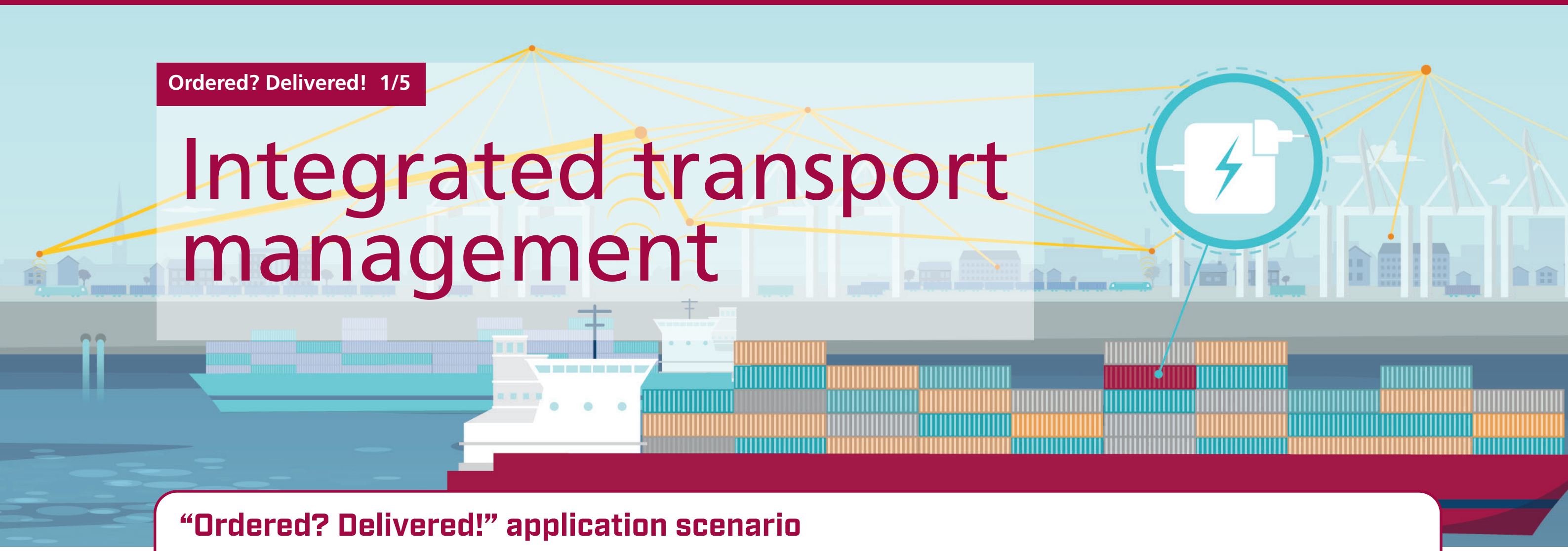
Lernende Systeme
GERMANY'S PLATFORM FOR ARTIFICIAL INTELLIGENCE



Ordered? Delivered! 1/5

Integrated transport management

"Ordered? Delivered!" application scenario

Carla Fuchs is on her way to an appointment in Berlin when she realises she has forgotten the charger for her laptop. She quickly orders a new one, trusting it will be delivered to the destination of her choice in a few hours. This is made possible by self-learning systems that support a fast, efficient and environmentally friendly shipping system. At the heart of this system is AI-based multimodal transport planning, which uses predictive and tactical procedures to control and optimise the logistics and transport process for goods. Fully automated goods transshipment and a highly automated delivery truck get Carla's charger to a central logistics hub on the outskirts of Berlin. An electric van then takes the charger to a small collection depot in the city centre, where a delivery robot takes over and brings the charger to Carla in a café. This application scenario is an example of how AI-assisted logistics and transport processes could work – and it could be feasible in approximately five years.

