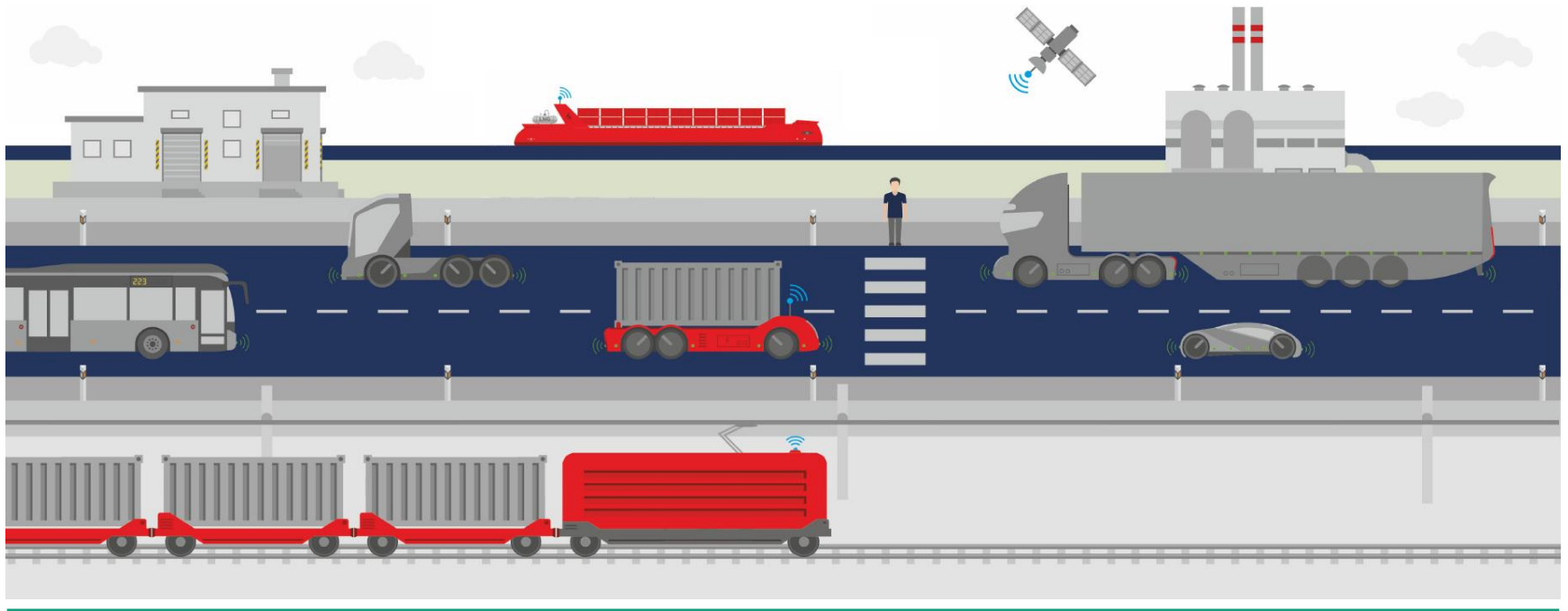


AUTONOMOUS VEHICLES' IMPACT ON PORT INFRASTRUCTURE REQUIREMENTS

A Study by Fraunhofer Center for Maritime Logistics and Services CML
commissioned by Hamburg Port Authority AöR and IAPH Port Planning and
Development Committee, ETC, 10.09.2020



OVERVIEW

1. About Fraunhofer
2. Goal and Course of the Study
3. Autonomous Driving in Maritime and Hinterland Transport
4. Recommendations for Action and Conclusion



Technology
enabler
Digitalization

Ports and
Logistics

Sea Traffic and
Nautical
Solutions

Ship and
Information
Management

Information-
technologies



Artificial
Intelligence



Auto-
matization



Goal and Course of the Study

Ports realize the demand for analyzing the interaction of ports and autonomous vehicles



Analysis of the state of the art and future prospects of autonomous vehicles covering road, rail, waterborne and air



Consequences for planning, maintaining and developing the infrastructure to meet future requirements



