R&D Insights from the Digital Testbed Air Cargo (DTAC)

Autonomous Handling from Truck to Belly

Manuel Wehner ◦ IATA Cargo Experts Conference (CEC)
Brussels Airport ◦ 25 September 2025

Photo: Fraunhofer IML, V. Neugebauer

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Pitch topics

- **AMR* development** for autonomous end-to-end airport cargo handling
- **Fleet monitoring and AMR control** through state-of-the-art software
- **Simulation and sensor tests** for specific and neuralgic airport traffic situations

** AMR = Autonomous Mobile Robot*

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Our Aviation Logistics Dept. - based in Frankfurt / Germany:

Fraunhofer IML - R&D focus topics

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Total funding: €13.7m.

Who we are:
Fraunhofer Society (Germany)

~ 32.000
employees

IML's Focus Dept.

76 institutes (incl. IML)
and research centers

Fraunhofer IML

€ 3.4 bil.
annual research volume

We are Europe's largest **non-profit organization** for applied research.

100%
Aviation Logistics

	PAX	Baggage	Cargo	Other
Aircraft	(Dis) Embarkation	(Un)loading & Servicing		Ground Handling
Apron	Passenger Transport	Cargo, Airmail, and Baggage Handling		Security Infrastructure Customs IT VAS ...
Terminal	Passenger Handling	Baggage Handling	Cargo and Airmail Handling	
Pre and On Carriage	Passenger Transport	Baggage Transport	Cargo and Airmail Transport	
Airport Automization				
Airport Digitalization				
Green Aviation				

Current research project DTAC: Focus on air cargo digitization and automation

Picture: Fraunhofer IML, V. Neugebauer

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→ **Focus of this pitch: our robotic developments and tests**

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Current challenges in the air cargo industry:

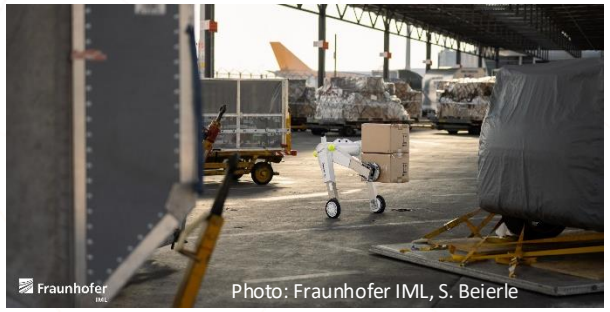
DTAC research focus (2021 – 2026)

Focus today – our robotic tests in 2024:

HOW can next-gen AMRs* support Air Cargo Handling?

* AMR: Autonomous Mobile Robot

Autonomous Warehouse Handling & Apron Transports

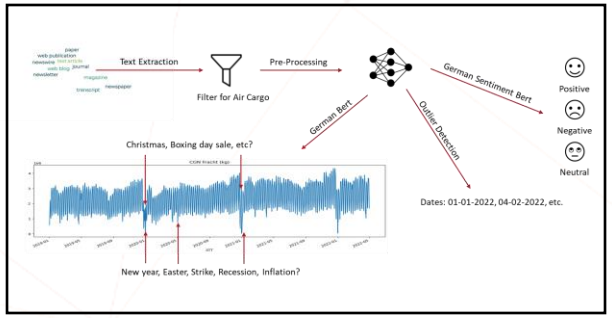


Our approach: R&D with own and market solutions

DTAC focus on AI:

HOW can AI improve Air Cargo efficiency?

Predictive Analytics



Our approach: analyses based on historic cargo data

DTAC focus on data:

Why is Data Sharing still so difficult ?

