For years, in almost every port there has been a huge increase on the world market in container and bulk goods traffic along with the volume handled. To successfully grow with this market, Germany’s largest company in the maritime industry relies on Industrial Wireless Communication: 84 radio-controlled automated guided vehicles transport containers in a fully automated area.

Hamburger Hafen und Logistik AG (HHLA) has been active in Hamburg’s port, one of the world’s largest container ports, for more than 120 years. Its high-performance container terminals help make the port of Hamburg into an international, modern, and efficient logistics hub.

The focal points of maritime traffic are container terminals, of which the HHLA operates three in Hamburg. This is where container handling takes place between the large vessels on the main routes, and the smaller feeder vessels for secondary distribution and inland waterways. Handling for further transport via road or rail is integrated into the terminals of the HHLA.

Container Terminal Altenwerder (CTA) is one of HHLA’s terminals. Several years after opening, it is still one of the most modern terminals in the world – not least because of its high-performance, driverless transport system comprising automated guided vehicles (AGVs) and operating software which simplifies and ensures container transportation between ship and intermediate storage. Intermediate storage facilities at CTA are built as block storage and allow the containers to be stored temporarily before they are transported. With 500 employees, the CTA works around the clock.

Together with Gottwald Port Technology GmbH (in short: Gottwald) of Düsseldorf, the CTA has successfully implemented a driverless transport system. Founded over 100 years ago, Gottwald Port Technology GmbH – a subsidiary of publicly traded Demag Cranes AG – now focuses on products and systems for cargo handling at ports and terminals.
The challenge – driverless container transport

Two years after Container Terminal Altenwerder began operations in 2002, it was required to exchange its previous interference-prone wireless automated guided vehicle (AGV) system for a more powerful and robust radio system. Like all components used in ports, the new technology had to meet the highest demands of port operability. The new system would have to provide 100 percent availability, despite harsh conditions such as wind and weather, ambient air with high salt content, temperature differences of up to 75 °C, and strong vibrations because of uneven ground. A further special requirement of the radio system was the avoidance of disruption due to radio interference. Experience has shown there are many interference sources in the port area. There was also the problem of overlap with another, independent radio system, which enables wireless communication with the tractors (manually operated vehicles for transporting containers to trains) in the hinterland (the loading area for trucks and trains).

The solution – On the air with 100 percent reliability

Initial tests soon confirmed that the new IWLAN technology from Siemens was far superior to the previous system in terms of reliability: “Very soon after the first test installation, it was clear that the new system had no measurable interference and could achieve higher data rates,” Dr. Ahmadian says.

The gradual upgrading of the system to the present 84 AGVs followed, part of which are diesel-electric driven and the rest diesel-hydraulic driven vehicles. Entirely driverless and independent, the vehicles traverse an area that is 1.4 km long and 100 m wide. Communication with the AGVs is wireless via Industrial Wireless LAN. To allow this, 13 SCALANCE W access points were mounted in control cabinets on several main masts near the automated area. Left and right of each main mast is a secondary mast with one or more antennas to ensure radio coverage. Dr. Ahmadian is pleased: “With the 13 access points – some of which are dual access points – we are able to cover the area redundantly, so operations could continue safely even if half the access points failed.” A SCALANCE W IWLAN client module is installed in each vehicle.

The graphic shows a section of the automated area of the terminal and the transport of containers. To the right, the structure of the transmission technology is shown in detail.

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Sophisticated system

The vehicles are oriented using transponders embedded in the driving surface, each of which has distinct x and y coordinates that are known to the system. These are located at regular intervals in the pavement. The AGV receives its orientation data from these transponders and by measuring wheel position and distance, it plans its route fully independently from the starting point to the destination. Their counterparts on the bottom of the vehicle are transponder antennas, of a type known as large-area antennas. The vehicle radiates energy to the ground, the coil picks it up, and then returns its two coordinates to the vehicle. These are not required for navigation, only for orientation and correction of the route, which is constantly altered by outside influences such as wind, bumps and different weights in the container.

On the other hand, Gottwald’s control software is responsible for navigation, which creates an invisible restricted area (“claim”) in front of each vehicle that must not be entered by any other vehicle.

Safety is top priority

The automated area is surrounded by a security fence, both for the driverless transport vehicles and for the rail mounted gantries (RMG). If a person enters the area without authorization, the entire system is immediately stopped.

