



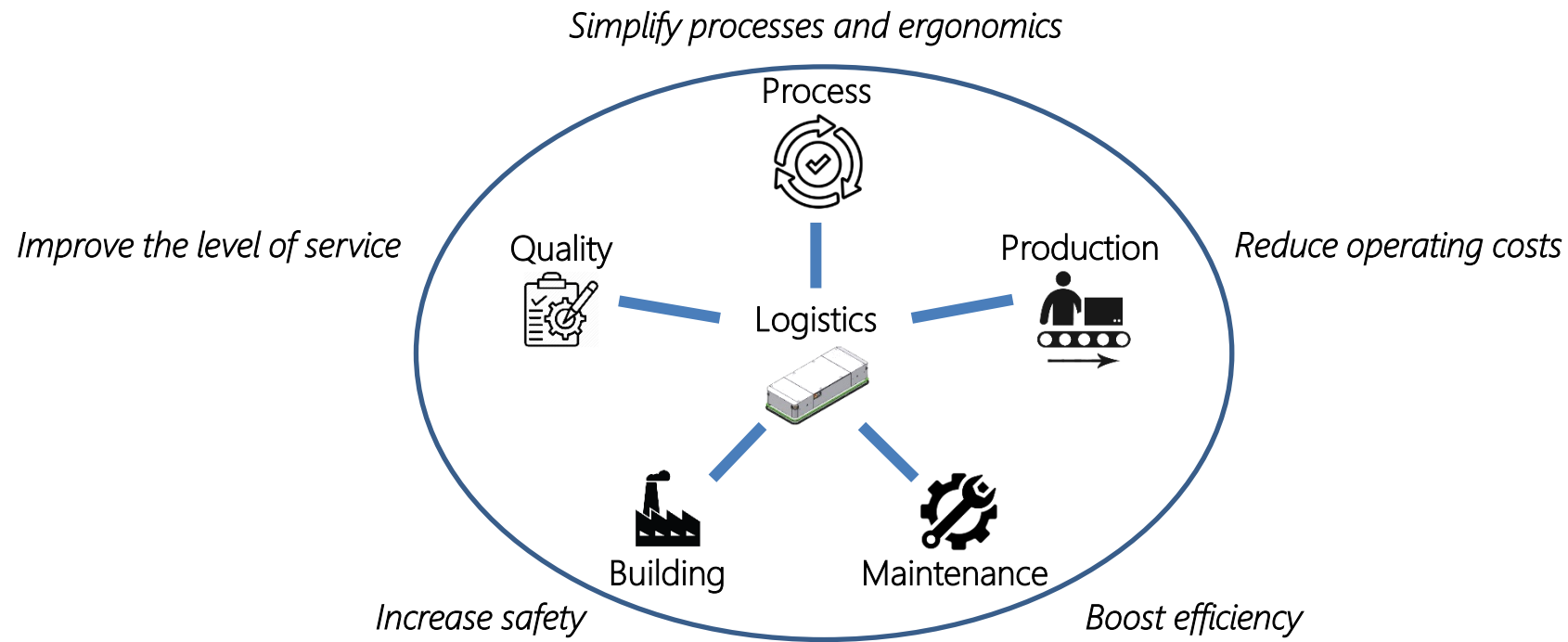
AGV/AMR-based Solutions Overview



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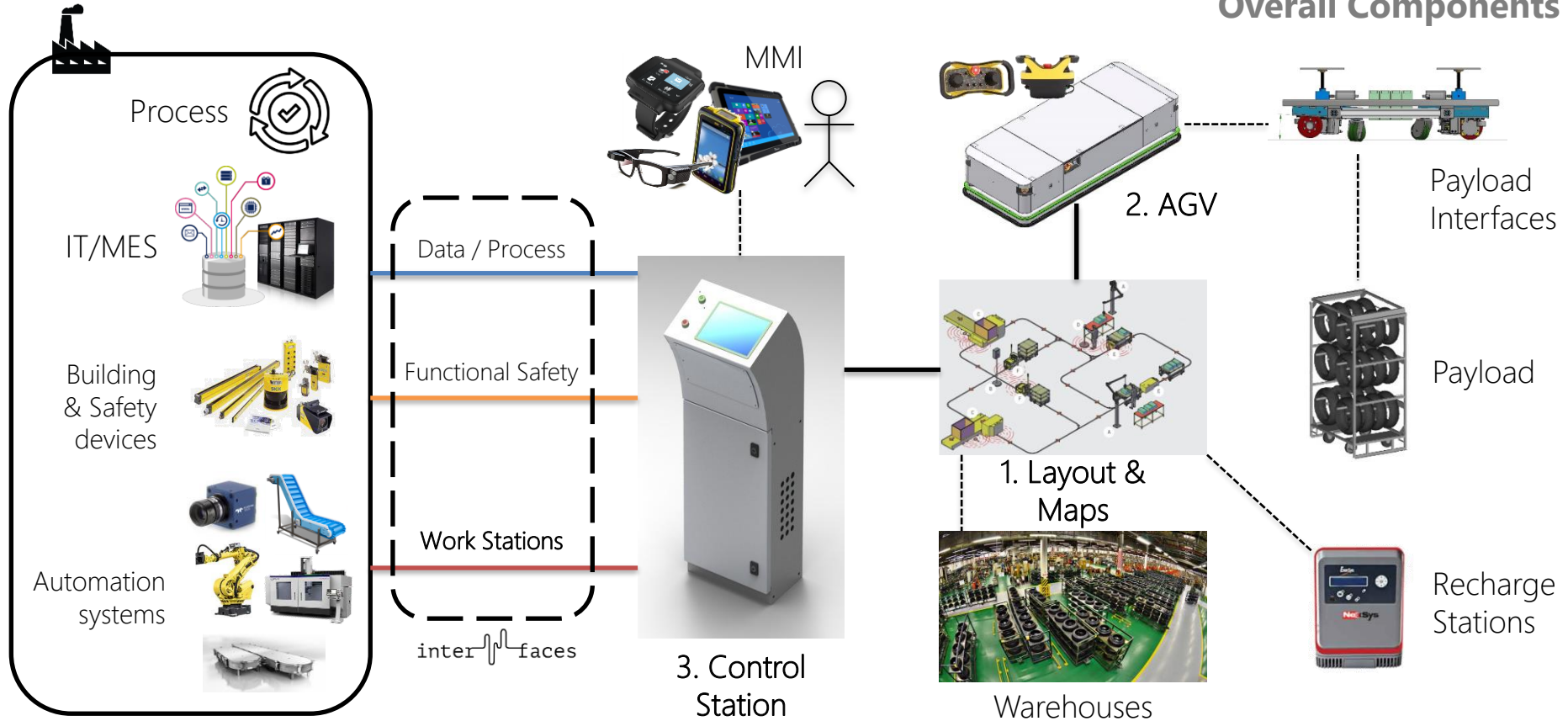
WHY automate industrial logistics processes?



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





WHAT is an AGV-based logistics platform?