Data Platform & Digital Avatar

Our approach: open-source server NE:ONE and IoT

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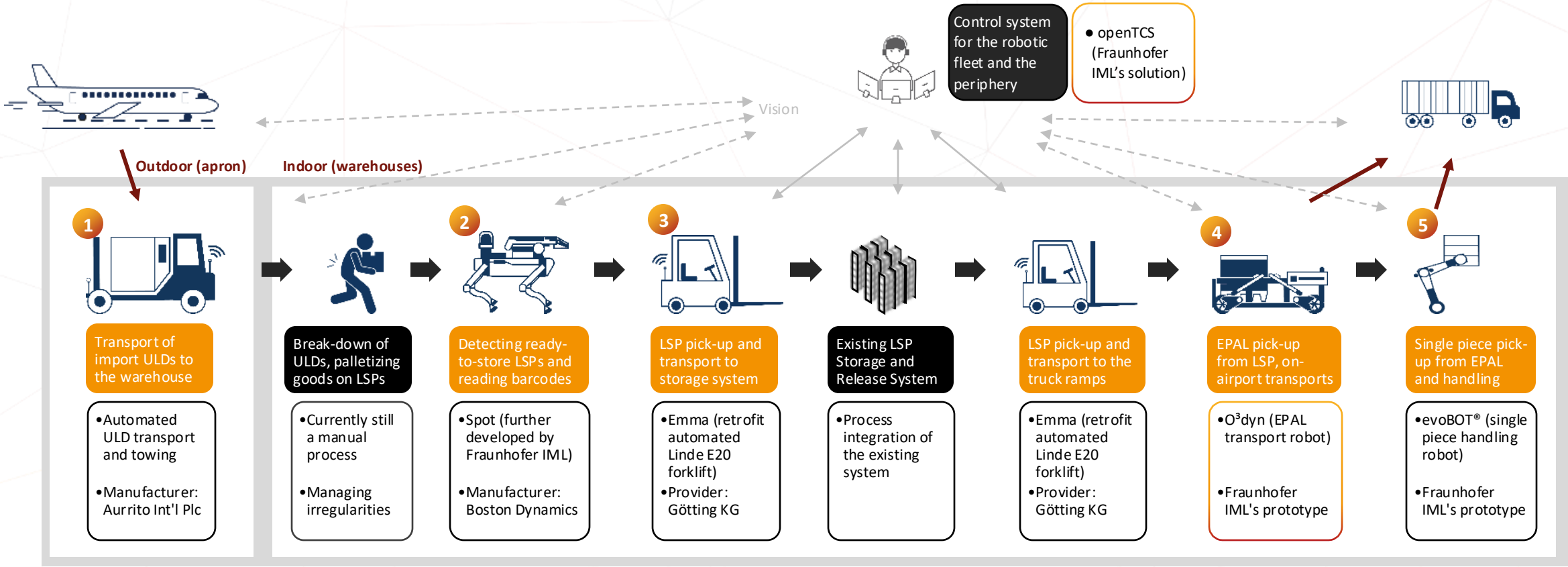
2024 - 3-month trials at MUC and STR with 5 different robots:

Multi-robot testbed for cargo flow automation



***ULD**: Unit load device (air cargo containers / build-up units, various sizes)*
***LSP**: Large metal storage pallet (130 x 130 cm or 200 x 200 cm)*
***EPAL**: Standardized wooden Euro-pallet (120 x 80 cm)*

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2 airports, 5 robots, 12 test weeks, 674 tests, 84% success rate

2024 test results

Auto-DollyTug® (Aurrigo)

Tests: n = 178
Success rate: 65 %
Autonomy level: 30 %

- ✓ Outdoor functionality
- ✗ Load handling

Spot® (Boston Dynamics & IML)

Tests: n = 77
Success rate: 95 %
Autonomy level: 60 %

- ✓ Autonomy level
- ✗ Assessing obstacles

LindeE20 (Götting KG)

Tests: n = 202
Success rate: 86 %
Autonomy level: 20 %

- ✓ Repetit. storage tasks
- ✗ Unbalanced loads

O³dyn (Fraunhofer IML)

Tests: n = 146
Success rate: 97 %
Autonomy level: 20 %

- ✓ Pick-up from pallet
- ✗ Busy intersections

evoBOT® (Fraunhofer IML)

Tests: n = 71
Success rate: 89 %
Autonomy level: 0 %

- ✓ Different shapes
- ✗ Automation outside lab

Pictures: Fraunhofer IML, V. Neugebauer

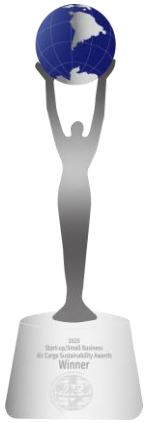
Awards and nominations

Winner

1st place: „Air Cargo Sustainability Award“

„Start-Up and Small Business“ category, The International Air Cargo Association (TIACA)

TIACA Exec. Summit 2025, Hongkong, 25 June 2025



Highly Acclaimed

Highly Acclaimed: „International Award for Excellence in Air Cargo“

„Innovative Logistics Solutions in Air Cargo” category, STAT Times

air cargo africa, Nairobi, 20. February 2025

Top 5

Top 5: „Air Cargo Technology Solution Provider of the Year“

„Air Cargo Technology Solution Provider of the Year“ category, Air Cargo Week (ACW)