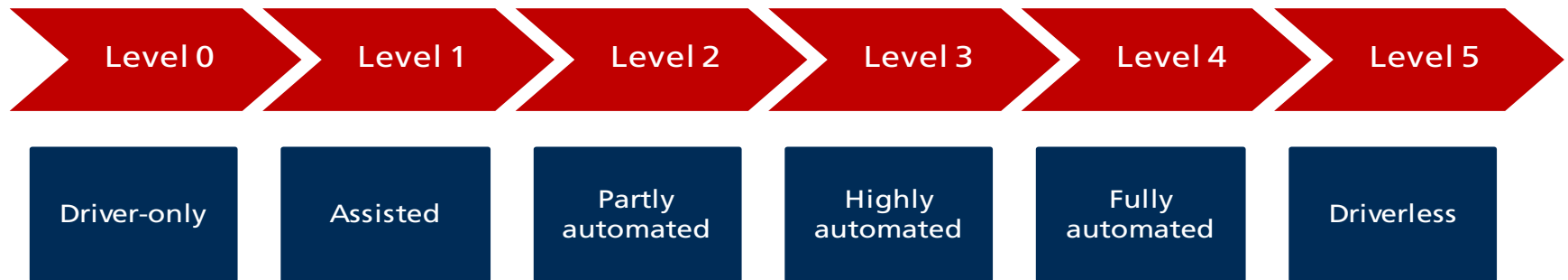
Recommendations for actions

Autonomous Vehicles in Maritime and Hinterland Transport

- Expectations towards the industry and promises of the industry are high, even though a certain downturn can be recognized since the last 2 years.
- But what does Autonomous Vehicles really mean?
 - independent locomotion of vehicles
 - further development of driver /pilot assistance systems
 - responsibility shifts from the human driver /pilot to a system in the latest phase
- Which are the characteristics of the driving tasks?
 - navigation
 - command
 - stabilization

Phase Model – Road Transport

- International standards already exist
- Phase Model for road focuses on the Dynamic Driving Task



Phase Models and Development Stages for other modes



AL = Autonomy Levels

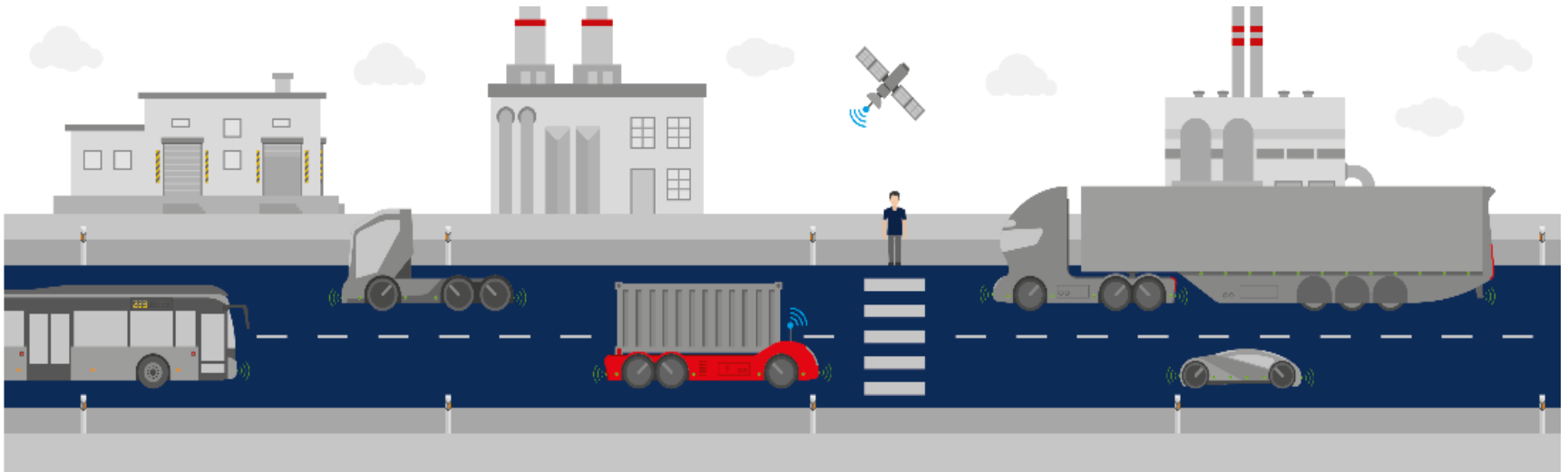
GoA = Grade of Automation

Aerial Transport

No comparable phase models exist

Autonomous Road Transport in Ports

- High complexity issues in road traffic have to be solved
- Savings in transport costs are the main expectation of potential users
- Many test sites already exist, experiences slightly disillusioning