Starting point

More than three billion metric tons of goods were transported by truck on Germany's roads in 2018 alone. That figure is set to rise. The consequences of this tidal wave of transport are clear to see – trucks, vans, cars and motorcycles are grinding to a halt in ever longer traffic jams while wholesalers, retailers and suppliers are finding it increasingly difficult to predict delivery times. On top of that is the environmental impact. Indeed, the energy consumed by the transport sector rose by 6.9 percent between 2005 and 2017 and makes a tangible contribution to climate change. However, within just a few years, goods could be reaching their destinations faster, more reliably, at lower cost and using less energy – with the aid of AI-based systems.

Application scenario

A ship carrying, among other things, a container of laptop chargers docks in the Port of Hamburg. One of those chargers is the one Carla will soon be ordering – and have delivered to her at her destination of choice within just a few hours. This just-in-time transportation is made possible by integrated transport management technology based on self-learning systems.

Optimum processes

To ensure goods reach customers quickly, reliably and cost-effectively, an AI-assisted multimodal transport planning system manages the entire logistics and transport process for goods – in both the B2B and B2C domain. Using predictive and tactical procedures, it takes routing decisions early on or issues recommendations. To do that, the management system factors in all relevant parameters – different shipping options and modes of transport (such as rail or road), the optimisation of traffic management systems and working timetables, energy consumption and much more.

AI-assisted multimodal transport planning identifies suitable strategies to ensure the transport networks are used efficiently and dynamically to their full potential and to suit the preferences of certain user groups. For example, in the future, smart transport units will be able to decide for themselves whether they are transported either more slowly and cost-effectively or faster and at greater cost – as appropriate to the predicted demand. This produces a highly dimensional and dynamic system that can be continuously optimised with the aid of self-learning algorithms.

Benefits

An integrated transport management system based on self-learning systems offers a wide range of benefits:

- **Efficiency:** The workload is spread evenly between the various modes of transport, and free capacity can be put to optimum use.
- **Speed:** Improved management speeds up transport flows and reduces delays.
- **Reliability:** Manufacturers, wholesalers, retailers, logistics companies and customers can plan delivery times more reliably.
- **Environmental protection:** Reducing traffic congestion lowers energy consumption in logistics.
- **Safety:** The transport infrastructure can use intelligent sensors to pass on relevant information about traffic (e.g. congestion, accidents, vehicles driving in the wrong direction) and weather (e.g. black ice) quickly and accurately (see e.g. the ANIKA[2] research project by the German Federal Ministry of Transport and Digital Infrastructure (BMVI)).

Challenges

The following questions need to be answered before an integrated transport management system can optimise goods transportation:

- **Data protection:** Given the large volumes of data that will be required from the public sector, how can adequate data security be ensured?
- **Financing:** Who will invest in the infrastructure (e.g. broadband expansion, V2I communication)?
- **Prioritisation:** Should equality of access to infrastructure be given up in favour of prioritisation (e.g. for fresh produce)?
- **International implementation:** How would cross-border implementation work?

What needs to be done?

The following steps would be required to establish integrated transport management in the space of a few years:

- Introduction of standardised communication protocols
- Creation of robust communication infrastructures
- Additional research and development work on e.g. algorithms for optimum traffic light settings or intelligent infrastructure sensors
- Development of intelligent IoT devices to create a transparent database for planning
- Analysis of decentralised/local optimisation concepts (e.g. for junctions)

"Integrated transport management" is a component (1 of 5) of the application scenario "Ordered? Delivered!" and has been developed by the Mobility and Intelligent Transport Systems Working Group of Plattform Lernende Systeme. You can find out more at: www.plattform-lernende-systeme.de/anwendungsszenarien.html and in the report On the way to intelligent mobility.

