VanAssist: what the driverless delivery vehicle of the future could look like

- **Test vehicle shows how efficiently driverless vehicles save walking and driving distances on parcel tours**
- **The project focus is on supporting the human workforce**
- **Test in normal traffic planned with VanAssist vehicle**

Aschaffenburg, 23 September 2021 – DPD is shaping the future: innovative solutions are required to deal with the 40% increase in the number of parcels transported annually in Germany to around 5.7 billion by the year 2025. This is why the parcel service provider is actively working on new and sustainable delivery concepts to meet the growth in demand. "VanAssist" is the name of a cooperative project with partners from science and industry which aims to conserve personnel resources, relieve traffic density in conurbations and promote a reduction in emissions. The result is an autonomous electric delivery vehicle.

As an international parcel and express service, DPD Germany is the project partner with a specific use case and the knowledge of what matters in practice: the autonomous vehicle which has been developed needs to be able to meet the increasing demands on the last mile of parcel delivery. Accordingly, in the design and programming of the individual components the partners focused on optimising the walking and driving sections of a parcel tour. For this purpose the vehicle has to independently navigate to the individual stops, react in real time to changes in the traffic and always be waiting at the exact spot where the delivery person has to deliver a parcel or wants to be taken to the next address.

"Rendezvous mode" arranges meeting points for vehicle and delivery personnel

Within the VanAssist project the **Institute for Enterprise Systems (InES)** at the University of Mannheim was mainly concerned with the intelligent and efficient cooperation between the delivery personnel and the autonomous delivery vehicle in the outdoor area. Here, two

aspects were particularly important: on the one hand the mobile interaction and communication between the delivery person and the vehicle during the delivery operations, and on the other hand the intelligent and automated navigation assistance provided by route optimisation algorithms for the optimal planning of a delivery route.

InES developed a mobile smartphone application for the interaction and communication between the delivery person and the vehicle. This enables him or her to interact with the delivery vehicle at any time during a tour and to view current vehicle information. As a result the delivery person knows where the vehicle is even if, contrary to expectations, it is unable to reach a particular stop and has to park at an alternative location. The main challenge here was to design the most efficient form of interaction for deliveries in the so-called "rendezvous mode".

This delivery mode enables the vehicle to cover the distance from the depot to the delivery area autonomously. The delivery person only joins the vehicle at a predefined meeting point. During the tour, he or she picks up the parcels that can be delivered on foot in the immediate vicinity. The relevant stopping points have been determined by the route optimisation algorithm. If several parcels are to be delivered in an area that is not accessible or only accessible via an indirect route, the delivery person can enter a stopping point and the vehicle will travel there on its own.

The delivery person can summon the vehicle by app, just like a taxi

But it isn't only on streets and pavements that routes can be optimised. In large and complex buildings it can make sense to guide delivery personnel quickly to their drop-off point with the help of an app. Accordingly the firm of bridgingIT has developed an intelligent indoor navigation system. This brings delivery personnel quickly to their destination. In addition, they remain in contact with the vehicle at all times and can also adjust delivery routes within an area or building spontaneously if, for example, a return parcel has to be picked up at short notice. The vehicle can be called to wherever it is needed, which makes the entire process even more efficient.

The vehicle uses a display to communicate with other road users

As part of the VanAssist project, the Institute of Vehicle Technology at the **Lower Saxony Research Centre for Vehicle Technology (NFF) at Braunschweig University of Technology** has constructed the modular, electrified test vehicle PLUTO (PLatform for future Urban mobility and TranspOrt), which is capable of autonomous travel. For this purpose the vehicle, which is based on an HFM motion board, was equipped with extensive computer units and measuring equipment. The vehicle also has an external human machine interface (HMI), which allows communication with the environment and other road users via a display and LED strips. In this way it can provide information about its own condition or possible problems. The NFF has also developed an autonomous driving function to represent the demonstration scenario of an automated parcel delivery. When a stopping point is entered as a destination the vehicle is able to drive there on its own. The system takes into account a large amount of information about the infrastructure and the recorded environment in order to reach the desired destination safely.

Dynamic radio cells ensure data transmission

In the VanAssist project the communication experts from the **Institute for Reliable Embedded Systems and Communication Electronics (ivESK) at Offenburg University of Applied Sciences** ensured the secure networking of all components within the overall system. They placed a special focus on the use of current and standardised technologies. For example, mobile radio networks with high data rates and low latencies are used to support especially time-critical controls and data-hungry live video transmissions. To ensure the reliability of the system, the institute created a backup that can, among other things, compensate for possible failures in the mobile network. For this purpose ivESK relied on so-called "low-power wide-area networks" (LPWAN), which are operated as dynamic radio cells completely without any dependence on providers.

