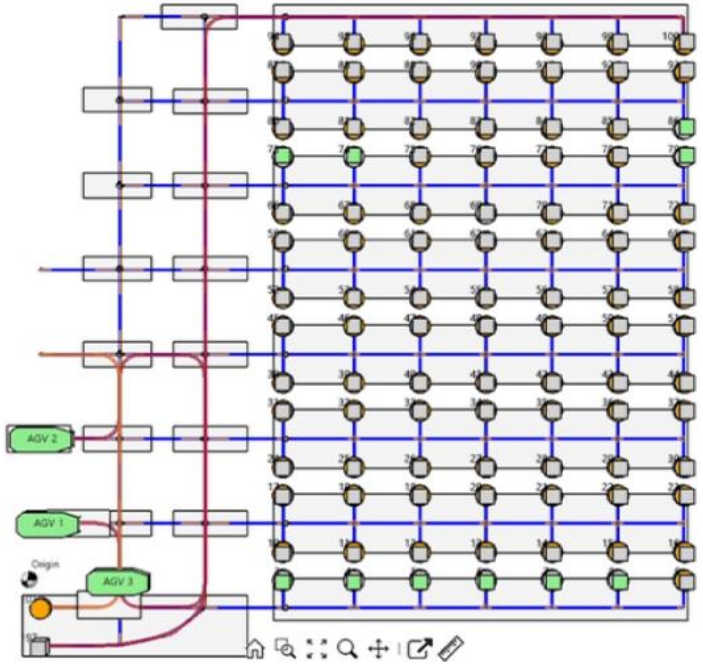
1. Layout & Maps

A map represents the operational domain of the logistics solution

It is made up of:

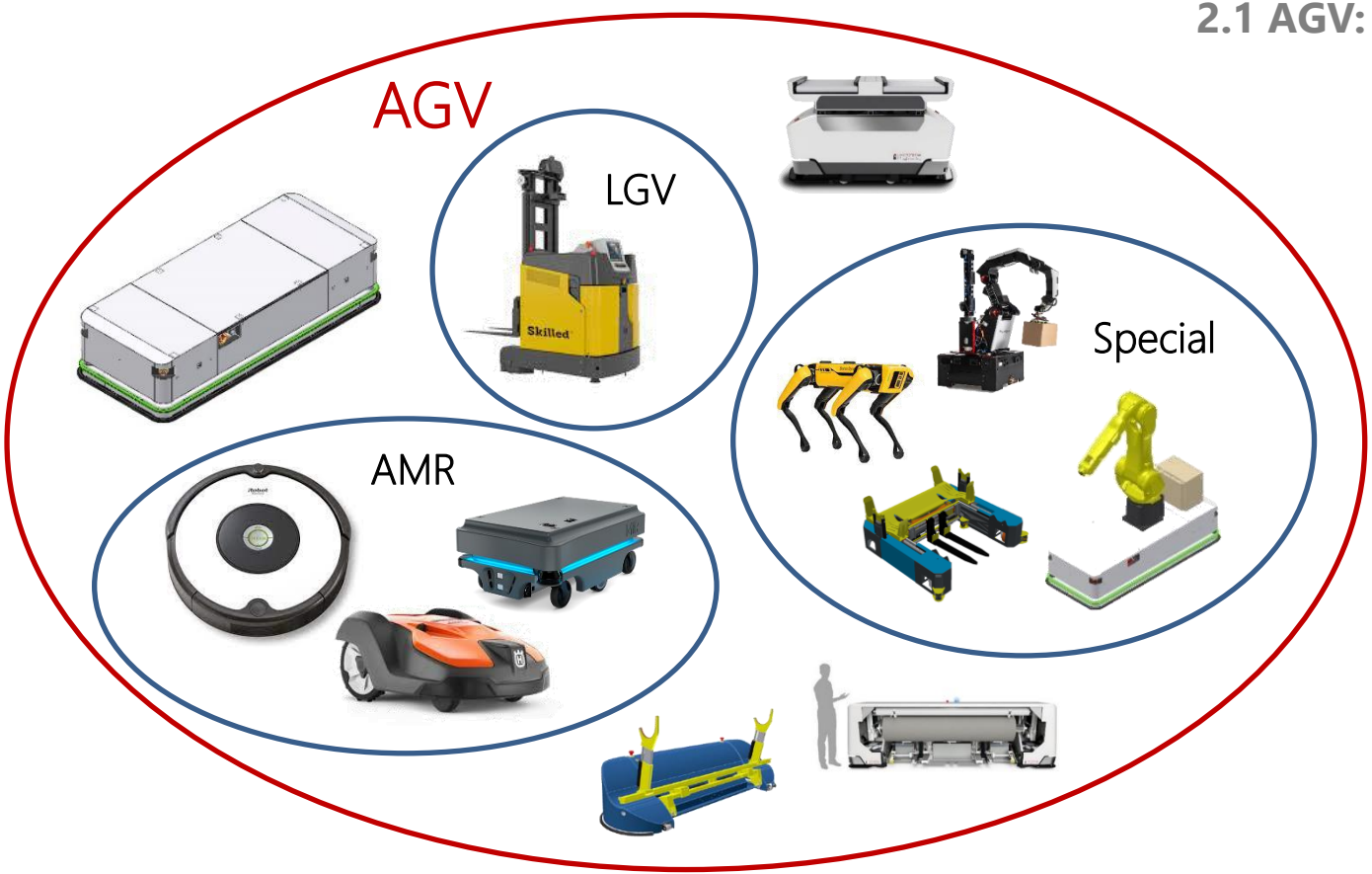
- Waypoints: the points through which vehicles can pass or stop to carry out work or recharging operations. They can be associated with operating stations.
- Connectors: the relationships that exist between adjacent waypoints. They can include directional and kinematic constraints.
- Traffic management rules: it is essential to analyze the layout in order to avoid dead-locks or excessive traffic situations