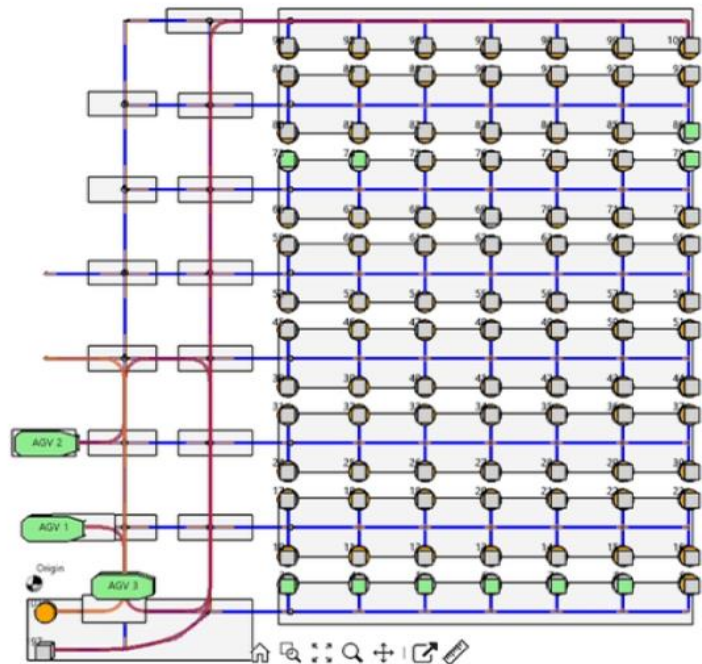
1. Layout & Maps

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

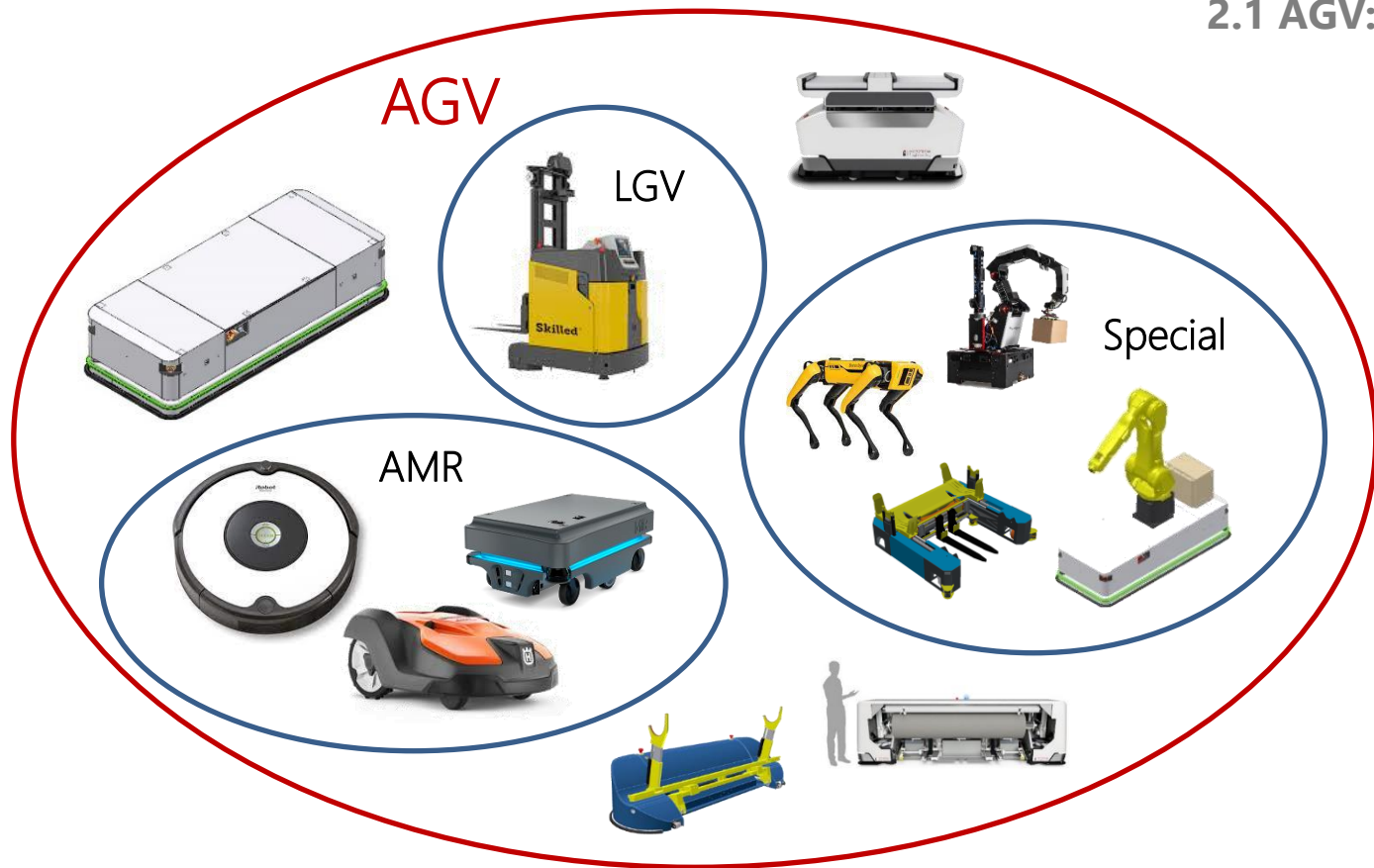
*The map must consist of the **minimum number of nodes and connections** such as to cover the entire functional domain of the solution.
It is important to favor solutions in which **traffic management and the calculation of the best trajectories is entirely automatic.***





