

The Automated Bus Depot

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From Vision to Reality

Peak Mobility/Unikie Solution for Automated Bus Depots



PEAK MOBILITY



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Vision – The Fully Automated Bus Depot ...

When we think of a fully automated bus depot, the image quickly arises of a facility where buses are operated completely without human intervention after their shift. Vehicles independently return from their routes, check in at the depot, automatically perform movements for charging, cleaning, repairs, and parking, and receive their instructions to prepare for the next trip. Depot operations only need to be supervised; all other tasks are performed autonomously.

Such a depot knows no limitations due to operating hours or the availability of driving personnel. Damage from manual maneuvers is a thing of the past; electric buses are automatically charged and cleaned. Depot management systems operate 24/7, optimize the depot's energy consumption, and ensure that every bus is ready and in perfect condition for the next deployment. Many bus depots are still operated manually, but the vision of a fully automated bus depot is coming closer step by step.

... and Reality – Automated Driving In The Bus Depot

The bus industry is working on the autonomous bus for urban environments. However, it will still take years before the technology is ready for daily operations and at a cost level affordable for public transport. Autonomous buses require onboard technology to recognize their surroundings and respond to trained situations in the city. This turns every single bus into a high-end computer on wheels.

But why not use the same technology just once and install it at the depot? A system that recognizes the entire bus depot with all buses, vehicles, and movements.

So the depot is represented as a digital real-time twin (a continuously updated 3D model of the environment), which now enables automated, computer-controlled driving of buses and other vehicles within the depot.

This is already a reality today. We are able to operate all buses within a bus depot at any time and simultaneously—parallel and fully automated.

Automated driving—without drivers and without teleoperated personnel, including automated charging, automated bus washing, and automated driving to the workshop—can be realized today.

The combination of the depot management system from PEAK MOBILITY, which optimizes depot operations, and the Automated Marshalling System from Unieke, which automates and moves all vehicles driverlessly (depending on their capabilities), already makes the automated bus depot a reality today.

Solving Today's Problems, Anticipating Future Challenges

The operation of bus depots faces a wide range of challenges today and in the coming years. Many of these can be solved or at least improved with automated driving.

Addressing the Driver Shortage

The growing demand for public transport coincides with an increasing shortage of drivers. While more buses are needed, well-trained and experienced personnel are becoming scarce. New employees are hard to recruit and have different

expectations regarding working hours and commitment. Automated depots will definitely help to solve this problem. Shunting drivers will no longer be needed, and with the ability to operate 24/7, the shortage of driving staff and the increased demand can be addressed.

Efficiency Through Automated Charging

The electrification of buses is already a reality and leads to investments not only in new buses but also in new depots and charging infrastructure.

Electric buses are ready and ideal for automated driving. Automated charging enables the optimization of the charging infrastructure in terms of the number of required stations and cost-optimal charging times.

Damage-Free Shunting

Damage caused by shunting within the bus depot results in significant costs – not only for the repairs themselves, but also for any replacement vehicles that may be needed during the repair period. Automated driving within the bus depot eliminates such damage entirely. An autonomously driven bus will not have any scratches or other damage

Fire Protection Through Automation

Fires are a risk not only for electric buses. Fires in a bus depot, especially at night when little or no staff are present, can be catastrophic. Automatically driven buses, in combination with the intelligent depot management system, are able to evacuate buses and other vehicles from danger zones or, depending on the chosen strategy, remove already burning vehicles.

Optimizing Depot Processes

Optimized processes in the bus depot are key to good performance for transport companies in fulfilling their transport services.

Automated buses, in conjunction with the depot management system, enable entirely new strategies and workflows for depot tasks. In some cases, even the depot's operating hours can be reduced by optimizing the overall process.

Integrated Vehicle Localization

Bus operators using a depot management system are familiar with localization systems needed to inform the management system about the individual position of the buses. With the introduction of the Automated Marshalling System, separate localization systems are no longer required. Since the marshalling system creates a real-time 3D model of the environment, every bus and vehicle is automatically and precisely located.