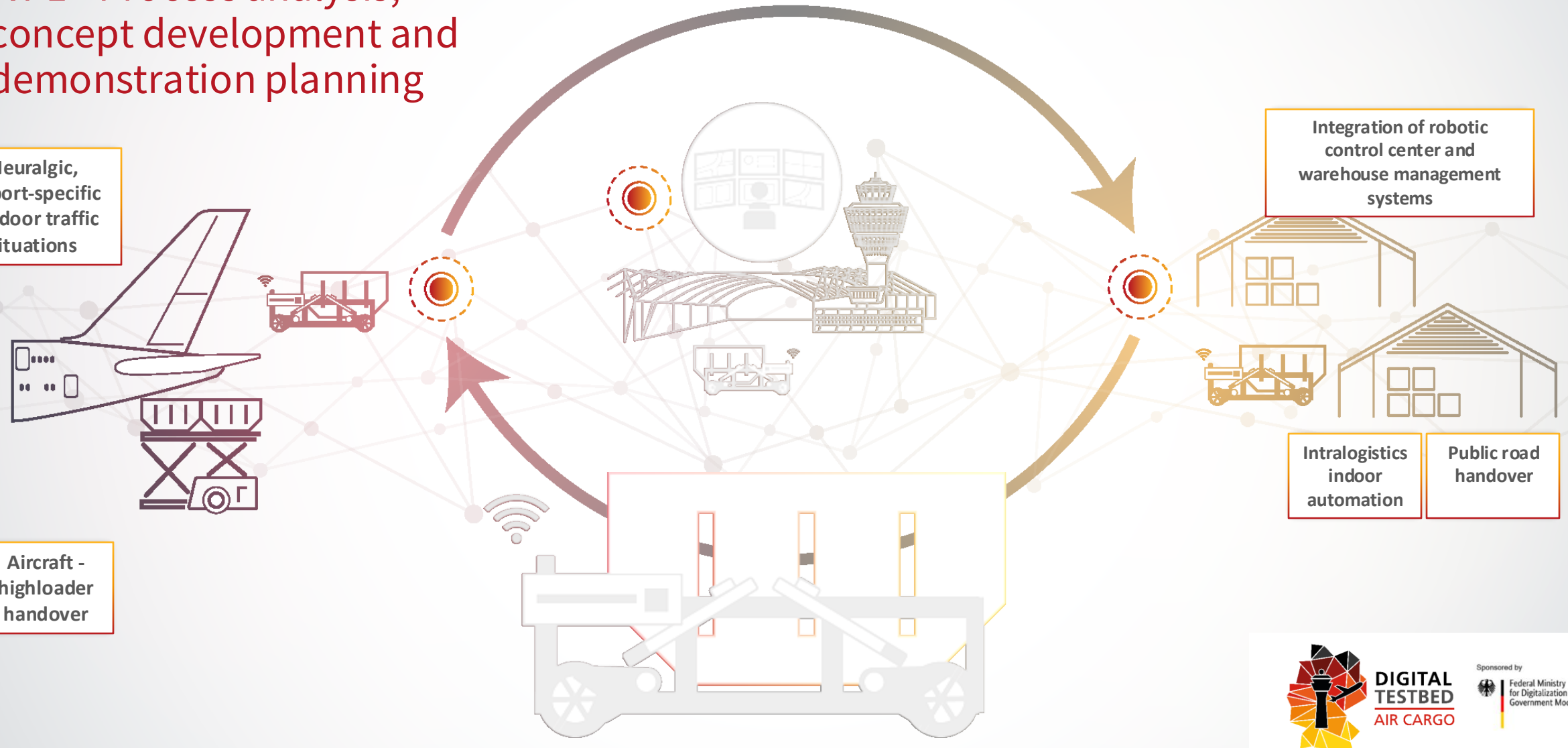
transport logistic, Munich, 03 June 25

DTAC 2024 - 2026

WP1 - Process analysis, concept development and demonstration planning

Neuralgic, airport-specific outdoor traffic situations

Aircraft - highloader handover