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



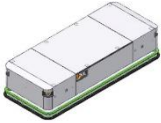
Cleaning

No payload



Inspection

< 10 Kg



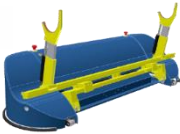
Support

< 10.000 Kg



Translation

< 4.000 Kg



Lifting

< 5.000 Kg

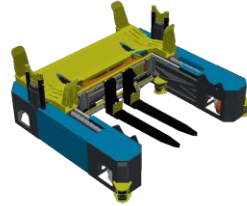


Handling

< 50 Kg

Hybrid

Any payload



Each vehicle can be extended by integrating sensors and actuators

Cost and performance depend on the application

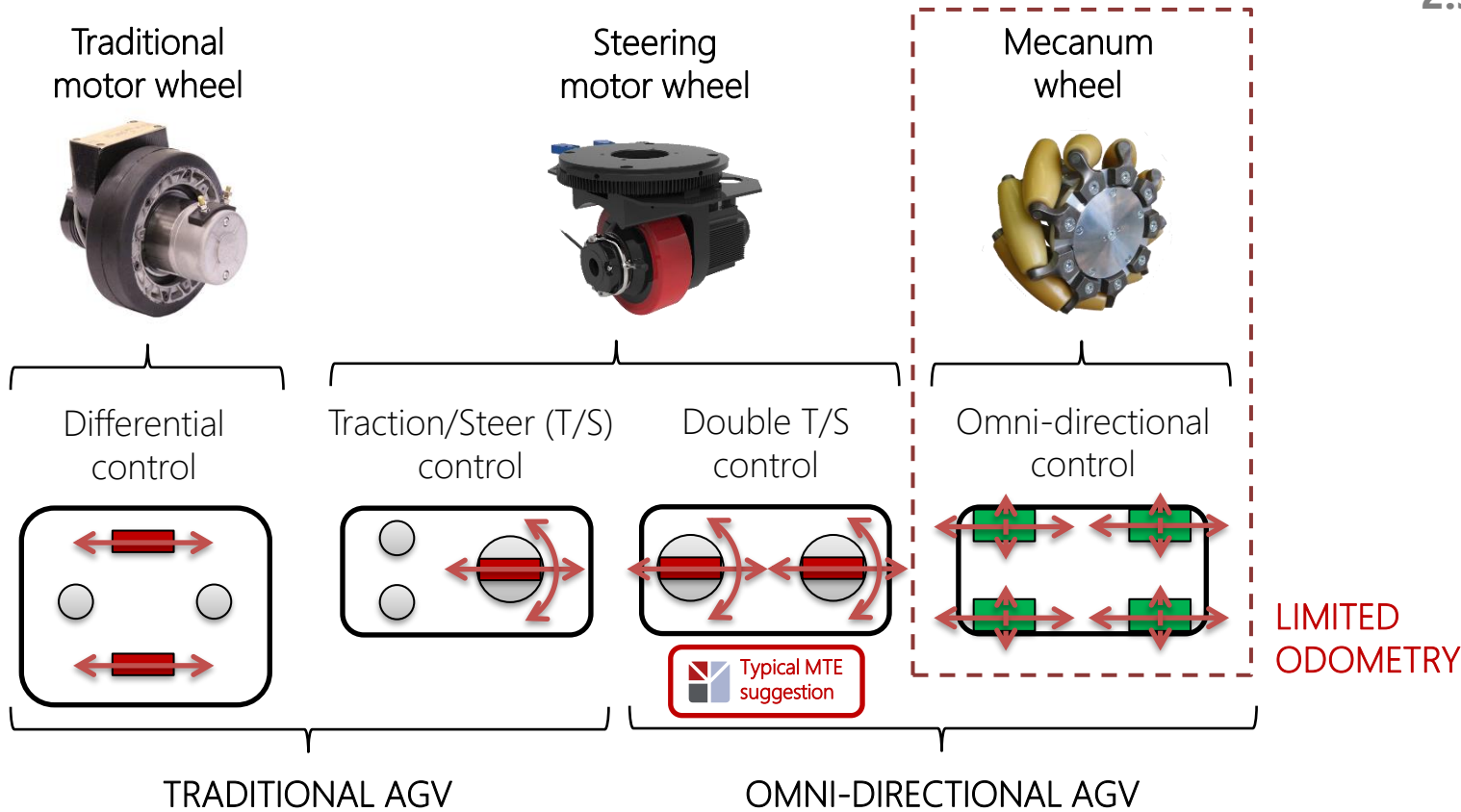
"Simplicity is prerequisite for reliability"

Edsger Dijkstra



WHAT is an AGV-based logistics platform?

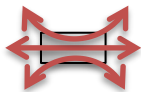
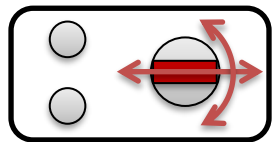
2.3 AGV: control



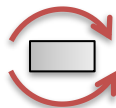
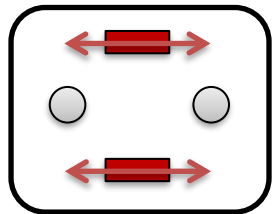


WHAT is an AGV-based logistics platform?

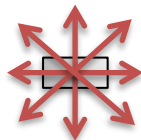
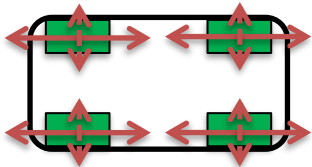
2.3 AGV: control



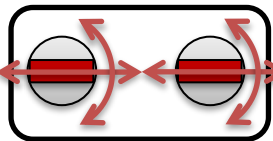
«Car-Like» Movements



Fixed-Point Rotations



«Crab» Movements



Combined
Roto-Translations



Minimum
costs



Maximum
performance

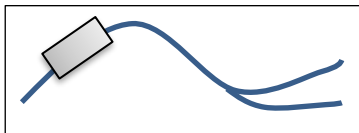
Beware of:

- Necessary movements
- Industrial flooring



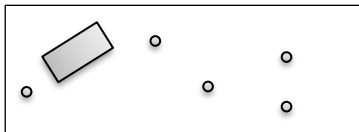
WHAT is an AGV-based logistics platform?