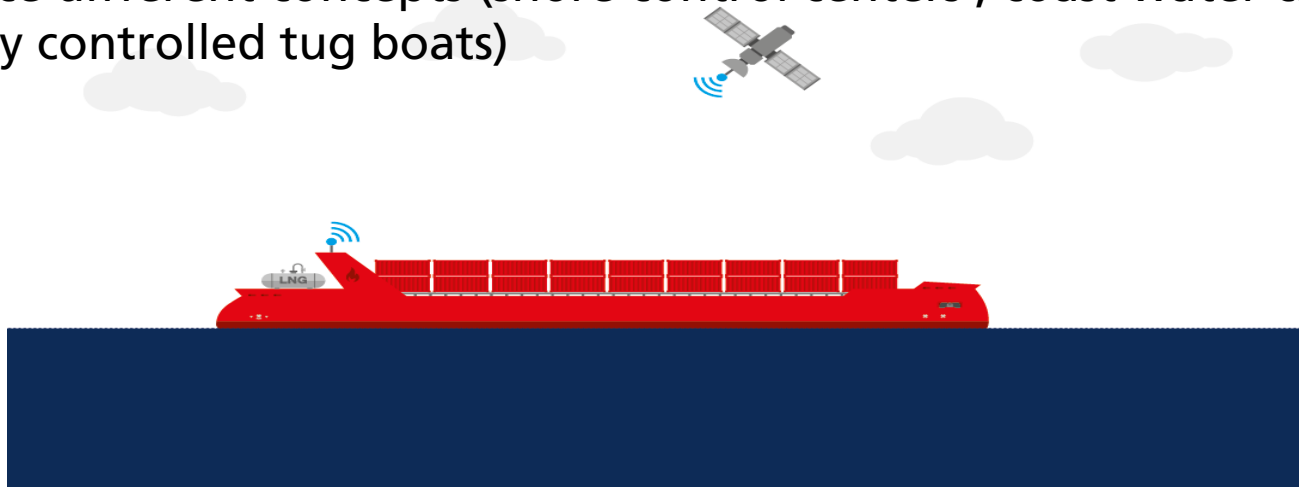
Autonomous Railway Transport in Ports

- Already high automation degree in closed systems, mostly in passenger transport.
- Track based traffic, remote surveillance and electrification seem to favor automatization in rail
- Challenges in railway transport entail
 - Mixed traffic in driving operations or shunting operations
 - Less costs saving expectations ->Not in focus of most railway companies



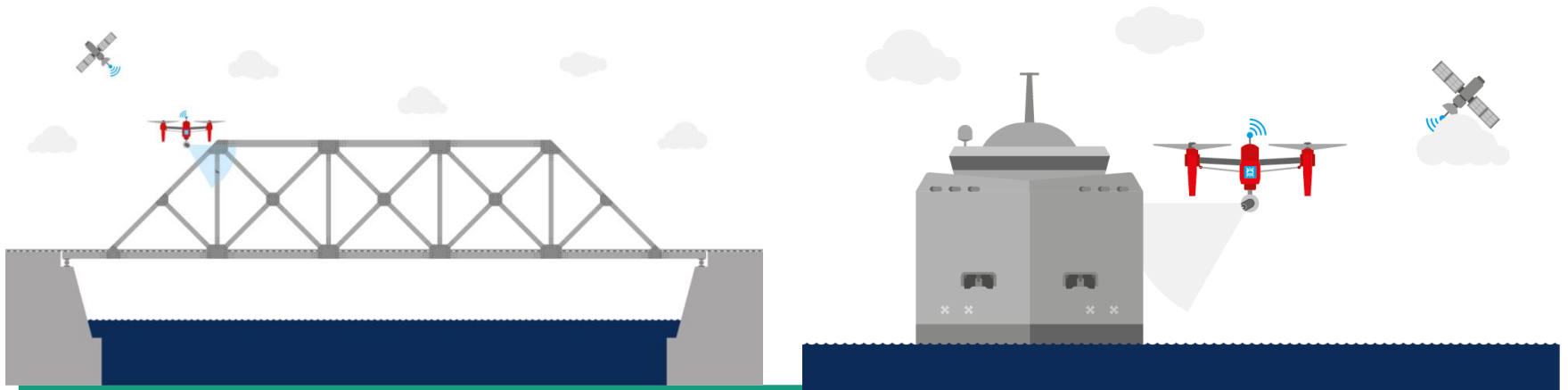
Autonomous Waterborne Transport in Ports

- Many field trials and already running projects exist incl. pax ferries or also autonomous tug boats
- Costs saving questionable
- Ports face different concepts (shore control centers , coast water crews, remotely controlled tug boats)



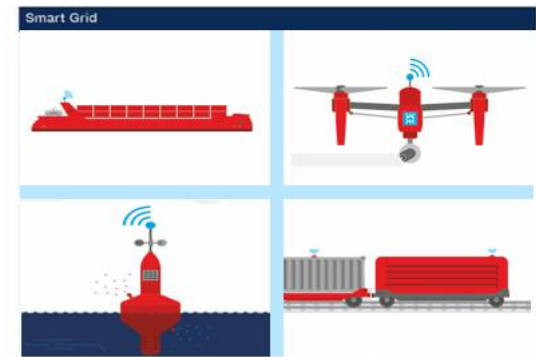
Unmanned Aerial Vehicles in Ports

- Wide range of services by UAV expected, including more maintenance and control than freight transport.
- Transport of freight units limited by energy demands and noise.
- Ports often not in legal charge regarding the air layers above them.