Seamless Integration of Autonomous Vehicles

Even fully autonomous vehicles such as robo-taxis and buses require a central coordination system in the depot. Investment in a combined depot management and automated marshalling system ensures that future autonomous vehicles are smoothly integrated into depot processes.

An Investment That Pays Off

The key question for bus operators considering investment in an automated bus depot is the business case. Is it worth it? How high is the investment? Can we implement it in existing bus depots? Do we need to redesign the depot to allow for automated bus driving?

First of all, automated driving is possible at any bus depot. Anything that can be driven by a driver can also be driven by the automated system. New or modified bus depots should already be optimized for automated operations during planning. In principle, however, every existing bus depot is suitable for driverless shunting.

The driver, returning from their route, drops off the vehicle at the depot entrance and leaves the bus. The bus is checked in and taken over by the marshalling system. For the bus leaving the depot, the process is reversed. It is driven to the depot exit, where the driver enters the bus and takes responsibility for the route.

Currently, mainly LiDAR sensors are used to monitor the depot environment and detect the position of vehicles and people. This enables mixed traffic (automated and manual) on the depot premises. Investments are made in the LiDAR sensors, their installation, and cabling (data and power supply).

IT systems can be located on-site or in the cloud. The latest technology is hosting the marshalling system within Telekom's mobile network.

The total investment pays off within a few years, depending on the size of the bus depot, the number of buses, and operational effort.

The Bus Question

As we have learned, automated marshalling and the automation of the bus depot are already a reality. All that is needed to get started are the buses themselves. Automated marshalling is already common practice in the automotive industry. BMW, for example, moves its cars fully automatically within production and logistics areas. Since 2019, automotive manufacturers have been working together with automated marshalling providers like Unikie on the standardization, safety, and scalability of the system.

The good news is that, in addition to tests and use cases, the interface to the automated vehicle has also been standardized. The most important requirement for the vehicle—in this case, the bus—is what we call “drive-by-wire capability.” This means

that the bus must allow access to the CAN data bus and be equipped with digitally controllable steering, transmission, brakes, and accelerator pedal.

Together with various bus manufacturers, Unikie has implemented the system and is testing buses at the test center in Kaarina, Finland. Discussions regarding the introduction of the necessary interface and control software are progressing successfully with several bus manufacturers.

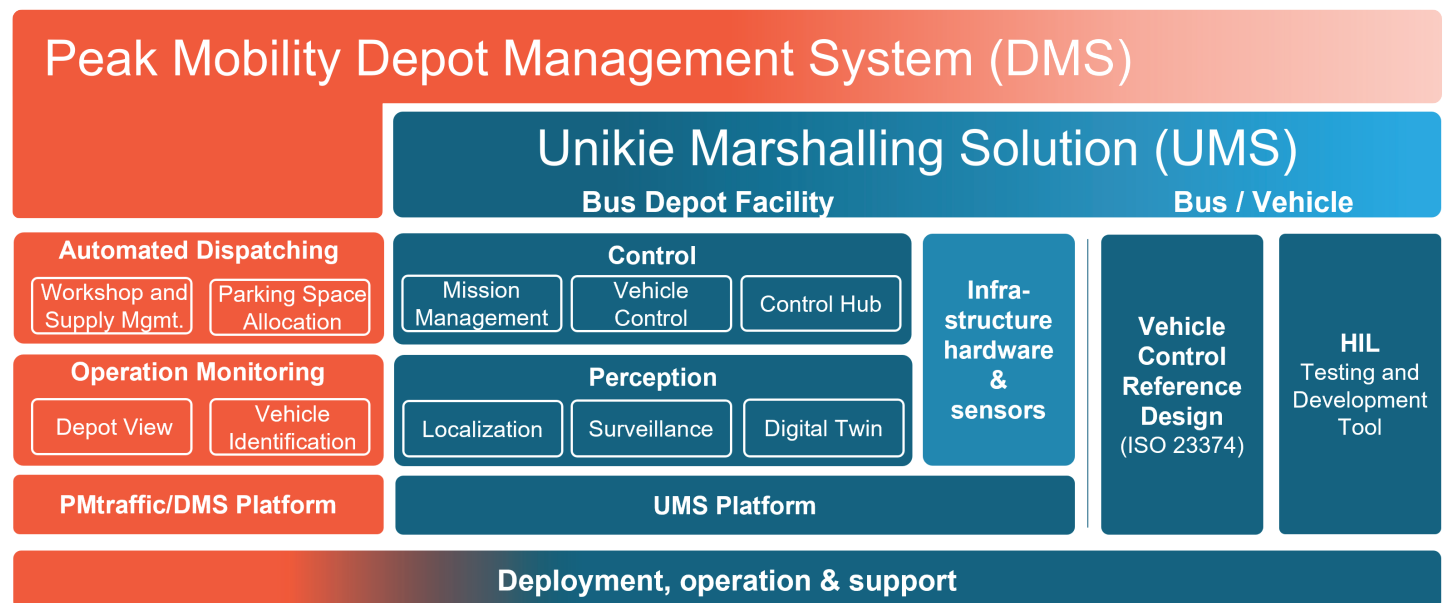
It is important for bus operators to order appropriately equipped and enabled buses with their next bus tender. What needs to be requested from the bus manufacturers is available as a predefined “copy-and-paste” text, based on the ISO 23374 standard interface.