2.4 AGV: navigation



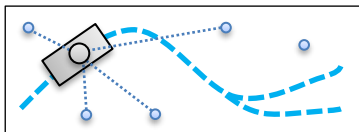
Wireguide

- Magnetic / Optic
- Odometry



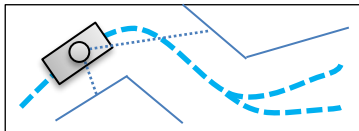
Marker

- Magnetic / Optic
- Odometry



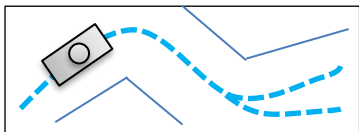
Laser

- Laser
- (Odometry)



Natural

- Laser
- (Odometry)



Natural 2.0

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



Fixed Layout

Slow Setup



Variable Layout

Fast Setup

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

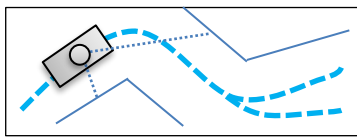
Great attention must be paid to the study of the layout in order to define the most appropriate navigation strategy

GPS / DGPS: available for OUTDOOR contexts



WHAT is an AGV-based logistics platform?

2.4 AGV: navigation



Natural

- Laser
- (Odometry)



CORRECTING

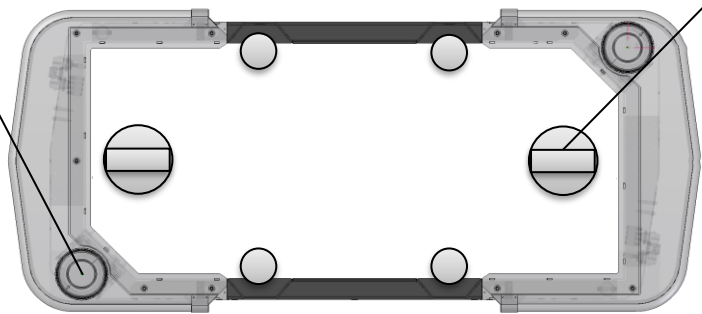
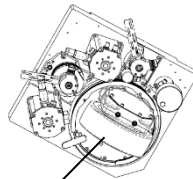
Estimates vehicle absolute position and attitude using low-frequency (1-5Hz) laser data

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



WHAT is an AGV-based logistics platform?

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 $V_{max} < 0.3 \text{ m/s}$