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GERMANY'S PLATFORM FOR ARTIFICIAL INTELLIGENCE

APPLICATION SCENARIOS FOR AI

Ordered? Delivered! 2/5

Automated goods transshipment

Starting point

Loading goods from a train onto a truck is not just physically demanding and sometimes even hazardous, it is also an important time and cost factor. For this reason, many logistics companies forego the complex process of changing between modes of transport and instead ship their goods from start to finish by road. It is an approach that generates more truck traffic, congestion and higher energy consumption. In just a few years, self-learning systems could be used to organise automated goods transshipment – moving goods from rail to road, for instance – and thus make the transportation of goods safer, less costly and more environmentally friendly.

Application scenario

The container holding the chargers is taken from the Port of Hamburg by rail to its next stop – a rail freight yard to the north of Berlin. The standardised transport units are soon automatically unloaded from the container and distributed to highly automated trucks.

Self-learning systems control the process

Goods transshipment takes place in fully automated rail freight yards – from automated trains to automated trucks. Self-learning systems are responsible for managing where rail and road traffic needs to be and when. Both the trains and the trucks are notified of their precise destinations in the yard. Stored in standardised transport units of different sizes, the goods are unloaded by cranes, robots and drones and then distributed to the trucks. During this process, self-learning systems control the goods allocation and the arrival, through-travel and loading of the trucks.

Staff take on new tasks

Staff working for the shipping companies can focus on monitoring the trains and any unforeseen incidents. The use of intelligent, self-learning and predictive systems thus ensures staff can be deployed more efficiently and can compensate for any staff shortage in the logistics sector.

Benefits

Automated goods transshipment offers a whole range of benefits:

- **Reduction in traffic:** Multimodal transport eases road traffic first and foremost.
- **Environmental protection:** Moving transport onto the rail network saves energy and helps protect the environment.
- **Efficiency:** Faster goods transshipment reduces storage times, thereby saving time and costs.
- **Safety:** People are freed up from laborious and sometimes hazardous work.

Challenges

The following questions need to be answered before automated goods transshipment can be introduced:

- **Infrastructure:** What infrastructure needs to be provided to make automated goods transshipment possible?
- **Robustness:** How is it possible to ensure everything runs smoothly and reliably, even during disruptions?
- **Autonomisation:** What level of autonomisation can be achieved in transshipment processes?

What needs to be done?

The following steps need to be taken to ensure automated goods transshipment can become a reality in a few years:

- Standardisation of suitable transport units
- Further development of AI methods for automatically loading and unloading trucks
- Basic and further training for logistics personnel

"Automated goods transshipment" is a component (2 of 5) of the application scenario "Ordered? Delivered!" and has been developed by the Mobility and Intelligent Transport Systems Working Group of Plattform Lernende Systeme. You can find out more at: www.plattform-lernende-systeme.de/anwendungsszenarien.html and in the report On the way to intelligent mobility.