However, the mere use and integration of communication technologies is not enough to operate such a highly networked system. In order to be able to establish secure, reliable and flexible communication between all the sub-components in the system, the various

technologies had to be linked with each other. In addition to implementing appropriate application and security protocols, this requires services to be provided by the respective system elements. These are not just the main participants, i.e. the delivery personnel and the vehicle, but also the many components in the backend which have to meet the requirements of the VanAssist project as well as future extended applications.

VanAssist points to future requirements

For DPD Germany the VanAssist funding project has shown above all what developments are needed to integrate autonomous delivery vehicles into everyday operations. *"Our tests have shown that we need a control centre which can intervene whenever something unforeseen happens on the tour that prevents the vehicle from deciding on its own what to do. This could be an obscured sensor or a blocked road, for example,"* says Gerd Seber, Group Manager City Logistics & Sustainability at DPD Germany, adding: *"We have realised that we need to fundamentally rethink our route planning. In future we will not just need to know the address to which we deliver a parcel, but also the nearby stopping points for this parcel which we can identify and store in the system".*

For cities, too, there will be new challenges in the implementation of autonomous driving and delivery solutions. *"On the one hand we need standardised intelligent traffic lights and traffic signs. On the other we need loading zones that can be reserved specifically for delivery vehicles to which our vans can navigate,"* says Seber.

A next step for the developed vehicle has already been identified: to enable further work and research on the topic of autonomous driving, the test vehicle is to be used on the road in a practical trial. So far it has only been possible to assess its performance on a university test site.

Dr Christian Bartelt, project leader and Director of the Institute for Enterprise Systems (InES) at the University of Mannheim, comments: *"For the optimal calculation of a delivery route this novel rendezvous delivery mode poses a great challenge. The optimisation problem resulting from this mode differs significantly from the optimisation*

problems considered in the scientific literature so far, since additional decisions regarding the cooperation between the delivery person and the vehicle are required. In practice, for example, it has to be clarified at what points the vehicle and the delivery person should meet. In the project, a heuristic approach was developed and evaluated for this novel optimisation problem, which is based on the combination of various machine learning methods. The evaluation also showed that delivery in the rendezvous mode can significantly reduce the time needed for a delivery tour. In this context, InES was able to gain valuable experience in the use of machine learning in the context of route optimisation, which will also be profitably used and deepened in further research projects."

Paul Czerwionka, project leader at IAV: *"As a cornerstone of autonomous driving, IAV was responsible for the positioning of the vehicle. The solution that was developed makes it possible to determine the exact position and orientation of the vehicle in the urban space and on a three-dimensional map. With the help of the map, which is updated from a backend, the autonomous vehicle navigates through the traffic with pinpoint accuracy. The map helps to ensure that all traffic rules are observed. By using different sensor technologies such as LiDAR and a camera, IAV's integrated positioning approach is more robust and can even be verified with a novel, independent approach."*

Alexander von Bergner, project leader at Ibeo: *"For VanAssist, Ibeo provided not only the hardware in the form of the ibeoNEXT Generic Solid-State LiDAR Sensor, but also the necessary software. This enables the precise positioning of the delivery vehicle as well as the detection of objects in its immediate vicinity. For VanAssist, Ibeo developed a new emergency braking system (AEB) that triggers autonomously and quickly in the event of danger. This will find further application in the future. The research project was also the first real test run for the new ibeoNEXT sensor, as well as a new calibration procedure with which the position of the sensors in the vehicle can be precisely determined. Participation in the research project provided us with extremely instructive and valuable results. Based on the collected data and experience, we can further improve our sensors and algorithms such as AEB, perception, positioning and calibration for future applications".*

Torben Hegerhorst, project manager for the VanAssist project at the NFF's Institute

of Automotive Engineering: *"The use of the relatively large test vehicle in the demonstration environment, which simulates real urban use with narrow access routes and tight curves, presented us with special challenges when planning the movements of the automated driving function. We were able to successfully solve these challenges for the depot as well as for the delivery tour using specially developed algorithms that utilise the existing drivable area as efficiently as possible. This enabled us to significantly increase the effective radius of the vehicle, which will also help us with future applications in other environments."*