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

Industrial Robot



Same rules as for
a robotic island

Vs

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



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



Wifi

4G / 5G

Radiomodem

Bandwidth and latencies
Usage for SAFETY



Distances



Outdoor Environment



Saving

TBD

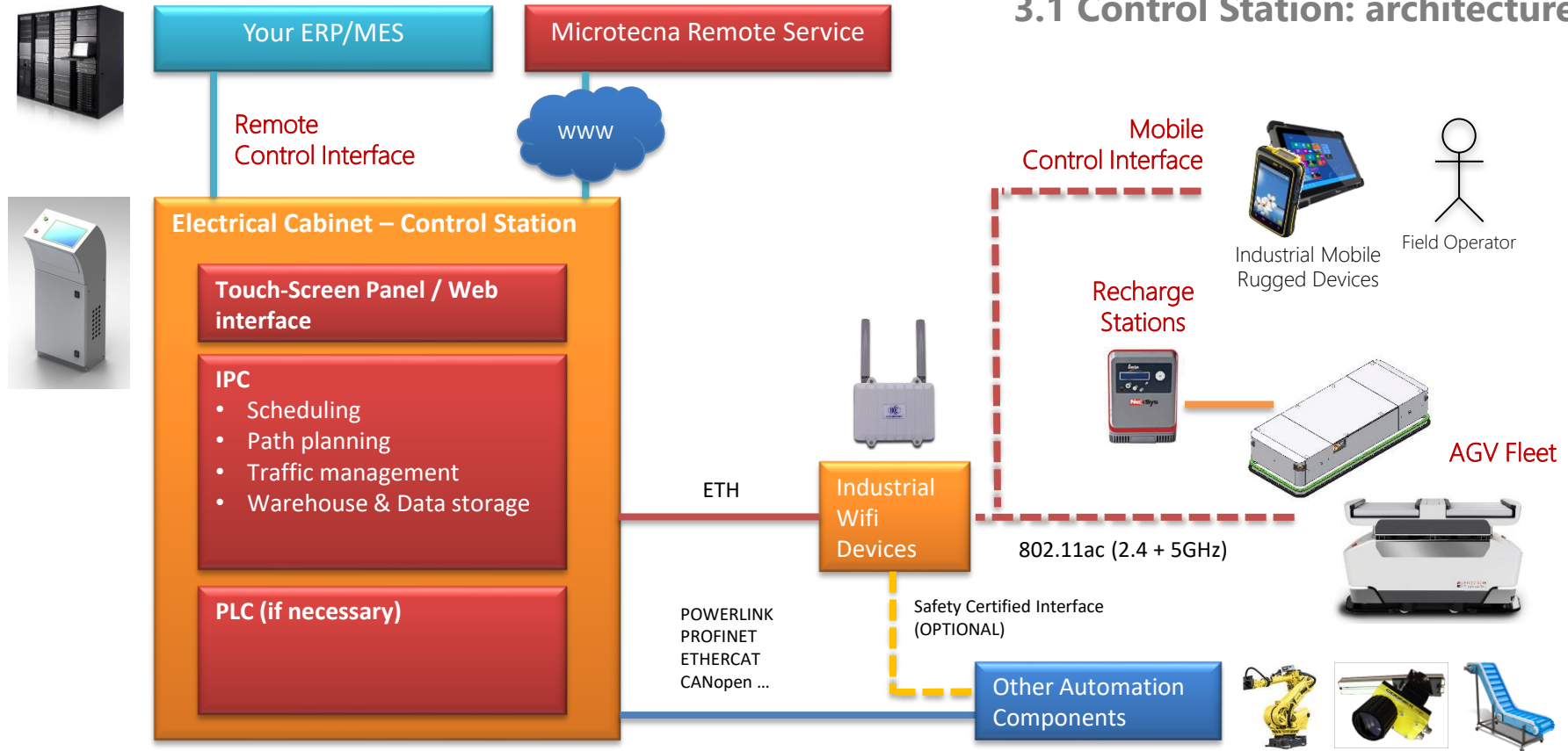
TBD

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?

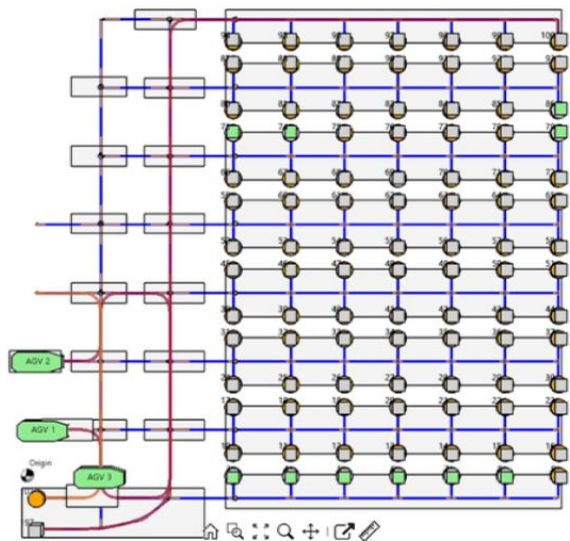
3.1 Control Station: architecture