Integration of robotic control center and warehouse management systems

Intralogistics indoor automation

Public road handover

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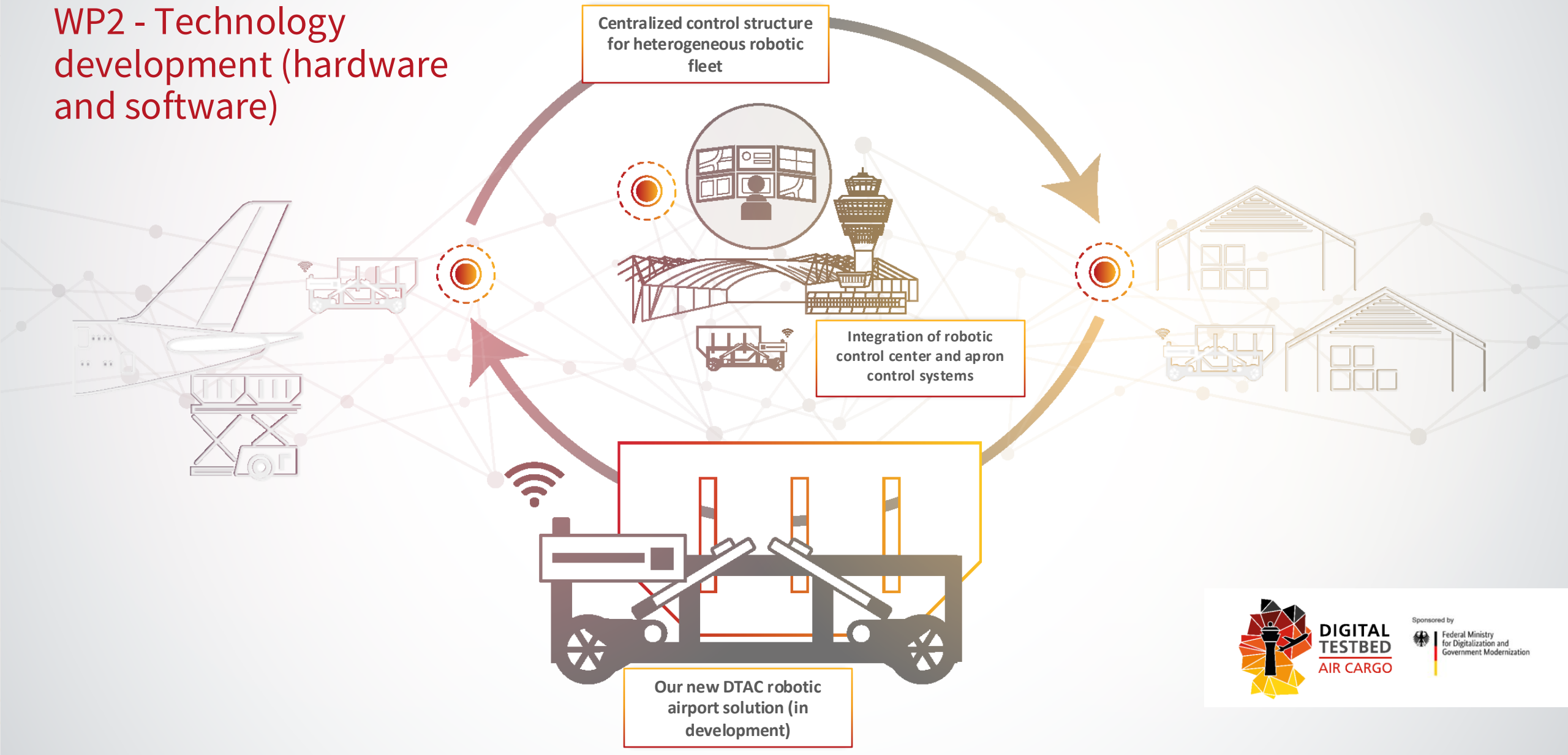
WP2 - Technology development (hardware and software)