Prof. Dr. Axel Sikora, Institute for Reliable Embedded Systems and Communication Electronics (ivESK) at Offenburg University of Applied Sciences: *"In the VanAssist project our task was to network the individual components in such a way that we could provide an optimal infrastructure for the specific use case. First and foremost, this had to be safe. Since driving manoeuvres can potentially be influenced by external intervention, an insecure connection would represent a serious threat. The great challenge was therefore also the skilful selection and integration of existing protocols and combining the many system components in an effective way. The resulting security concept still remains flexible enough for an expansion of the use cases and the integration of further components in the future. In this way we provide the security and communication architecture as a service platform."*

Detlef Schumann, management consultant at BridgingIT GmbH: *"It was a great success for BridgingIT GmbH to be able to demonstrate indoor navigation in a real process. The efficiency gain through technology such as automated driving, in combination with the Deep MapTM technology, makes the work of the delivery personnel much easier while optimising the overall process and the use of resources. In addition, we were able to contribute developments from VanAssist to the Aspect Open Location standard in a very positive way. The processes were optimised from end to end and the technical knowhow we have acquired will be incorporated into the OMLOX industry standard. VanAsisst is thus a success across industries in the context of location-based services and goes far beyond parcel logistics."*

The project partners at a glance

In addition to the international parcel and express service provider DPD, the scientific project partners behind VanAssist are the Lower Saxony Research Centre for Vehicle Technology (NFF) at Braunschweig Technical University, Clausthal Technical University, Offenburg University of Applied Sciences and the University of Mannheim, as well as BridgingIT GmbH, IAV GmbH, Ibeo Automotive Systems GmbH and ZENTEC GmbH.

- BridgingIT GmbH
- DPD Deutschland GmbH
- Offenburg University of Applied Sciences - Institute for Reliable Embedded Systems and Communication Electronics
- IAV GmbH - engineering for cars and traffic
- Ibeo Automotive Systems GmbH
- NFF, Technical University of Braunschweig - Institute for Automotive Engineering
- NFF, Clausthal University of Technology - Institute for Software and Systems Engineering
- University of Mannheim - Institute for Enterprise Systems
- Project coordinator: ZENTEC Zentrum für Technologie, Start-up and Cooperation GmbH

Image: *The test vehicle developed in the VanAssist project can not only navigate in traffic, but also independently search for parking spaces. As a result, in future delivery personnel will be able to concentrate entirely on providing services along the last mile.*

Über DPD

DPD Deutschland gehört zur internationalen DPDgroup, Europas größtem Paketdienst-Netzwerk. DPD hat deutschlandweit 79 Depots und 7.000 Pickup Paketshops. 9.500 Mitarbeiter und 11.000 Zusteller sind täglich für die Kunden im Einsatz. Im Jahr transportiert die Nummer 2 im deutschen Paketmarkt mehr als 400 Millionen Pakete – und das vollständig klimaneutral, ohne Mehrkosten für die Kunden. Mit zahlreichen Initiativen zur nachhaltigen Paketzustellung zeigt DPD insbesondere in den Innenstädten auf, wie sich der Paketversand umweltfreundlich und lokal emissionsfrei gestalten lässt.

Mit innovativen Technologien sowie einer konsequenten Orientierung an den Bedürfnissen und Lebensumständen aller Kunden und Empfänger bietet DPD einen einfachen, bequemen und flexiblen Service beim B2B- und B2C-Paketversand. Ein Beispiel dafür ist der branchenweit einzigartige Service Predict mit einem kartengestützten Live-Tracking, vielfältigen Optionen zur Umleitung eines Pakets und einer auf eine Stunde genauen Zustellprognose. Die digitalen Innovationen von DPD erhielten bereits zahlreiche Auszeichnungen wie etwa den Digital Transformation Award, den eco Internet Award, den Deutschen Preis für Onlinekommunikation oder den UX Design Award.

Die DPDgroup versendet in 230 Länder und Gebiete weltweit und verfügt über ein einheitliches Netzwerk von 58.000 Pickup Points auf der ganzen Welt mit harmonisierten Services auch beim grenzüberschreitenden Versand. Europaweit sorgen 97.000 Zustellexperten dafür, dass täglich 7,5 Millionen Pakete für die Kunden zugestellt werden. Muttergesellschaft von DPD ist GeoPost, eine hundertprozentige Tochtergesellschaft der französischen Groupe La Poste. GeoPost verzeichnete im Jahr 2020 einen konsolidierten Jahresumsatz von elf Milliarden Euro.

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