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



Logistics 4.0

- Supervision
- Remote control
- Process integration
- Traceability
- Data collection
- ...

MMI



Automation systems



Work Stations

- Conveyors
- Manipulators and handling systems
- Robotic islands
- Processing machines
- Quality control systems
- ...

Building Automation



Safety systems



Equipments

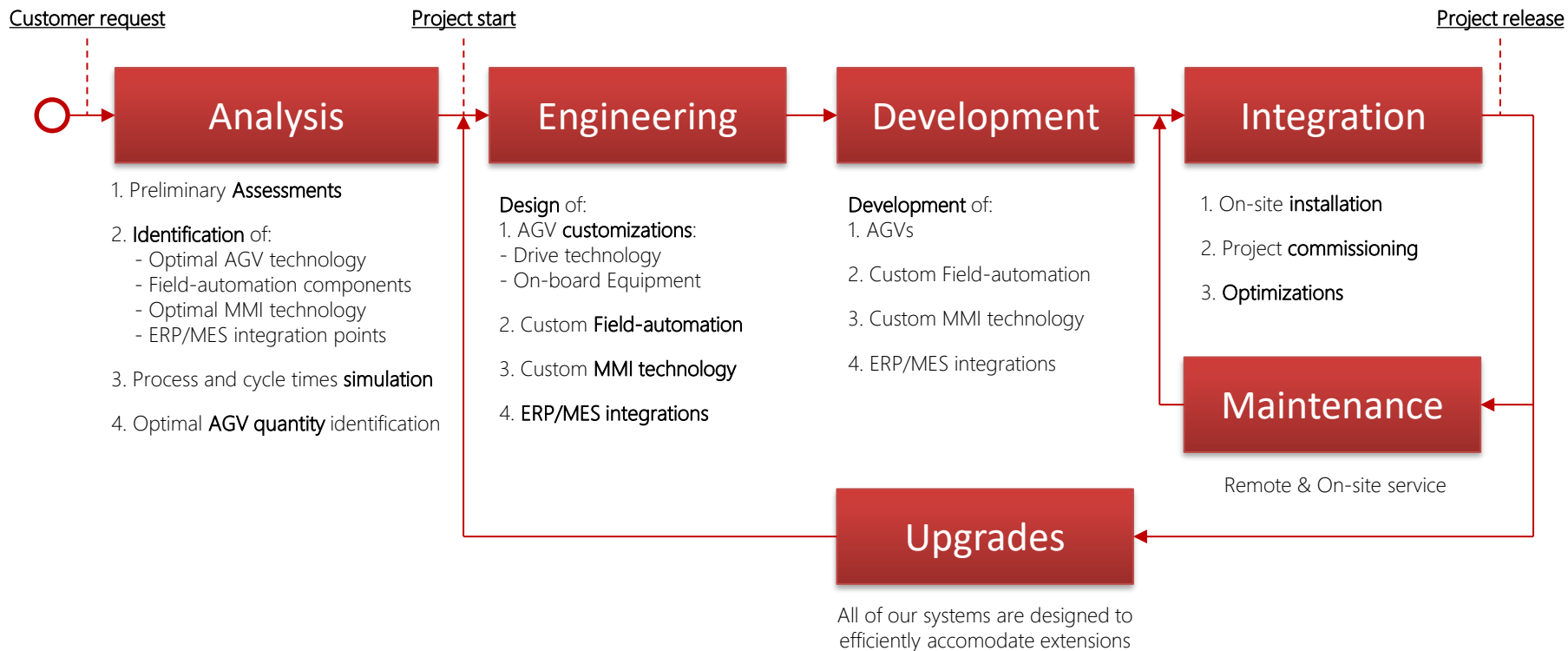
- Doors and Elevators
- Plants (HVAC, lighting, ...)
- Fire prevention systems
- Remote ESTOP buttons
- ...