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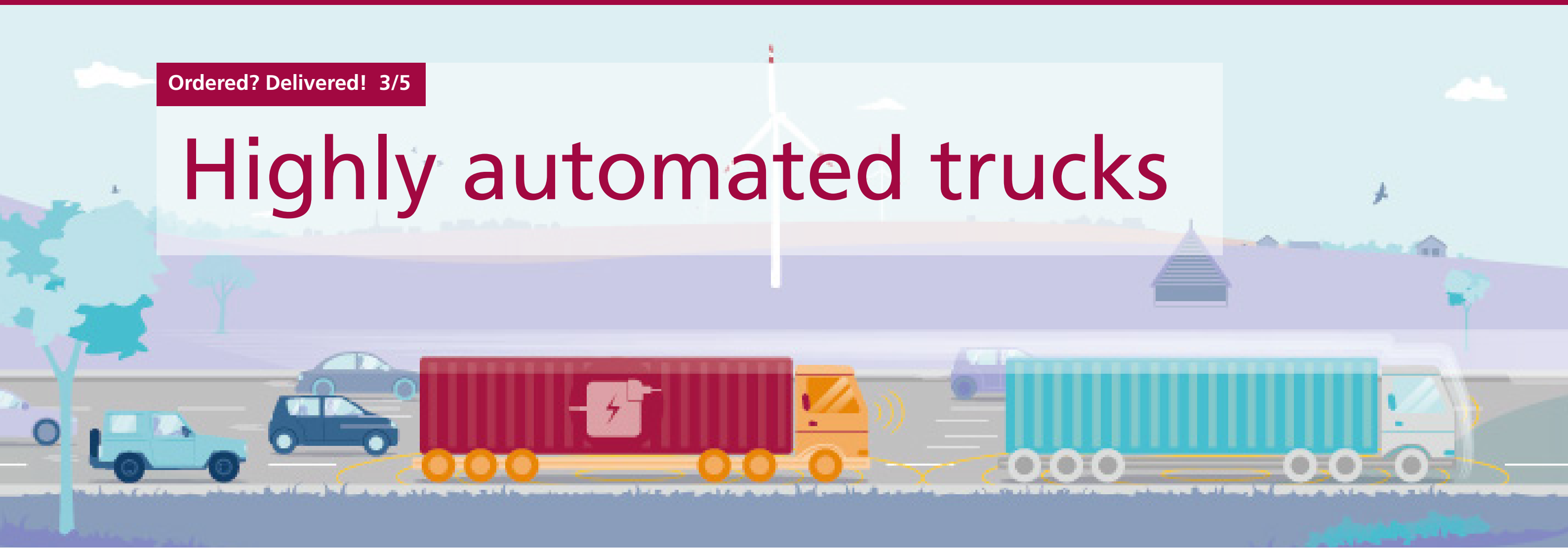
Ordered? Delivered! 3/5

Highly automated trucks



Starting point

There are already semi-automated trucks on the road that take control in straightforward or monotonous driving situations and assist drivers during hazard situations. In a few years, highly automated trucks promise to provide support for additional sector-specific challenges – from rigid rest breaks and high accident risks to personnel costs and energy consumption. Highly automated trucks use integrated intelligent sensors to perceive their surroundings. They are also networked with elements of the transport infrastructure, evaluate the current situation and take action with lightning speed. What is more, the data that has been captured can be used to retrain these systems, thus ensuring they learn from their experience.

Application scenario

The laptop chargers leave the goods rail yard to the north of Berlin in the back of a highly automated truck. With the aid of its intelligent sensors and AI-supported assistance systems, the truck navigates the motorway safely, avoiding traffic jams and conserving resources, too. It completes a large section of its journey in a "platoon", in other words, saving energy and costs by driving in the slipstream of another highly automated truck in front of it. A short time later, the chargers reach an industrial zone on the outskirts of Berlin.

Self-learning trucks

The highly automated trucks are networked with other automated vehicles on major traffic arteries to support platooning and are linked up to infrastructure facilities (such as traffic lights) and the traffic control centre, too. This ensures they can factor in traffic forecasts when selecting their route and journey time, taking early steps to avoid traffic congestion and hazard points.

The neural networks of the automated truck have been trained with various hazard scenarios during their development and updated during its last service. Throughout its journey, the vehicle processes a huge volume of sensor data that it captures itself via e.g. camera, laser, radar and ultrasound sensors. The truck's AI system evaluates this information in real time, interprets it and uses it to calculate steering and/or braking commands so that even hazardous situations can be negotiated without incident. The datasets are collected for the purpose of training the fleet and are evaluated ready for the next update.

Benefits

Highly automated trucks that learn from their surroundings improve road traffic in a whole range of ways:

- **Safety:** Highly automated driving reduces the risk of accidents.
- **Energy efficiency:** Platooning reduces air resistance, avoids overtaking manoeuvres and stop-and-go traffic, and saves fuel and, in the longer term, electricity.
- **Avoidance of congestion:** As journeys can be moved to times of day when there is little traffic and platoons take up less space, traffic jams can be reduced or avoided.
- **Efficiency:** As energy consumption is lower and fewer staff need to be deployed, business costs are also lower.