Technical Solution

The Unikie Marshalling Solution is fully integrated into the leading depot management system from Peak Mobility. Instead of communicating with drivers, the PEAK MOBILITY DMS (PEAK.DMS) issues driving commands to the marshalling system and receives vehicle positions and data from the UMS. PEAK.DMS is a comprehensive

depot management system designed to meet the complex requirements of a modern public transport operation. The system monitors and controls all processes in the depot – from vehicle entry to maintenance, repair, and parking – in a resource-efficient and cost-effective manner.

Depot Automation Ecosystem



By using intelligent, integrated optimization algorithms, PEAK.DMS can make the best decisions within seconds and also supports dispatchers in unforeseen situations.

PEAK.DMS is based on a modular architecture that allows flexible configuration and step-by-step implementation according to specific project requirements.

The most important modules include:

- Dispatching: Automatic vehicle assignment and rescheduling as needed.
- Integration of electric buses: Integrated charging management and range prediction.
- Parking allocation: Optimal parking spaces based on vehicle needs and depot layout.

- Workshop and supply management: Manages all workshop, maintenance, and supply operations, including unplanned vehicle defects.
- Driver information: All necessary information for drivers, driving assignments, staff attendance, and block assignments.
- Operation monitoring: System information/operational overview, real-time monitoring.
- Fueling/charging optimization: Optimizes refueling/charging based on consumption data.
- Integration hub: Seamless data exchange with existing systems, ensuring smooth integration into the current IT landscape.

About Peak Mobility

Peak Mobility (formerly PSI Transcom), founded in Germany in 1981, is a leading provider of control technology software for public transport (bus and rail).

The portfolio includes highly available systems such as depot management systems, train management systems, and operations control systems with real-time passenger information for buses and trams based on the PEAK.X platform, as well as the proven workforce management solution PEAK.PROFAHR.

With PEAK.X and decades of project experience, Peak Mobility sustainably optimizes the operational processes of transport companies. The solutions increase the efficiency of internal processes while also improving passenger satisfaction through better service quality. Fast, convenient, and punctual connections enhance passenger service and ensure smooth operations.

Peak Mobility systems create greater mobility – both in urban and rural environments – while also protecting the environment through resource-efficient use of energy and fuels.

About UNIKIE

Unikie is a Finnish software engineering and innovation company that brings intelligence to machines, vehicles, and industrial solutions. Unikie enables its customers to become leaders in their industries and secure their success in the evolving digital landscape of tomorrow.

Founded in Finland in 2015, Unikie now employs over 600 people in Estonia, Finland, Germany, Poland, Sweden, and the USA. Unikie is a leading provider of software solutions for intelligent vehicles, machines, and

industrial solutions that are capable of making real-time decisions. The company specializes in smart space solutions and automated mobility, utilizing sensor fusion, real-time data, and secure communication.

Since 2019, Unikie has been investing in automated driving technology for closed areas in cooperation with several automotive manufacturers.



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