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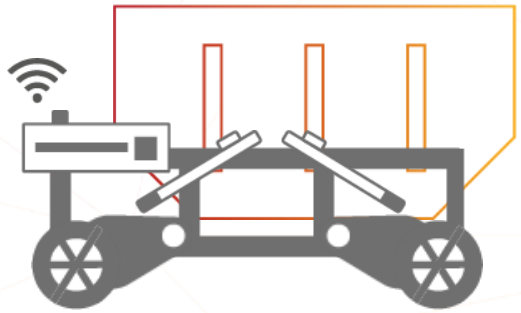
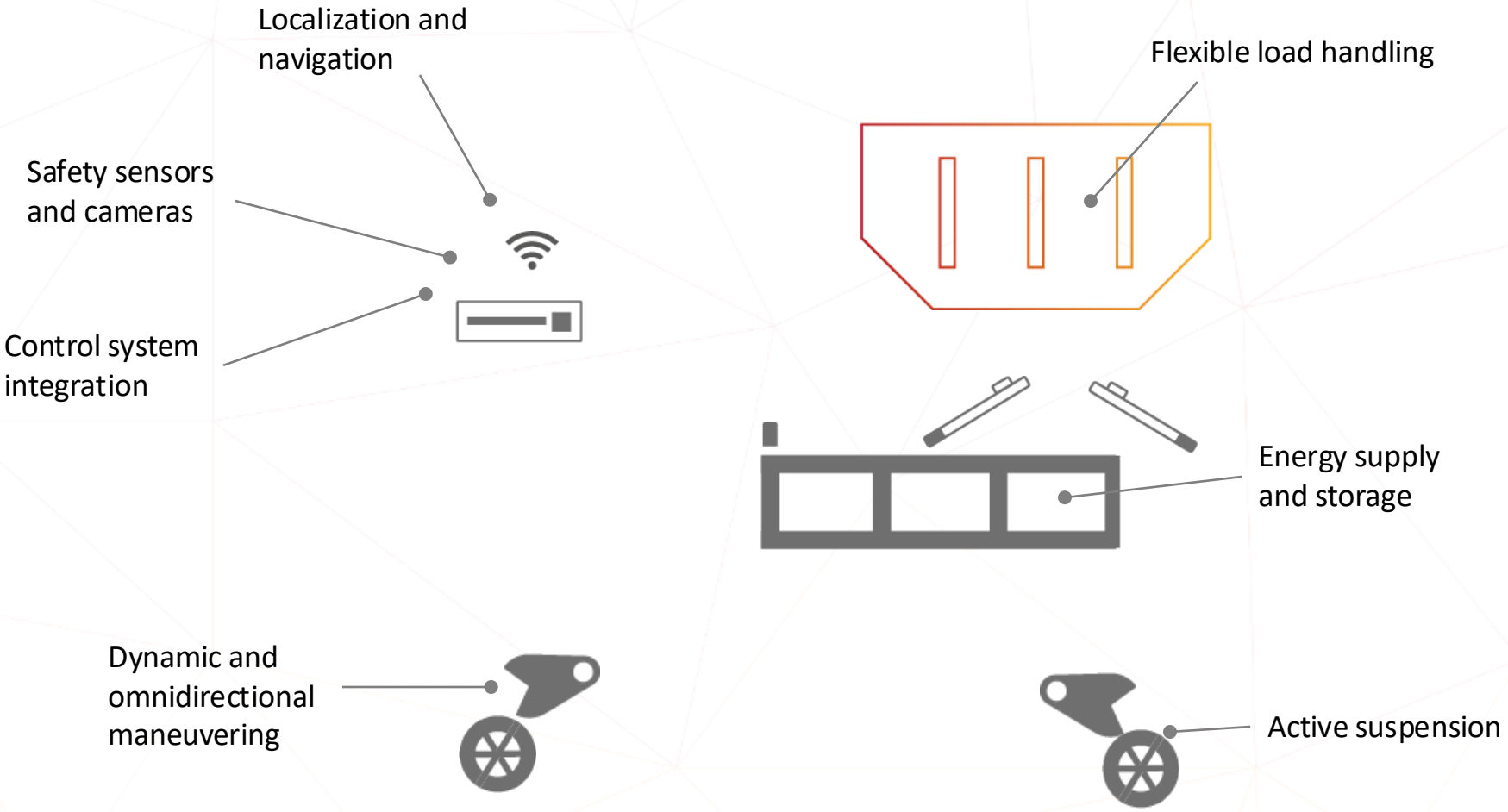
Vehicle requirements (selection)