Intelligent Transport Systems (ITS)

- A tool to make infrastructure safer and to increase its efficiency
- International ITS-C standard already exists
- Started for Road Transport and meanwhile extended to all modalities



How should ports act? Prepare or wait for things to come?

- Comparing the lifecycle of vehicles and related infrastructure shows necessity to plan infrastructure according to future vehicle demands
- There are two possible choices:
 - 1. to deal with the challenges is to do nothing and wait until the autonomous technologies have reached a level of maturity which enables them to use any given transport infrastructure.
 - 2. to actively sustain their competitive position by investing in bridging technologies that support (semi-) autonomous vehicles, even though some of these investments might become obsolete.

Recommendations for Action Road, Rail and Air

Road infrastructure

- Prepare the road with high quality road surfaces to minimize irritation.
- Ensure a high quality of formation, contrast and regular maintenance of road markings.
- Provide as further support road guidance systems and road demarcation markers.

Railway infrastructure

- Prepare the port owned railway infrastructure in such a way to keep track to the developments on the main network in terms of deployed technology.

Aerial vehicles

- Develop or contribute to a concept for the regulation of aerial corridors (concept for lower airspace) or zones for UAV.

Recommendations for Actions Waterborne

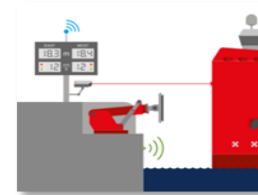
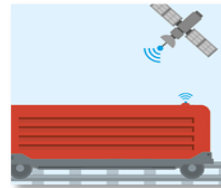
Waterborne infrastructure

- Prepare for the appearance of shore control centers for remotely controlled vessels.
- Prepare for the integration of advanced data transmission technology systems to support autonomous shipping.
- Prepare for auto-mooring facilities, install sensor technologies to support V2X and maneuvering prepare HD Maps for vessels.
- Plan for training the involved personnel with the new processes arising.
- Since autonomous vessels could be smaller and more flexible ships for more frequent services such vessels are also an opportunity for smaller ports or inland waterway links and nodes.

Recommendations for Digital Infrastructure

- Provision of low latency communication networks such as 5G or wireless standards such as G5.
- Prepare how to handle the issue of data generated by V2X infrastructures to be compliant with national or international law.
- Prepare HD Maps of the relevant owned port transport infrastructure for land, sea and air modes.
- Take into concern the most likely increasing demand for IT security of the ports' IT systems.

Recommendations for Actions



Road

Rail

Waterborne

Air

Hardware Infrastructure



High Infrastructure Quality

Keeping Track with Main Network

Shore Control Centers

Aerial Corridors/ Flight Zones

Sufficient Road Markings

Auto-Mooring Facilities

Framework for New Services

Digital Infrastructure



Sensor Technology

Sensor Technology

Sensor Technology

Safe Navigation Systems

HD Maps

Data Transmission Systems

HD Maps

Data Transmission Systems

Data Transmission Systems

Data Transmission Systems

Conclusions 1 / 2

- Ports have always been more in a reactive position than in an active positive among other transport and logistic actors.
- Costs savings are mostly expected as a saving of costs for personnel and additional some fuel cost savings.
- Most cost savings are expected in road transport, while this is the most complex case. Road transport companies will switch to autonomous vehicles once the regulations are set and the cost savings become evident.
- Freight rail transport automatization is not a subject of interest to most railway companies.
- Ship operators look interested into the subject of MASS (Maritime Autonomous Surface Ship) for regular port to port services.

Conclusions 2 / 2

Ports should prepare themselves for the demand of their customers to use (semi-) automated vehicles, being it road, waterborne, rail or air.

The most important challenges for the ports include

- The infrastructural requirements
- The vehicles' technological requirements such as reliable low latency communication networks
- Regulatory requirements
- Data protection and IT Security requirements (i.e. PKI-Public Key Infrastructure)
- Requirements in possible connection with additional services und business cases

Stay in Contact

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