Challenges

A number of questions need to be answered before highly automated trucks can be deployed:

- **Safety:** How can safety and resistance to errors, faults and attacks be ensured?
- **Liability:** How will responsibility and liability for highly automated and autonomously operating systems be regulated?
- **Privacy:** How can the environmental data captured in the public sphere be utilised in line with data protection requirements?
- **Employment:** How will the job of truck drivers change?
- **Law:** Does the technical system have to satisfy the legal framework or should the latter be modified?
- **Acceptance:** How can trust in highly automated truck platoons be increased?

What needs to be done?

The following steps need to be taken to ensure highly automated trucks can become a reality in a few years:

- Additional research and development work on e.g. the design and security of communication networks
- Additional training for highly automated vehicles in intermodal test environments
- Availability of detailed and continuously updated maps of the mobility infrastructure (roads, railway lines, ports, but also construction sites, for instance)
- Development of standards, certifications and permit procedures for self-learning systems
- Discussion of the need to adapt the current legal system

"Highly automated trucks" is a component (3 of 5) of the application scenario "Ordered? Delivered!" and has been developed by the Mobility and Intelligent Transport Systems Working Group of Plattform Lernende Systeme. You can find out more at: www.plattform-lernende-systeme.de/anwendungsszenarien.html and in the report On the way to intelligent mobility.

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GERMANY'S PLATFORM FOR ARTIFICIAL INTELLIGENCE

APPLICATION SCENARIOS FOR AI

Ordered? Delivered! 4/5

Central logistics hubs

Starting point

More and more goods are now being posted to customers. Courier vans have become part of the landscape in many residential areas, which has implications for traffic levels, noise, exhaust emissions and hazards for residents and other road users. In just a few years, centralised local logistics hubs based on self-learning systems could ensure that fewer transport vehicles take on more logistics services and that goods reach their destinations faster.

Application scenario

The laptop chargers on the back of the highly automated truck reach a centralised logistics hub on the outskirts of Berlin. Autonomous robots in this highly automated warehouse unload the truck and distribute the goods independently to racks. As there is a major conference taking place, which Carla is attending, a short-term increase in demand for mobile chargers has been forecast for Berlin city centre. A short while later, the chargers are loaded onto an electric van, which sets off for the city centre of Berlin.

Fully automated and urbanised

Central logistics hubs are spread out around the outskirts of cities, at a distance of several kilometres. It is in these hubs that goods are unloaded fully automatically from the trucks and transferred to city-friendly modes of transport. These include zero-emissions vehicles with a short range, such as electric vans, cargo bikes and delivery robots, which are already used in some cases today.

Tailored to demand

Using self-learning systems, predictive analyses can help to forecast which goods need to be held in storage to meet current demand in a part of the city, thereby ensuring they can be delivered within just a few hours. Carla's order was to be expected. Past experience has shown that a spike in local demand for laptop chargers occurs during major trade fairs and conferences. As a result, the chargers – along with other goods from various dealers – can now be shipped to a local distribution hub close to the venue.

Benefits

Central logistics hubs offer a range of benefits:

- Delivery times: More goods can be delivered on the same day that an order is placed.
- Reduction in traffic: Strain on the transport infrastructure is eased, particularly in urban areas.
- Quality of life: Less dense traffic, lower noise levels and reduced exhaust emissions improve quality of life for residents.
- Energy savings: Using fewer and smaller vehicles reduces energy consumption.

Challenges

The following questions need to be answered before central logistics hubs can be introduced:

- Business models: Which new business models are possible/necessary (e.g. leasing of loading/unloading robots)?
- Liability: Who is responsible when goods out for delivery are lost or damaged?
- Structural change: What do short-term delivery options mean for the retail sector?

What needs to be done?