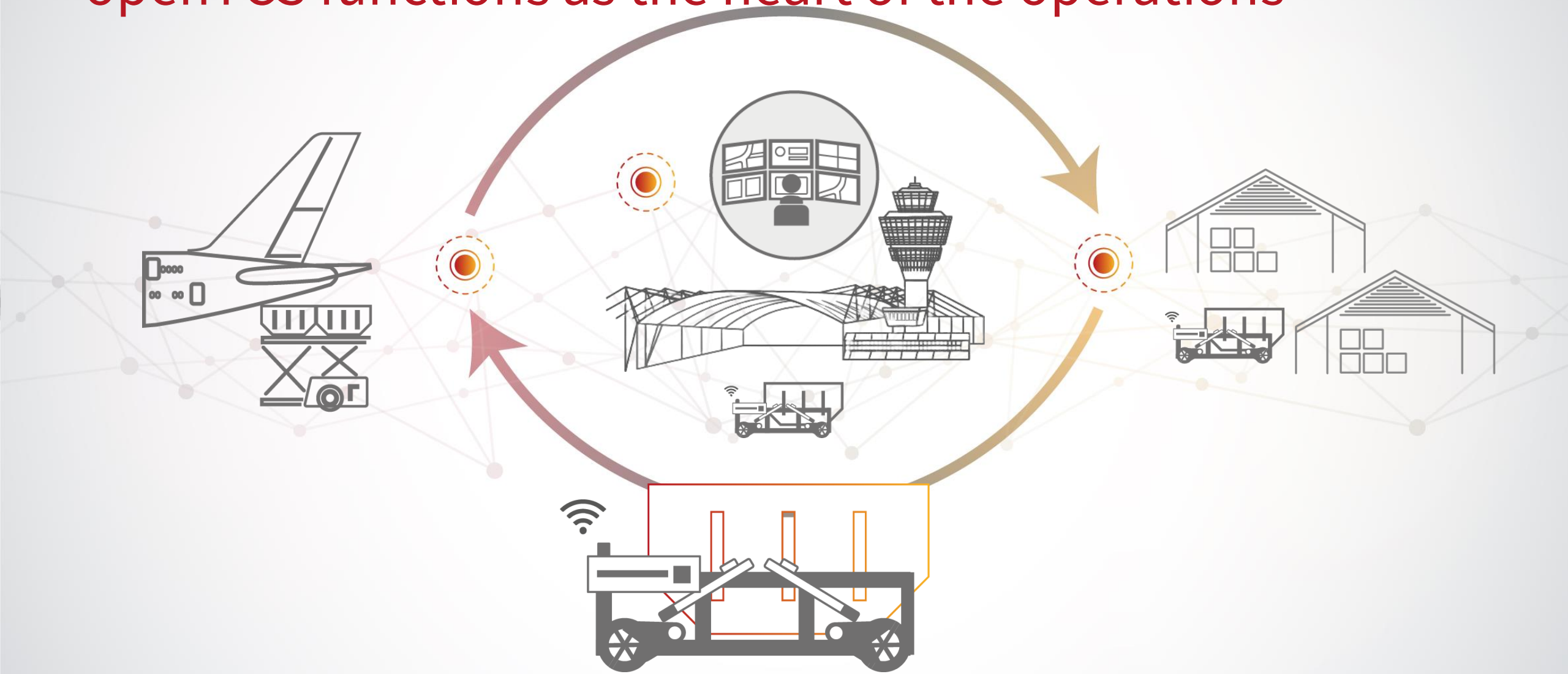
Vehicle requirements (selection)

→ Rolling Chassis to be developed until 04/2026



Centralizing monitoring and control:

openTCS functions as the heart of the operations

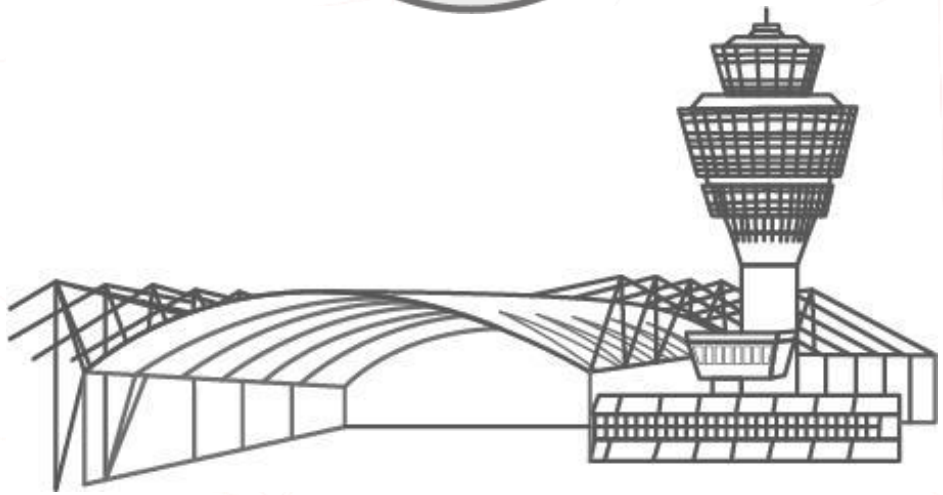


Centralizing monitoring and control:

openTCS functions as the heart of the operations

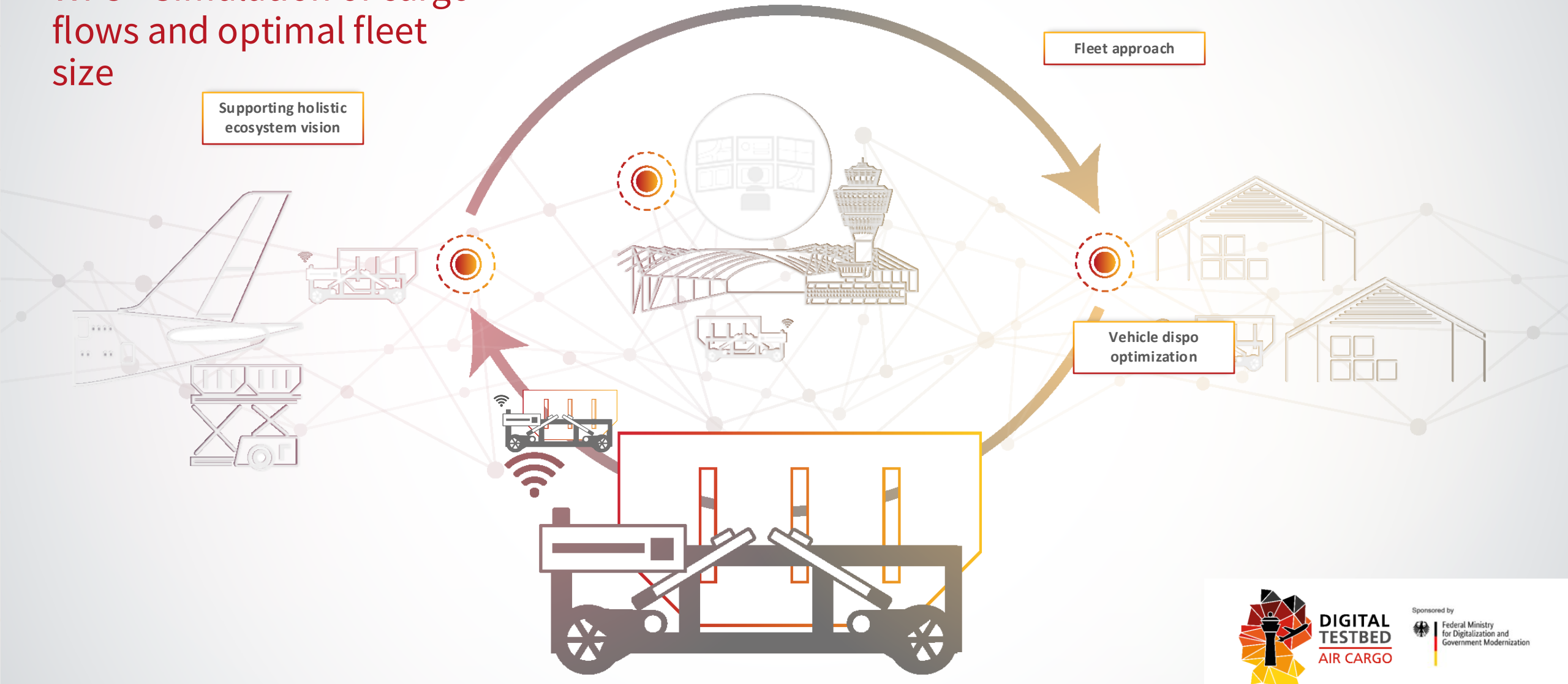
- Open-source
- Manufacturer independent
- VDA5050 communication standard
- Airport specific control center for DTAC
- Web-based, mobile devices
- Integration with airport AI/Flightradar