*The map must consist of the **minimum number of nodes and connections** such as to cover the entire functional domain of the solution.*
*It is important to favor solutions in which **traffic management and the calculation of the best trajectories is entirely automatic**.*



WHAT is an AGV-based logistics platform?

2.1 AGV: typologies and classes



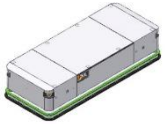
- **Payload**: what should it carry?
- **Control**: how should it move?
- **Navigation**: How does it navigate in space?
- **Safety**: How does it work safely with the environment?
- **Power**: How does it power and recharge?
- **Networking**: how do you communicate with the vehicle?

WHAT is an AGV-based logistics platform?

2.2 AGV: payload

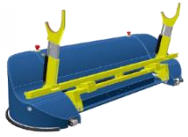
Cleaning
No payload

Inspection
< 10 Kg



Support
< 10.000 Kg

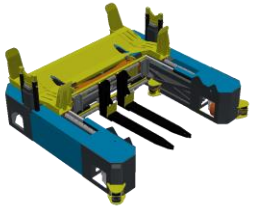
Translation
< 4.000 Kg



Lifting
< 5.000 Kg

Handling
< 50 Kg

Hybrid
Any payload

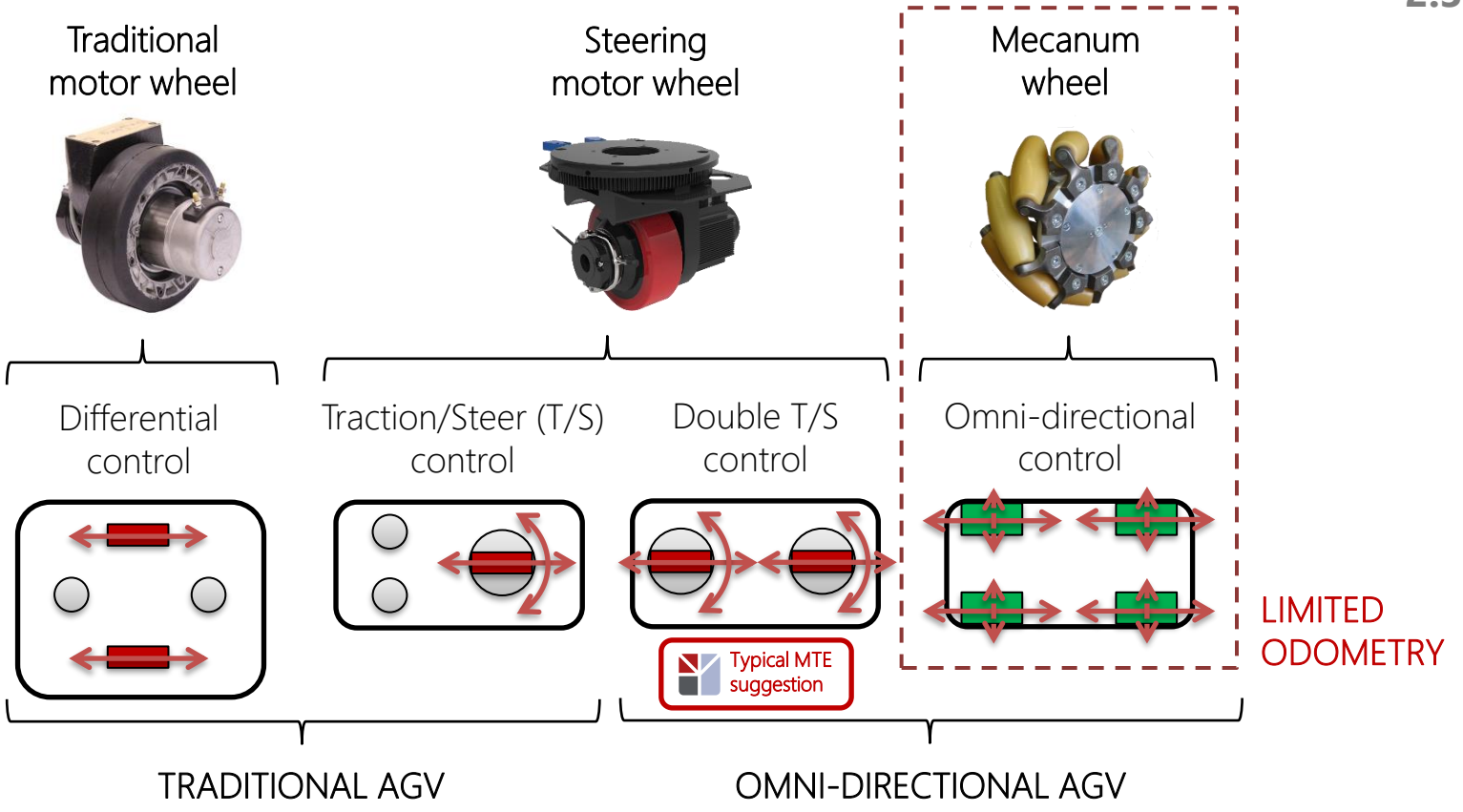


Each vehicle can be extended by integrating sensors and actuators

Cost and performance depend on the application

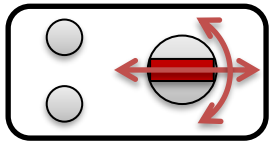
"Simplicity is prerequisite for reliability"
