HYCOWARE

Hybrid connected warehouses: improving operations and efficiency

Efficient warehouse operations are the cornerstone of reliable logistics – whether its ensuring your online purchase is delivered on time or maintaining the supply chain for a multi-billion-dollar industry. Automated warehouses streamline operations and cut costs, but currently fall short of their ultimate potential due to the difficulty of implementing true connectivity in a challenging environment. The HYCOWARE project aimed to unlock the connected warehousing market through novel, low-cost wirelessly-connected products that can be easily deployed or integrated with existing solutions. Leveraging the Internet of Things (IoT), it explored ways to link products from multiple export-oriented service providers in an interoperable, cost-effective solution for all automated warehouse needs. Such a multi-vendor solution could allow traditional warehouses to evolve over time into connected warehouses that collect data from all connected sources, regardless of their brand.

"Warehouses are an extremely tricky environment for reliable RF communication. The warehouses themselves are effectively forests of steel structures, leading to multiple reflections and shielding. On top of that, they can house all kinds of products that absorb RF signals. So, while IoT technologies are really starting to take off in the home, they have not yet been widely adopted in warehouses," Rudi Vanhoutte of Dematic, an industrial partner in the HYCOWARE project. "Many companies have some RFID systems in their warehouse, but they have quite limited capabilities. They just track products at certain locations e.g. when entering or leaving the warehouse. If something goes wrong in between, it takes a lot of time and effort to find them. With more and better connectivity, we could do so much more – tracking products everywhere in the warehouse and even beyond on their journey to the client," adds Pieter Suanet of Aucxis. "Operators are needed to move the trolleys and goods and to resolve issues when they arise. Localization information is only sparsely available and the time it takes to identify and resolve issues is obstructing

an efficient flow within the warehouse. This process can be improved when more information on the whereabouts of all goods and trolleys is available, combined with information on the warehouse management system. In this way, the flow will be more efficient and issues can be identified at an early stage. Making this information available to operators in the field in real-time, with tasks assigned efficiently has great impact on the overall efficiency within the warehouse process and goods flow," says Daan Roks, CTO at Intation. To address this issue, the HYCOWARE project focused on exploring innovative connected products, low-cost wireless networking, localization and 'plug-and-produce' connected goods, devices and people.

THE OUTCOMES

1. One technology is not enough

The project partners explored and developed prototypes for four novel connected products, including a conveyor system, an always-connected shuttle for storing goods, advanced tracking tags and an augmented reality system for operators. "Step 1 was to assess the available communication technologies to see how they perform in the warehouse environment. It quickly became clear that no one RF technology can do everything. For example, we have created a hybrid approach for the tracking tags combining RFID, Bluetooth low energy and LoRa," explains research lead Jeroen Hoebeke. Also the easy roll-out and interoperability received much attention. To test and verify the prototypes, the project partners integrated them into two use cases at industrial sites.

2. Use case 1: flower auction

The first use case is a global flower auction. This comprises some 300,000 trolleys for storing and transporting flowers, located at the auction and customer sites. Trolleys are continuously tracked via the hybrid tag. For example, in areas of critical handling it is vital to know the trolleys' location very accurately and here BLE-based Angle-of-Arrival is used. In storage areas, it is

enough to know which sector a trolley is in, and this is done via multilateration with BLE beacons, optimized to work with limited prior knowledge. Detection at dedicated locations like warehouse entrance and exit is done with UHF RFID. Outside the warehouse, LoRaWAN technology is used to follow the trolleys to customer locations with accuracies as low as 100m using a novel localization algorithm .

Based on this localization, operators are provided with the trolley's whereabouts, the best route to it and their next action via a novel augmented reality application on their HoloLens headset or a dedicated application on mobile devices like a tablet or smartphone. Sites equipped with a conveyor system, can benefit from the conveyor's new capabilities to be tracked, interact with the operators in real-time based on location info and to provide operator feedback. To enable a fast roll-out of all these systems and achieve interoperability of sensing, actuation and localization data, the possibility of using LwM2M - a novel IoT device management standard - has been explored and its benefits demonstrated. The management systems use REST API's to integrate the different systems for communication, making information available throughout from top to bottom.

3. Use case 2: communicating with moving vehicles

Many existing technologies are optimized for communicating with static objects. The project's second use case demonstrates how these technologies can be used to communicate with moving vehicles. This test installation uses the time-slot channel hopping protocol of IEEE 802.15.4e to communicate with autonomous shuttles, handing over communication between different base stations as the shuttle moves from sector to sector within the warehouse. Also here, the connected operator comes into play, for instance for performing maintenance tasks.

NEXT STEPS

"Through these use cases, we have shown that hybrid communication is the way to go, as no single solution fits all needs. The partner companies have built up a lot of know-how on candidate technologies, how to make communication set-ups more reliable and how to benefit from the IoT world" points out Hoebeke. Based on these learnings, the partners want to promote wider discussions within the industry to determine how the work can be taken further. For example, there could be efforts to add gesture feedback into the AR system and explore ways to increase security within the RF communication. In the meantime, they also expect interested parties within the industry to look to further develop the approaches and prototypes into commercial products.

FACTS

NAME	HYCOWARE
OBJECTIVE	Improve operations and efficiency of warehouses through hybrid connectivity solutions
TECHNOLOGIES USED	RFID, BLE, LoRa, IEEE 802.15.4e TSCH, Wi-Fi, LwM2M, CoAP, HoloLens, Quuppa
TYPE	imec.icon project
DURATION	01/04/2016 – 31/05/2018
PROJECT LEAD	Wim Van Betsbrugge, Dematic
RESEARCH LEAD	Jeroen Hoebeke, IDLab, an imec research group at UGent
BUDGET	2,164,473.38 euro
PROJECT PARTNERS	Aucxis, Dematic (formerly Egemin), Intation
IMEC RESEARCH GROUPS	IDLab & WAVES, both imec research groups at UGent

HYCOWARE project partners:

The HYCOWARE project was co-funded by imec (iMinds), with project support from Agentschap Innoveren & Ondernemen.

WHAT IS AN
IMEC.ICON PROJECT?

The imec.icon research program equals demand-driven, cooperative research. The driving force behind imec.icon projects are multidisciplinary teams of imec researchers, industry partners and/or social-profit organizations. Together, they lay the foundation of digital solutions which find their way into the product portfolios of the participating partners.