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

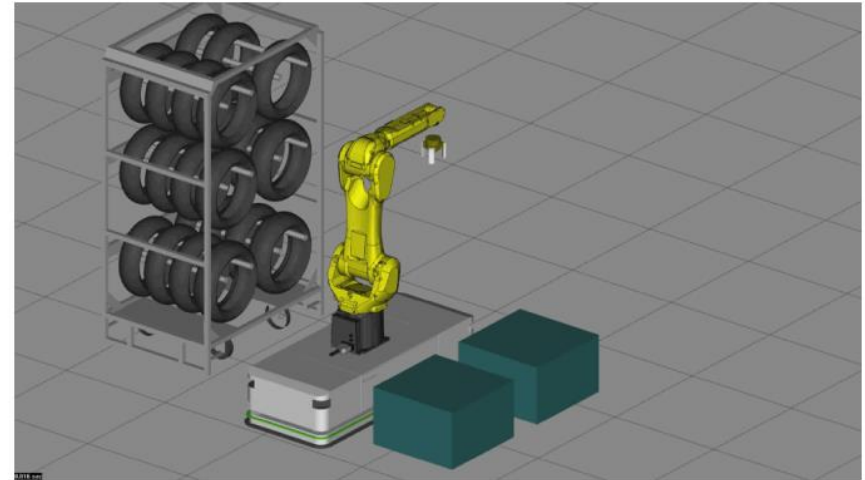




HOW to evaluate an AGV-based logistics platform?

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?