Edsger Dijkstra

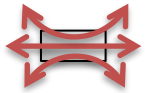
2.3 AGV: control



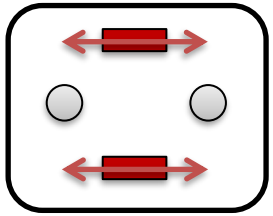
WHAT is an AGV-based logistics platform?

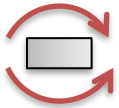
2.3 AGV: control



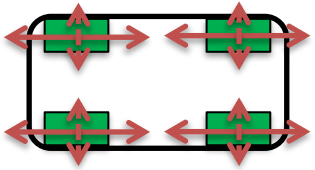


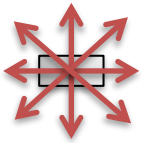
«Car-Like» Movements



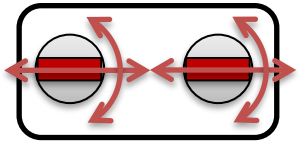


Fixed-Point Rotations





«Crab» Movements



Combined
Roto-Translations

Typical MTE suggestion

Minimum costs

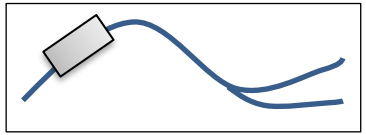
Maximum performance

Beware of:

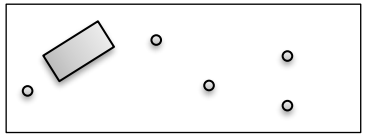
- Necessary movements
- Industrial flooring

WHAT is an AGV-based logistics platform?

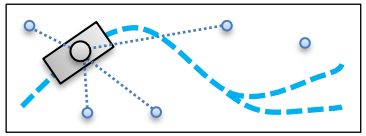
2.4 AGV: navigation



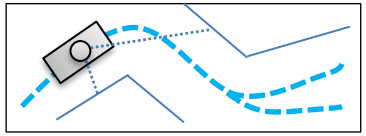
Wireguide
- Magnetic / Optic
- Odometry



Marker
- Magnetic / Optic
- Odometry

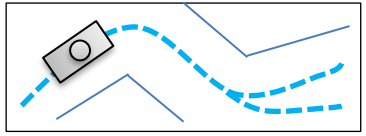


Laser
- Laser
- (Odometry)



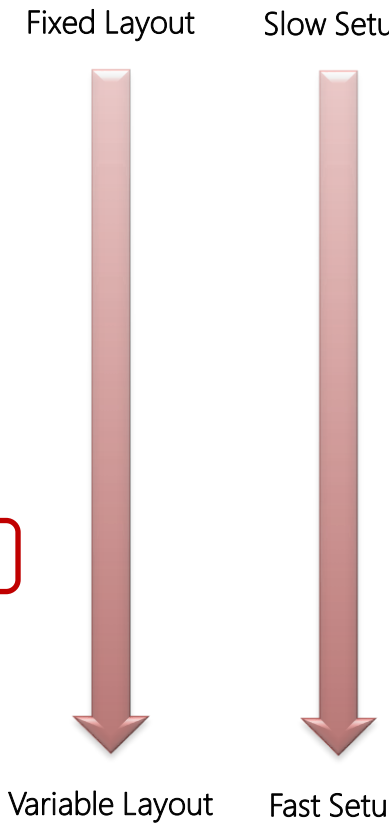
Natural
- Laser
- (Odometry)

Typical MTE suggestion



Natural 2.0
- SLAM
- 3D Laser / 3D Optics
- Odometry

GPS / DGPS: available for OUTDOOR contexts



Beware of:
- Layout variability
- Setup time

Costs ?