In the event of service, a technician may enter the automated area without causing the plant to stop completely. For this, short term special restricted areas are systemically created. This information is transmitted securely by the Siemens IWLAN system to the vehicles so that they no longer enter a restricted area.

Boris Wulff, of CTA terminal development, emphasizes the optimal safety of the terminal: “From the safety perspective, the CTA is also an exemplary terminal. This is due in large part to the fact that we are an automated terminal. And in this automated area, there is no unauthorized access.” Injuries to people are thus avoided from the outset. When a vehicle does not report back within a certain time, or does not receive any signals from the control center, the vehicle has to stop.

Certification system

In 2008, the CTA was certified according to the Container Terminal Quality Indicator (CTQI) to demonstrate the non-stop handling process of the terminal and improve its quality management. The uniform external evaluation should thus further increase the efficiency of the terminals as well as demonstrate the standard of quality required by customers and local authorities.

Reliable radio field

In comparison tests, the CTA stands out due to its high turnover rate and overall effectiveness. Key performance indicators for the industry, such as surface area productivity, quay productivity, and employee productivity earn top marks. These beat the scores of conventional container terminals by a factor of 1.5 to 2.

According to Boris Wulff of the CTA, transshipment has become much more efficient (since the introduction of the new technology): “Nearly all the movements that we make here are automatic movements and these follow continuous processes, with continuous braking curves. This means we are very careful with the containers and thus reduce the risk that we might damage the goods in the container. Moreover, it is a very reliable system, which can be used with any wind or in any weather. If this system were to break down, e.g. due to a network failure, that would be disastrous, because in that moment the entire transshipment process would come to a standstill. We can deal with the failure of a crane or a container bridge. But not if the IWLAN of the AGV system were to fail. At that moment all vehicles would stop. For this reason, we are very satisfied with the reliable network that we have with the IWLAN technology from Siemens.”

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Their vehicle-mounted counterpart is the SCALANCE W744-1PRO, which acts as a client module (right). The photo also shows the Gottwald control in the vehicle (front).

Dr. Ahmadian from Gottwald adds: “The benefits of the IWLAN system are high availability and robustness, and with them, the cost-effectiveness of the system – which is why the customer decided to adopt this system from Siemens.”

In addition to the benefits offered by high reliability, cost advantages are also in the foreground. Conventional terminals use van carriers or straddle carriers, which are long-legged devices on eight wheels. In contrast, four wheels are enough for the AGVs. This significantly reduces material and wear costs. In addition, straddle carriers use spreaders (hoisting gear) to pick up the containers, which are service-intensive. AGVs do not use spreaders. This is a great service advantage. Even compared with conventional devices, significantly lower mass is moved, meaning the AGVs consume significantly less power at a weight of 25 tons per AGV.

Outlook

Dr. Ahmadian is pleased with the good cooperation with Siemens: “It worked out great. We could express our wishes at any time and these wishes were passed on directly to the Siemens development department and implemented. Therefore, such a rapid success was possible here at CTA.”

Gottwald Port Technology GmbH is already in talks with more customers to use the system in other future port applications: „Because of the good experiences we have had with the Siemens IWLAN system, we would recommend and use it worldwide for future projects,“ Dr. Ahmadian says.

What makes Container Terminal Altenwerder special is its automated terminal structure

It is a rarity worldwide, but Container Terminal Altenwerder can load and unload a ship using 110 m wide, manned cranes – known as mega container gantry cranes – which are operated with two load trolleys. These carriages are used for the load pick up on the crane boom and have a bearing capacity of 70 t. When unloading a ship, the main trolley removes one container from the ship and places it within the container bridge on a lashing platform. Here the container is prepared for further handling, for example by removing the twist locks with which the containers were connected to each other on deck. After the container is „checked in“, a fully automated process is initiated: A portal trolley takes the container from the lashing platform and moves it to the rear area of the bridge, adjacent to an automated area for the driverless transport system. There, the container is placed onto one of the AGVs, which are four-wheel vehicles with a holding platform that is similar in size and shape to a truck trailer without the cab. The vehicle is assigned a route by a software system and transports the container to the appropriate storage block. The container is then transferred to a rail-mounted gantry (RMG), which is also fully automatic, and transferred to stock. The storage block system consists of 26 units with two cranes each, thus 52 cranes in total. Due to their different sizes, they can pass by each other. The container is then stored according to time-optimized criteria so that during subsequent reloading of a container, no time is wasted for locating hidden containers.