The following steps need to be taken to ensure central logistics hubs can become a reality in a few years:

- Standardisation of communication interfaces (e.g. between robots and rack systems)
- Modification of legal regulations (delivery by autonomous robots is currently not an option)
- Development of innovative transport concepts such as cargo bikes (e.g. loadster)

"Central logistics hubs" is a component (4 of 5) of the application scenario "Ordered? Delivered!" and has been developed by the Mobility and Intelligent Transport Systems Working Group of Plattform Lernende Systeme. You can find out more at: www.plattform-lernende-systeme.de/anwendungsszenarien.html and in the report On the way to intelligent mobility.

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Ordered? Delivered! 5/5

Intelligent local delivery

Starting point

Couriers, express delivery services and parcel carriers in Germany transported more than 3.5 billion consignments in 2018, some 84 percent of which were parcels. The number and frequently also the speed of deliveries are impressive. However, it is still predominantly vans with internal combustion engines that make these deliveries at set times of day. The result is traffic congestion and a heavy burden on the environment. Furthermore, parcels cannot always be delivered, because the recipient is not at home. Self-learning systems that are fed by big data could soon be supporting a quiet, clean, convenient and flexible means of delivering parcels.

Application scenario

The laptop chargers are taken by electric van to a micro hub – a small inner-city collection point that covers a portion of the city centre. Meanwhile, Carla is on her way from Brandenburg to Berlin, where she is attending a major conference. While on the train, she realises that she has left the charger for her laptop at home and orders a new one on her smartphone. Two hours later, a delivery robot picks up the charger from the micro hub and delivers it very quickly to Carla, who is preparing for the conference in a nearby café.

Following the best possible route

Micro hubs are local storage facilities that are evenly distributed across urban areas and are no more than one kilometre apart from one another. They can be set up quickly and for a limited period as “pop-up hubs” – on the edge of marketplaces or in empty local shops, for example. Ordered goods can be stored in these hubs for a short period of time in direct proximity to customers.

The intelligent route planner of the last-mile courier uses self-learning algorithms to calculate the optimum transport option for reaching Carla and other customers. In doing so, it employs real-time data from the traffic control centre and sensor data from other road users and the infrastructure. Artificial Intelligence also helps to create dynamic maps of inconsistently utilised paths and cycleways. Maps like these are needed to accurately forecast surrounding traffic volumes and facilitate optimum route planning.

Intelligent delivery robots
Since Carla is sharing her location data with the supplier, the latter suggests delivering her charger to the Berlin café in which she is currently drinking a cup of tea. Carla agrees and, just a short time later, receives her package from a delivery robot. Delivery robots are robotic self-learning systems that perceive their surroundings through sensors and move autonomously. In doing so, they are continuously learning from environmental data, which they also make available to other delivery robots via a platform-based system.

Benefits

An intelligent local delivery system offers a whole range of advantages:
- **Efficient logistics:** (Pop-up) micro hubs cut distances and costs and thereby optimise the logistics network.
- **Flexibility:** Round-the-clock deliveries are possible, even in difficult-to-access delivery areas (e.g. in pedestrian zones and narrow streets).
- **Speed:** Same-day deliveries are possible on a more frequent basis.
- **Reduction in traffic:** Intelligent delivery robots that are not limited to using the roads ease city centre traffic.

Challenges

The following questions need to be answered before an intelligent local delivery system using delivery robots can be implemented:
- **Liability:** How will responsibility and liability for highly automated and autonomously operating systems be regulated?
- **Privacy:** How can all necessary data be fed into one overarching system while also ensuring that personal data is protected?
- **Business models:** What are the consequences for wholesalers, retailers, logistics service providers and local shops?
- **Acceptance:** How can the general public be encouraged to trust autonomous delivery robots more?
- **Design:** Can distribution hubs be devised as mobile depots or pop-up hubs and set up temporarily in unused city centre spaces (e.g. parking facilities, marketplaces, empty properties)?

What needs to be done?

- Further research and development work on e.g. the robustness of the systems or mixed AI-based logistics chains
- Development of standards, certifications and permit procedures for self-learning systems
- Availability and amalgamation of detailed and continuously updated data from the mobility infrastructure

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