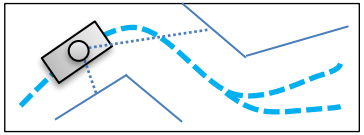
The overall cost of the navigation system depends on:
- *the number of AGVs*
- *the size of the infrastructure*
- *the setup time.*

Repeatability & Performance ?

It is never a DETERMINISTIC system

Great attention must be paid to the study of the layout in order to define the most appropriate navigation strategy

2.4 AGV: navigation



Natural

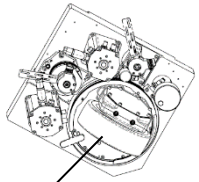
- Laser
- (Odometry)

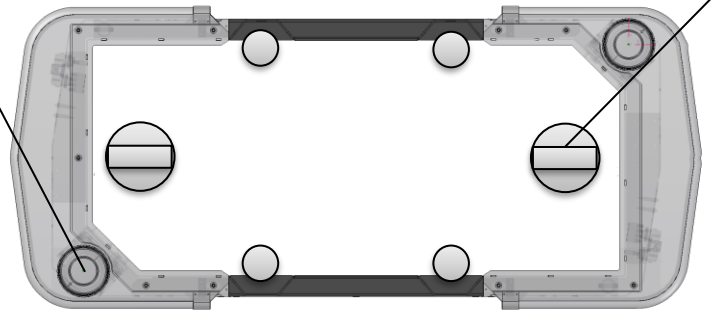
Typical MTE suggestion

CORRECTING
Estimates vehicle absolute position and attitude using low-frequency (1-5Hz) laser data

FILTERING
Combines predictions and corrections to obtain accurate absolute position and attitude data at high frequency

PREDICTING
Estimates vehicle absolute position and attitude using hi-frequency (100Hz) tractions and steers data





Repeatability & Performance

5-50 mm @ 1 m/s depending on the technology used and the control system.

Odometric observability always helps.

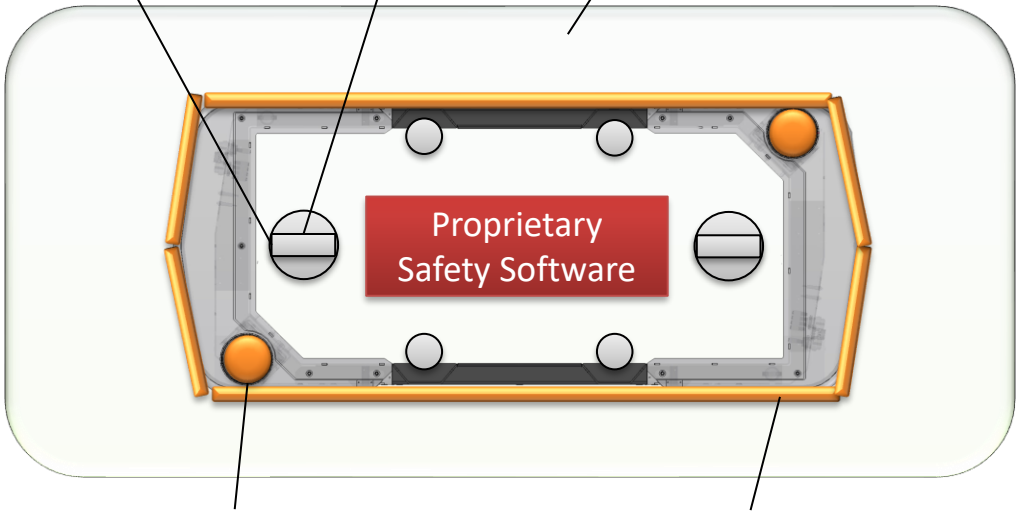
«Sensor-fusion» of additional data to increase repeatability up to 1 mm

2.5 AGV: safety

SAFE ENCODERS
For traction and steers.
Used for both safety and navigation.

SAFE BRAKE
Independent Safe braking control system

Adaptive Safety-Laser Areas
Observes vehicle surroundings at 360°
Automatically adapted basing on vehicle's kinematics conditions.



2D LIDARS
Used for both safety and navigation.

Perimetrical Bumpers and ESTOP buttons
Sufficient if Vmax < 0.3 m/s

Obstacle Avoidance
Beware of effective available space and impact on cycle times.
Normally not necessary…

And if you need a robot on the vehicle ?

