DACHSER Future Terminal – A digital twin for groupage logistics

Together with Fraunhofer IML, DACHSER is setting technological standards in groupage logistics and continues to advance the degree of innovation in logistics with two new highly digitalized transit terminals. This benefits customers, employees, and partners.

In a joint research project with the Fraunhofer Institute for Material Flow and Logistics IML in Dortmund, DACHSER has created a pioneering digital image of all packages, assets, and processes for groupage logistics. This “digital twin” for transit terminals has already been put into operation in two pilot @ILO Terminal facilities in Unterschleißheim near Munich and Öhringen near Stuttgart. @ILO, which stands for Advanced Indoor Localization and Operations, is the new digital twin: in the future, it will provide real-time data, generated fully automatically, on every palletized shipment in DACHSER’s European transport network.

@ILO is part of the DACHSER Future Terminal research and development program, under which the logistics company intends to deploy pioneering technologies and processes in its transit terminals and warehouses in the European logistics network in the coming years. The idea is for DACHSER to innovate its own solutions for the challenges and opportunities presented by digitalization and sustainability.

The results obtained so far are grounds for confidence that the @ILO terminal can achieve a level of supply chain visibility previously considered unattainable in the industry. In the future, DACHSER also plans to develop an application to give its customers and partners access to this new type of transparency, plus the associated optimization options. Starting in 2024, Dachser plans to begin rolling out the technology in its transit terminals in Europe.

The technological innovations implemented in the two @ILO pilot plants in Unterschleißheim near Munich and Öhringen near Stuttgart will lead to significant process improvements and are also opening up new opportunities for DACHSER's customers and service partners:

Fully automatic identification makes scanning unnecessary

In the future, packages will be identified fully automatically whenever they enter and leave the @ILO terminal as well as during their stay, and will be recorded in DACHSER's own transport management system. This means there will be no further need to manually scan the barcodes on inbound and outbound goods. It will also enable a fully automated real-time inventory of all packages as well as improved management of manually operated ground conveyors—and in the future, autonomous ones, too. DACHSER will also offer customers and partners an application with the option of fully automatic identification and loading documentation, for example for their inbound and outbound goods zones. Initial test deployments with pilot customers are being prepared.

Accurate pallet tracking down to the meter

A second innovation in the @ILO terminal is how it can locate, down to the meter, all pallets throughout the transit terminal building, which can often be the size of a soccer field. This significantly shortens search times and, in turn, loading processes. It gives customers, drivers, and transit terminal employees themselves a level of transparency regarding the location of goods that is unprecedented in groupage logistics. Using a website or other means such as smartphone apps, e-ink displays, and 3D visualizations, it's possible to map both the locations of shipments and the position of ground conveyors in real time. This is also a function that customers and partners can use in their own facilities in the future.

Digital information for employees

Employees at the DACHSER Future Terminal stand to benefit the most from all that the digital twin has to offer. They can check special displays for instructions on internal transport. These can also be supplemented with additional information such as

dangerous goods warnings, prioritized loading instructions, or a photo of the package, all of which increase the quality and safety of the handling processes.

Constant measurement of packages

One more technological highlight of the @ILO terminal is in the pipeline: the fully automatic and constant measurement of all packages. The digital twin is already able to determine the length, height, and width of different packages with high accuracy. In contrast to other measurement solutions, this system can determine the volume data many times at different locations in the transit terminal while other processes are ongoing. In the two pilot plants, the large number of measurement points and data leads to higher measurement accuracy, yet without disrupting the transport processes in the terminal or involving measurement stations. The Fraunhofer scientists and DACHSER experts are currently still working on making this process, which at the moment is probably one of a kind, practical for everyday use. If they manage it, then the volume data obtained on each package could be fed to intelligent algorithms in the future. These could, for example, assist drivers and employees in the transit terminal with loading and route planning and could also further increase the capacity utilization of swap bodies, trailers, and local transport vehicles. The result would be a reduction in transport kilometers and thus also a reduction in avoidable CO_2 emissions.

2D codes and artificial intelligence

The technological basis for all the innovations in the @ILO terminal is provided by data matrix codes on the top of each package, which serve as an identifier, as well as by several hundred optical scanning units in the facilities' ceiling area, which capture the entire floor. With several thousand pallets passing through a typical DACHSER transit terminal every day, any package registration system needs to be simple and environmentally friendly. Radio-based solutions such as RFID and BLE were also tested, but they can't meet the requirements of groupage logistics.

The core of the digital twin is the @ILO software, which the DACHSER Enterprise Lab developed. New custom AI-based algorithms interpret the data that the optical scanning units capture every second; this way, they can ensure the automatic identification, location, and measurement of all packages in real time. Both the height and the position of each scanning unit are fixed and precisely known to the system. That, in combination with the standardized 2D data matrix codes, lets it calculate the package's height. It does this by comparing the known reference size of every data matrix code with the size in pixels of the code on the package in question as determined by the optical scanner; the pixel size will vary depending on the height of the package. In simple terms, the height is determined according to the Pythagorean theorem. The package's length and width are determined by the @ILO image processing approach developed on artificial neural networks.

Fully automated acquisition of conveyor package pickup

Another innovation is the automatic "wedding" of the ground conveyors and packages. The @ILO system automatically detects when a ground conveyor picks up a pallet; it then transmits the information on each package in real time using a WiFi connection and the MQTT protocol. This data can then be immediately shown on displays, for example, without further processing. This is another function that cuts process times and redesigns established transit terminal processes. In technical terms, it relies on the orientation information contained in the 2D codes together with the known position of the code on each ground conveyor: codes are affixed to the top of the vehicles in a fixed orientation so that they are legible and point in the direction of travel. The 2D code reader calculates the vehicle's current position and orientation with reference to the image area and immediately transmits this information. As soon as a vehicle's data matrix code is detected, the system can use the code and the vehicle's orientation to determine the relative direction of its forks. The software then defines a rectangle with a fixed size in this direction as the package pickup area. As soon as a package's data matrix code (an SSCC) is located in this package pickup area, the package is registered as having been picked up by the vehicle. The information stored relating to this package is retrieved via a software interface (REST API) and displayed to the driver.

Close cooperation between logistics experts and scientists

Logistics experts from DACHSER worked together with the Fraunhofer team on the digital twin and the DACHSER Future Terminal for over four years. With a lot of knowledge, ideas, and passion, they have made the internet of things and the vision of Logistics 4.0 a reality in groupage logistics, too.