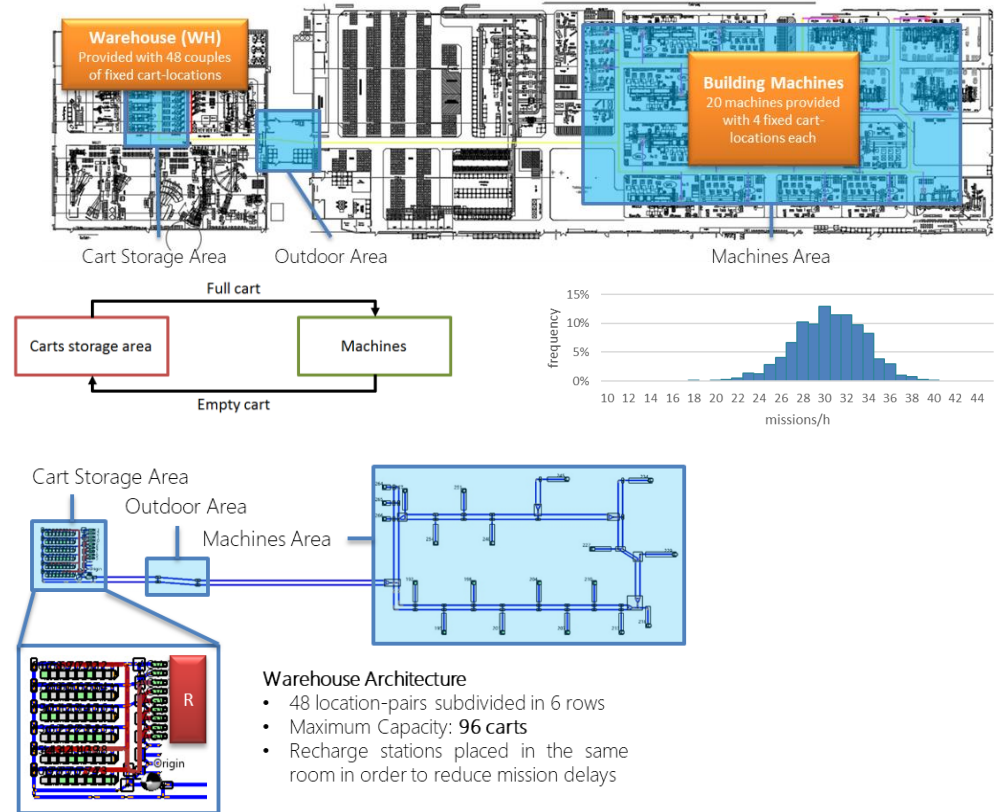
3. Layout & Operations

- 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

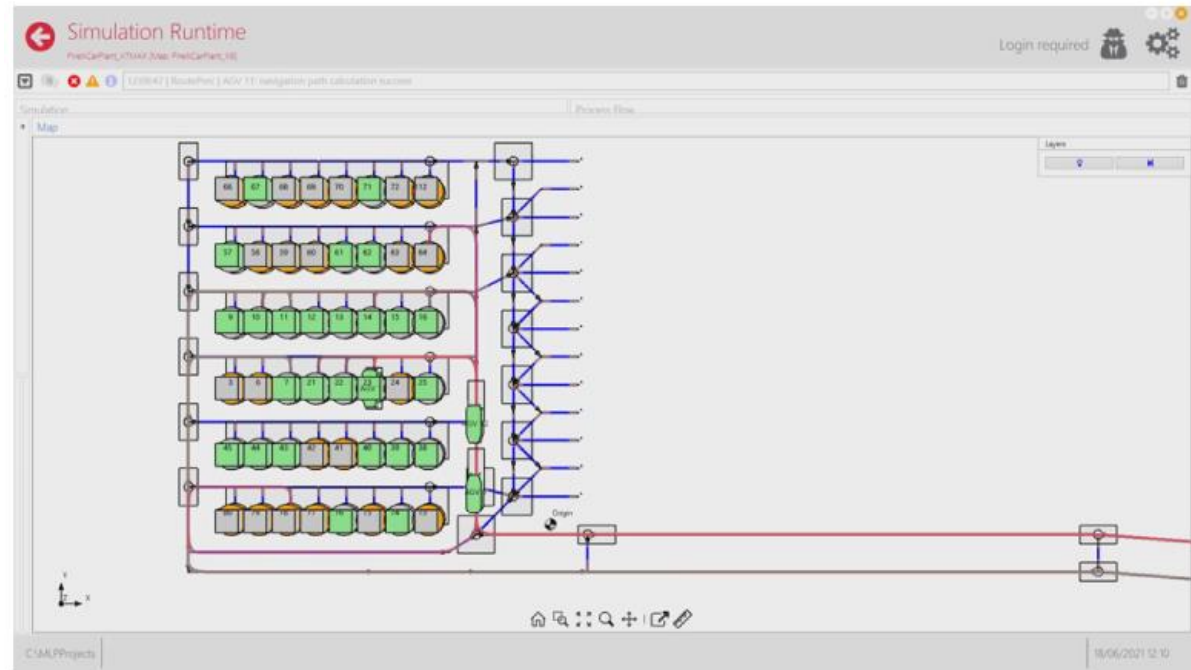




HOW to evaluate an AGV-based logistics platform?

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





- 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

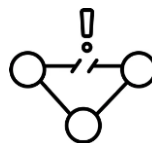




HOW to evaluate an AGV-based logistics platform?

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



Evaluation Roadmap



Logistic solution



Simplify processes and ergonomics



Reduce operating costs



Improve the level of service



Increase safety



Boost efficiency



Payload



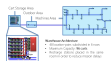
Layout



Workstations and safety devices



Operating cycles



Simulation



Networking



HMI



Industry 4.0



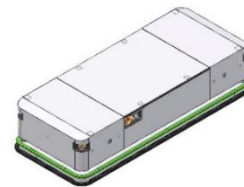
Installation and testing plan



Redundancies



Diagnostics



Premature optimization is the root of all evil

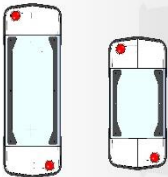
C.A.R. Hoare



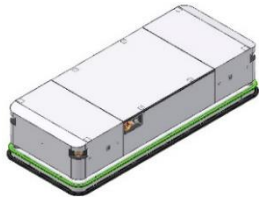
1. MLP ... What is it ?

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**

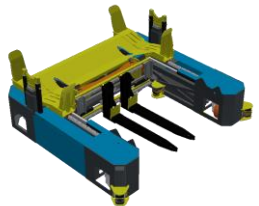


SHAFTBOT

Industrial shaft pairs transport with automatic load-unload system

Payload: 100-900 Kg

Status: **RELEASED**

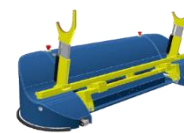


PAPERBOT

Extremely compact hybrid AGV for jumbo beams 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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