Collaborative Robot

Less Problems
Less Performances

Vs

Industrial Robot

Same rules as for a robotic island

NOTE: The reference is the SAFETY level of the entire plant → strong dependence on the layout

WHAT is an AGV-based logistics platform?

2.6 AGV: power

Typical MTE suggestion

	TPPL	LFP	Supercapacitor
Capacity (direct impact on N° of AGVs)	↑	→	↓
Charge Density Capacity / Weight (Size)	↓	↑	→
Reload times (direct impact on N° of AGV)	↓	→	↑
Saving	↑	↓	→

- Correct sizing is one of the main factors to ensure the functionality of the entire logistics solution
- The dimensioning is carried out according to the simulations → strong dependence on the layout
- If possible, stay within the **low-voltage** range (48 VDC)
- In critical contexts (e.g. ATEX or sterile) the entire AGV design could be heavily questioned

WHAT is an AGV-based logistics platform?

2.7 AGV: networking

Typical MTE suggestion

	Wifi	4G / 5G	Radiomodem
Bandwidth and latencies Usage for SAFETY	↑	→	↓
Distances	↓	→	↑
Outdoor Environment	↓	→	↑
Saving	TBD	TBD	TBD

- Correct sizing is one of the main factors to ensure the functionality of the entire logistics solution
- The sizing is done according to the layout
- In indoor environments, favor WiFi mesh solutions (possibly multi-band)
- Beware of interference from other sources

WHAT is an AGV-based logistics platform?

3.1 Control Station: architecture

Your ERP/MES

Microtecna Remote Service

Remote
Control Interface

www

Electrical Cabinet – Control Station

Touch-Screen Panel / Web interface

IPC
- Scheduling
- Path planning
- Traffic management
- Warehouse & Data storage

PLC (if necessary)

ETH

Industrial Wifi Devices

POWERLINK
PROFINET
ETHERCAT
CANopen …

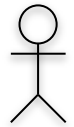
Safety Certified Interface
(OPTIONAL)

Other Automation Components

Mobile
Control Interface

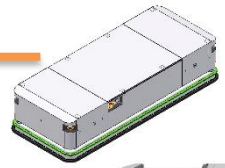
802.11ac (2.4 + 5GHz)

Industrial Mobile
Rugged Devices



Field Operator

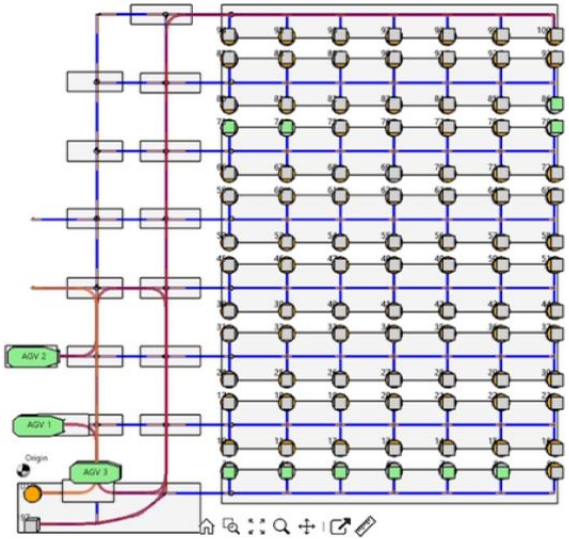
Recharge Stations



AGV Fleet

WHAT is an AGV-based logistics platform?

3.2 Control Station: «core» components



- This workflow strongly depends on the application context → Favor integrated solutions over standard packages
- The generation of optimal trajectories and traffic management are critical and very complex concepts → Favor automatic but flexible solutions
- Warehouse architecture is highly dependent on the payload and how you interface with it

WHAT is an AGV-based logistics platform?

3.3 Control Station: interfaces

IT/MES

MMI

Automation systems

Building Automation

Safety systems

Logistics 4.0
- Supervision
- Remote control
- Process integration
- Traceability
- Data collection
- …