→ **Control system software for trials and implementations**



DTAC 2024 - 2026

WP3 - Simulation of cargo flows and optimal fleet size



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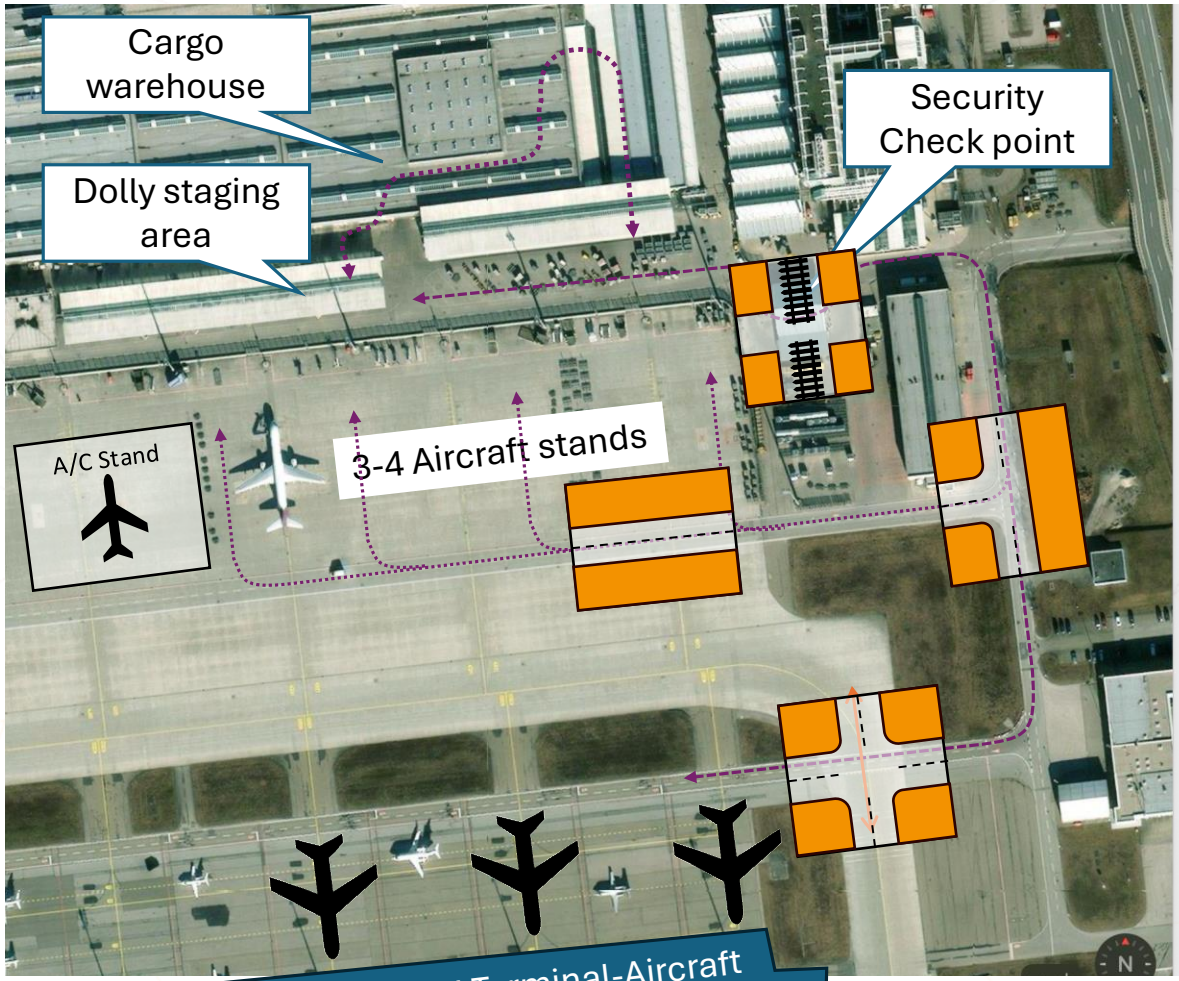
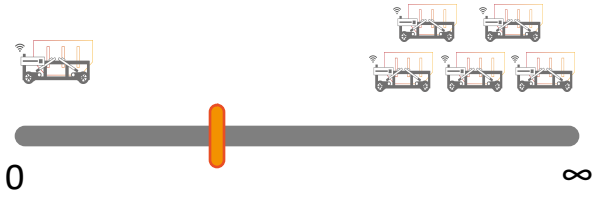
Modular simulation concept:

Analysis of different fleet scenarios

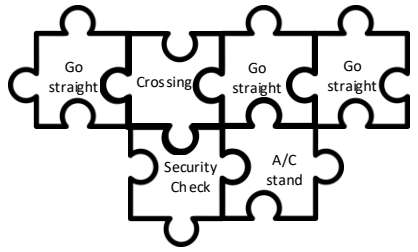


Fleet Size



Cargo Volume

Traffic Infrastructure



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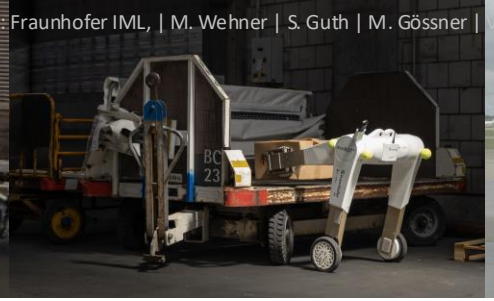



Photos: Fraunhofer IML, | M. Wehner | S. Guth | M. Gössner | V. Neugebauer

"The control of airport surface traffic today can be described as manual.

(…) Many of the tasks [could] be done more easily, more reliably, and more efficiently with automation.

(…) A new [airport] surface surveillance and communication system must be developed to (…) provide surveillance and classification of surface vehicles."

Hollister, W. M., "Airport Surface Traffic Automation Study"
*Massachusetts Inst. of Tech., Technical Report ADA194553, ATC-156, DOT/FAA/PS-87/1 ,**1988**.*

Has the time finally come?






Photos: Fraunhofer IML, V. Neugebauer | M. Gössner | U. Ostermann | M. Wehner

Next steps – outlook until 08/2026

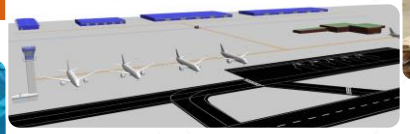
Vehicle developed

Develop rolling chassis

Control system integrated

New robot integration

Simulation prepared



Finalize simulation model

Laboratory testing completed

Evaluate lab tests

Field test prepared

Finalize test concepts

Target: new vehicle ready for airport tests from 09/2026

Thank you for your participation !

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Photo: Fraunhofer IML, V. Neugebauer