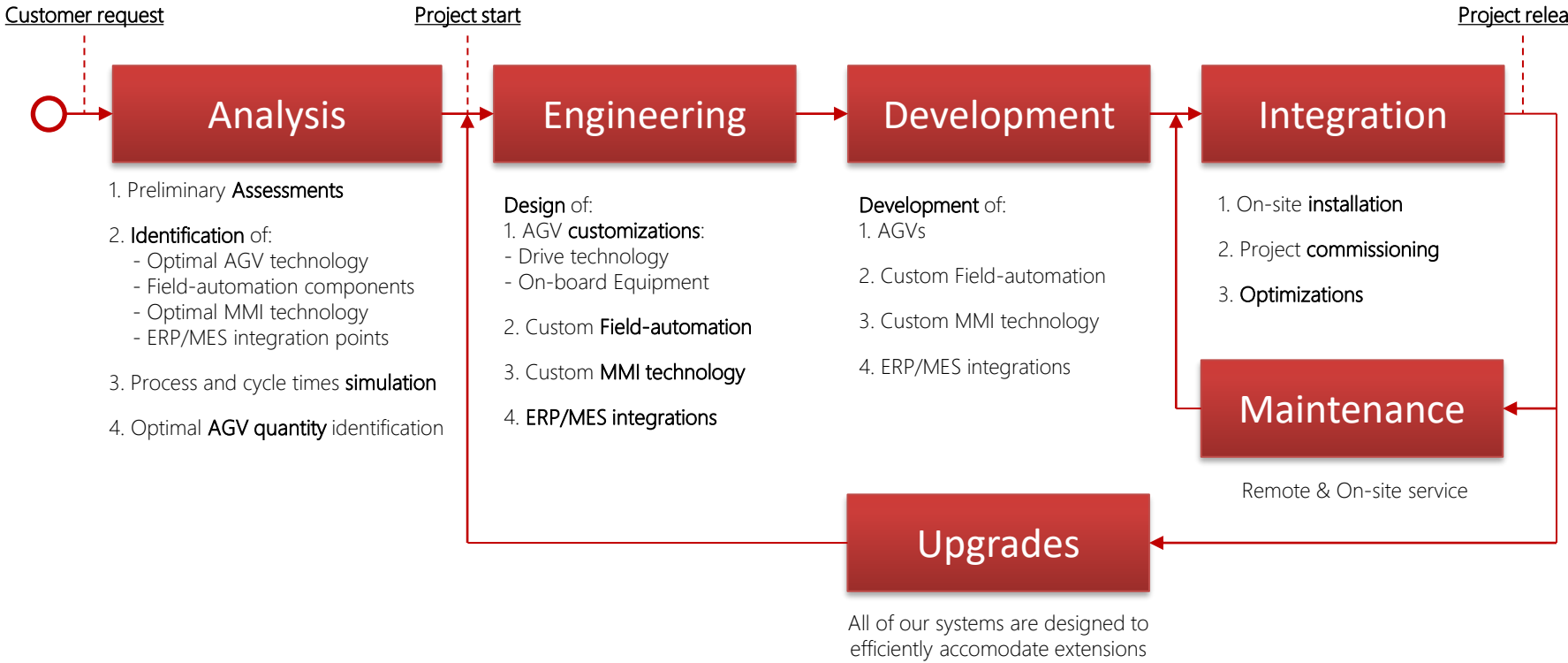
Work Stations
- Conveyors
- Manipulators and handling systems
- Robotic islands
- Processing machines
- Quality control systems
- …

Equipments
- Doors and Elevators
- Plants (HVAC, lighting, …)
- Fire prevention systems
- Remote ESTOP busttons
- …

The greatest added-value point of an AGV-based solution is its ability to physically and logically interact and collaborate with external industrial components

HOW to evaluate an AGV-based logistics platform?

1. Follow a strict method

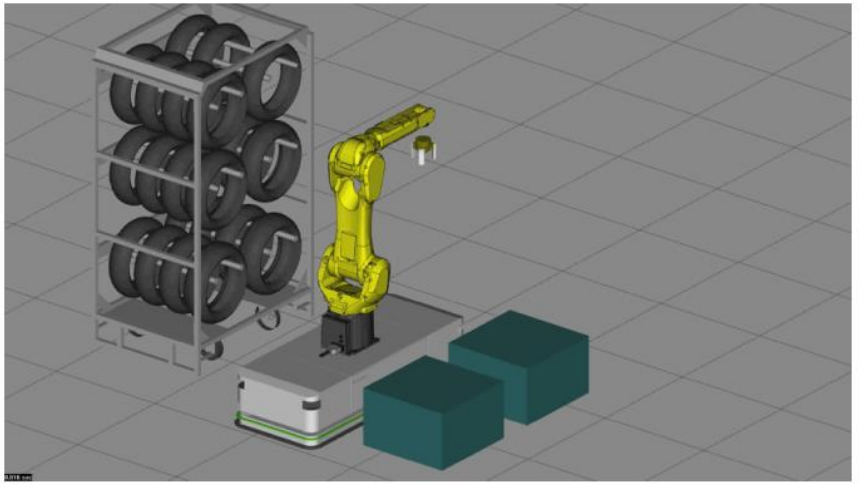


HOW to evaluate an AGV-based logistics platform?

2. Always start with the «Payload»

- Clearly identify the **objects** transported and/or processed by the AGVs in terms of types, dimensions and mass

- Clearly identify the **supports** which, possibly, will host the objects moved by the AGVs



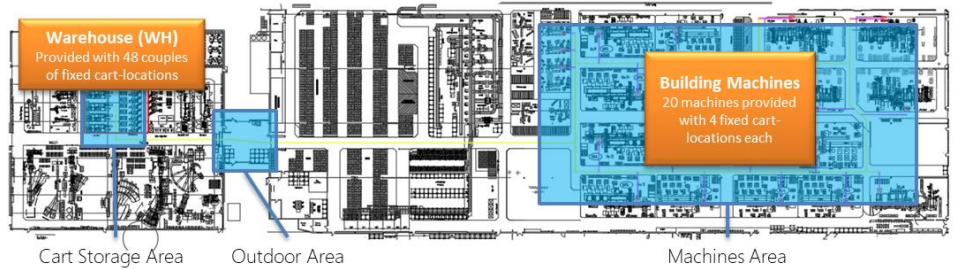
HOW to evaluate an AGV-based logistics platform?

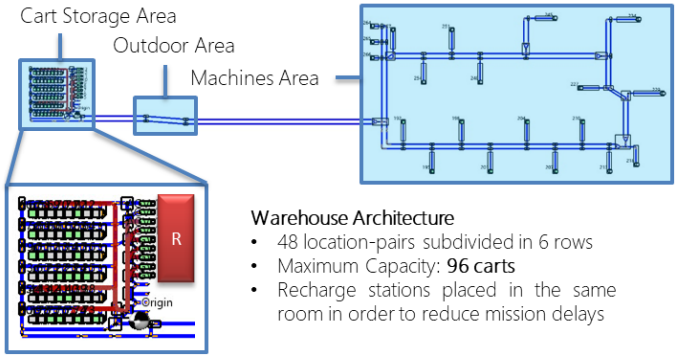
3. Layout & Operations

- Accurately define the application **layout**
- Define **work stations**, **reloading stations** and potential **warehouses**
- Define the areas shared with operators, the AGVs' exclusive ones and any **safety** constraints present in the layout
- Define the **environmental constraints**: doors, lifts, outdoor areas, ATEX zones, dustiness status, flooring status
- Accurately define the types of **operations** and the relative **frequencies**

TARGET

Creation of a model of the logistics solution





Warehouse Architecture

- 48 location-pairs subdivided in 6 rows
- Maximum Capacity: **96 carts**
- Recharge stations placed in the same room in order to reduce mission delays

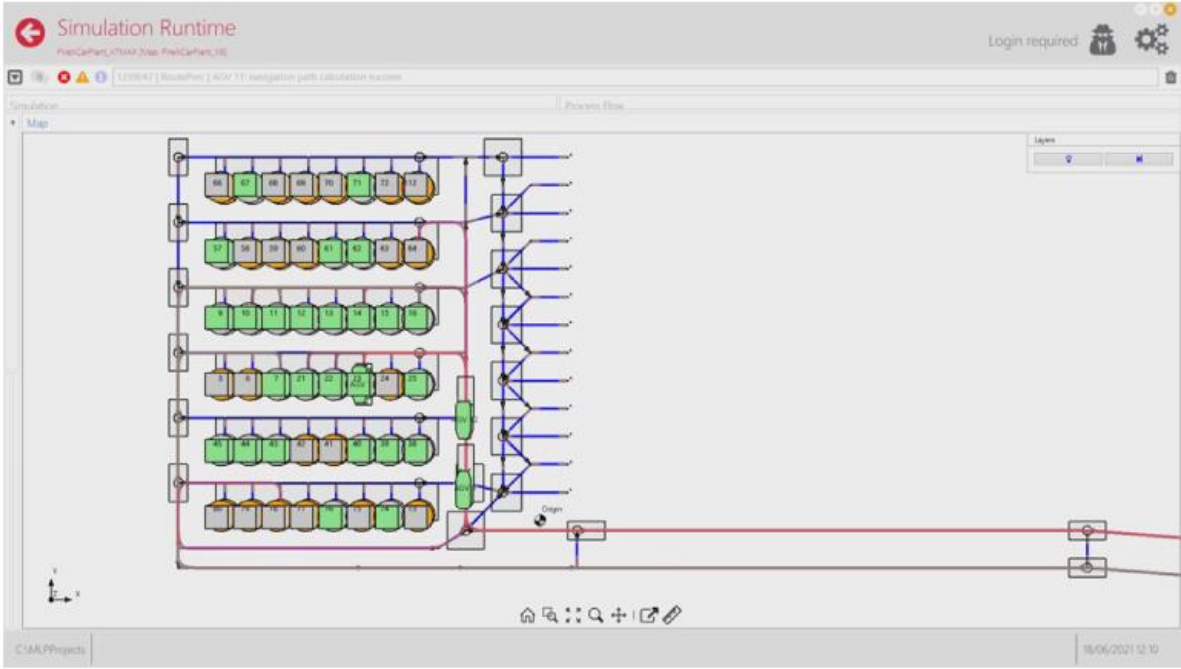
HOW to evaluate an AGV-based logistics platform?

4. Process simulation

- Simulation is not a "plus" only, it is a "**must**": structured logistics processes cannot be judged with the naked eye

- Simulate to evaluate:
  - Process **times** and interlocks
  - **Traffic** patterns
  - Battery **drain**
  - The **number of AGVs** needed
  - The level of performance «derating» in case of **exceptions** and faults

- Favor the usage of tools integrated with the logistics platform



HOW to evaluate an AGV-based logistics platform?

5. Interfaces & Logistics 4.0

- **Networking** architecture

- **Operator interfaces**: wearable, mobile, web, synoptic panels, …

- «Advanced» computer functions
  - Systems remote control
  - Traceability and process data collection
  - KPI, business analysis and statistics
  - Condition Monitoring

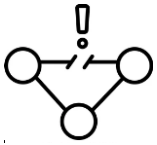
- Integration with corporate information systems

HOW to evaluate an AGV-based logistics platform?

6. Prevention is better than cure

- Operational plan for the **installation** of the solution

- Physical and logical **redundancies** consistent with the criticality of the operating context



- Powerful, fast, and easily accessible system **recovery** and **diagnostic** tools

HOW to evaluate an AGV-based logistics platform?

7. Checklist

Goals

- Simplify processes and ergonomics
- Reduce operating costs
- Improve the level of service
- Increase safety
- Boost efficiency

Evaluation Roadmap

- Payload
- Layout
- Workstations and safety devices
- Operating cycles
- Simulation
- Networking
- HMI
- Industry 4.0
- Installation and testing plan
- Redundancies
- Diagnostics

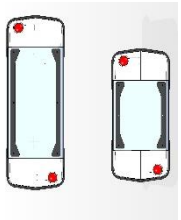
Logistic solution

Premature optimization is the root of all evil
C.A.R. Hoare

1. MLP … What is it ?

MLP (Microtecna Logistics Platform) is a framework created by Microtecna with the aim of enhancing the realization of special logistics solutions based on tailor-made AGVs

MLP framework can be extended in order to fit your operating context

	AGVs	Management & MMI	Applications
MLP COMPONENTS	**«Standard» Vehicle Frames**  Omni-Directional Control system Customizable Navigation system Adaptive 360° Safety Technology	**«Standard» Fleet Control Station**  Integrated simulation system Path, Traffic & Obstacle Manager Mobile & Remote Control Interfaces (for Field-operators and ERP/MES interfacing)	• Process **simulations** • Item Transportation (with external pick & place) • Cart/Frame towing
EXTENSIONS	**«Custom-built» Vehicle Frames**  On-Board Automation Technologies (i.e. Conveyors, Lifters, Robots, Handling Systems, Measurement sensors, Object tracking & recognition …)	**«Custom-built» Control Station** Automatic Process Control System Additional Field Automation (i.e. Robots, Handling Systems, Conveyors, lifters, doors, …) Custom ERP/MES Interfaces	• Cart/Frame lifting • Pick&place operations • On-board assembly operations • Environmental measurements • Inventory and object identification • …

2. MLP applied to MTE Industrial AGVs

KARTBOT
Industrial cart lifter

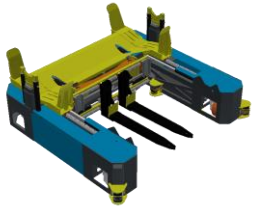
Payload: 100-10.000 Kg
Status: **RELEASED**

ROLLERBOT
Industrial components transport on conveyors

Payload: 100-3.000 Kg
Status: **RELEASED**

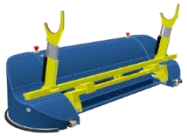
SHAFTBOT
Industrial shaft pairs transport with automatic load-unload system

Payload: 100-900 Kg
Status: **RELEASED**



PAPERBOT
Extremely compact hybrid AGV for jumbo beans and pallet lifting and transportation

Payload: 1.000-7.500 Kg
Status: **RELEASED**



BEAMBOT
Jumbo-Beam transport and lifting

Payload: 800-5.000 Kg
Status: **AVAILABLE ON REQUEST**

HANDBOT
AGV with integrated industrial Collaborative Robot

Payload: 5-50 Kg
Status: **AVAILABLE ON REQUEST**

BostonDynamics® Spot
Advanced inspection outdoor mobile robot

Payload: 5-15 Kg
Status: **AVAILABLE ON REQUEST**

BostonDynamics® Stretch
Automated case handling for efficient warehouse operations

Payload: 10-20 Kg
Status: **AVAILABLE ON REQUEST**

3. Can we assist you ?

Our first and unique goal is to create the right solution for you

Innovation is waiting and we are ready to start a new journey with you.
We eagerly anticipate establishing contact with you

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