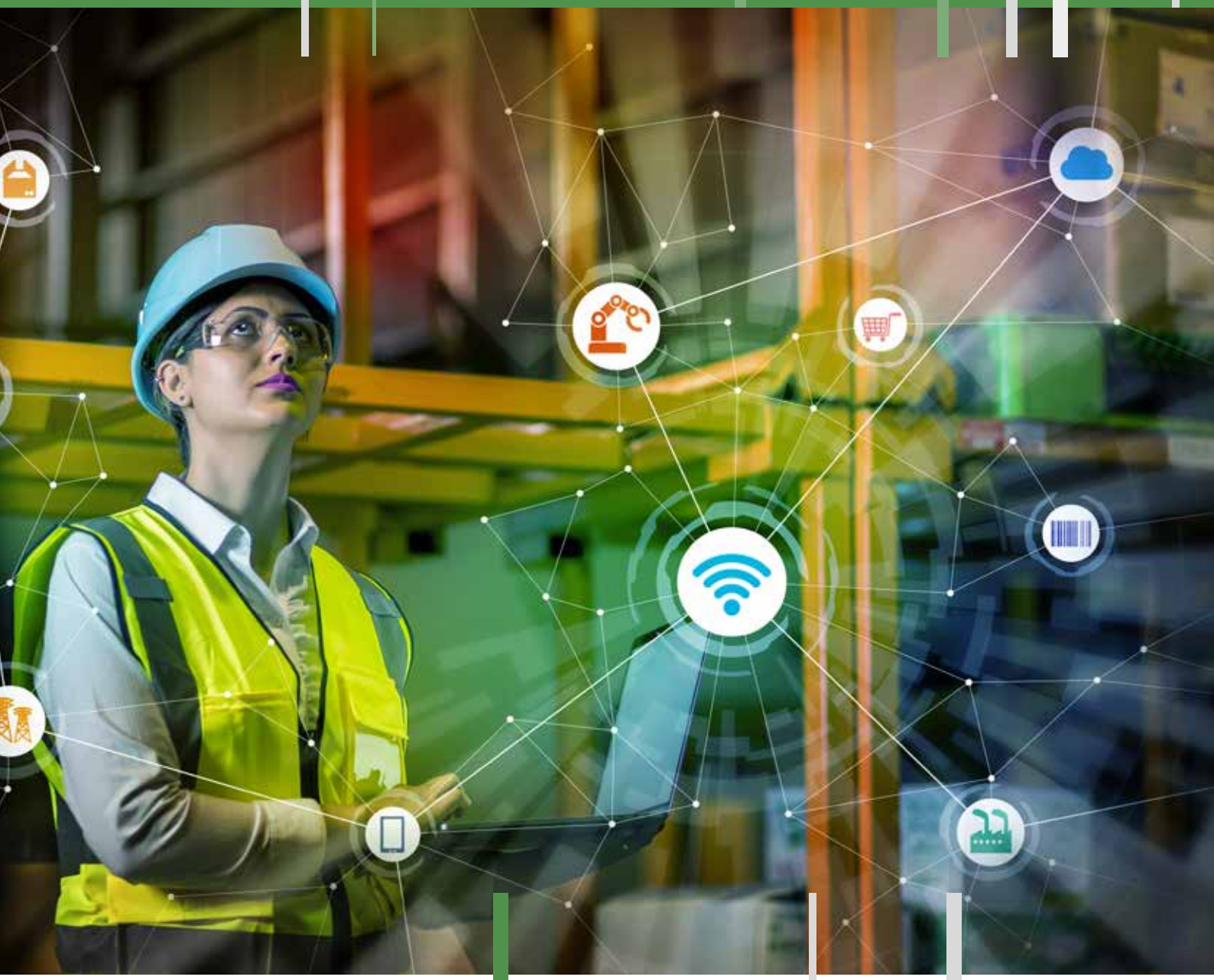
OPTIMUM

Offering greater efficiency, safety and usability in future smart factories

Success story

In today's factories, machines such as cranes are typically operated manually using heterogeneous hardware. These are usually not interoperable and diverse control environments are used; static machine configurations also make evolution hard to achieve. In a global market with strong competition, Industry 4.0 concepts like greater software modularity, interoperable frameworks and Industrial Internet of Things (IIoT) must be embraced to enable truly smart factories.



The ITEA project OPTIMUM, which ran from 2017 to 2021 and gathered 17 partners from Germany, Türkiye, South Korea, Romania, Spain and the United Kingdom, enabled machines of different kinds and from different manufacturers to communicate with each other and their operators, improving the safety of workers and equipment. This was achieved through real-time machine-to-machine and machine-to-human communication utilising a distributed control platform (DCP), localisation awareness and 3D engineering and visualisation for smart factory applications. This was ground-breaking because previously only machines from the same manufacturer could communicate with each other at a reasonable cost and engineering effort.

Improved safety and reduction in assembly time

For smart manufacturing processes, this communication needs to be realised at an extremely high speed – in real time – and at an extremely reliable rate. Only then can the safety of operators and equipment be guaranteed. The basis for this is twofold: firstly, the communication channels need to permit data exchange with high reliability in real time and, secondly, the system needs to be aware of the current positions of all of the actors within it – moving or static, human or machine. This way, the system can gain the necessary context/positioning awareness of all of the actors participating in the material flow.

A great innovation for standard semi-automated applications is the potential for new and cost-efficient assistance functions that revolutionise the

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More information
https://itea4.org/project/optimum.html

efficiency of processes. The outcomes of OPTIMUM are prerequisites for the implementation of smart processes in real smart factories in the future.

The consortium has implemented and validated the diverse technical results through 15 demonstrators in four countries. Cranes, forklifts and autonomous driving vehicles were equipped with new assistance functions, like 'come to me', 'go-to' and 'follow machine'. This will make machines and processes smarter. These innovative assistance functions will significantly reduce assembly times in semi-autonomous processes, where an 18% reduction was already achieved during a proof of concept. In real industry applications, even larger efficiency increases are expected. This improves resource utilisation and overall sustainability. Users of the software and applications developed in the OPTIMUM project will also enjoy safer and more flexible material handling processes.

In the meantime, the distributed control architecture and the M2M communication approaches developed in OPTIMUM have been continued in several Konecranes and Demag development projects. The result of the Electric 2.0 project will be an innovative, bus-based crane control architecture. The crane control components will be modular and scalable so that they will be suitable for a wide application range, from light lifting to industrial cranes with manual, semi-automatic or fully automatic operational modes. The new crane control solution will consider the EU Cybersecurity Act requirements and will be prepared for security level certification. In addition, OPTIMUM's cybersecurity-related topics have been deepened and continued in the SUSTAIN research project. In this new project, four OPTIMUM partners – Demag, IFAK, IOTIQ and the University of Rostock – are working on the security certification of the OPTIMUM IoT Kernel.

One of the most crucial technologies for the realisation of innovative assistance functions in OPTIMUM was wireless, real-time capable M2M communication, for which the project chose to utilise 5G technology with ultra-reliable, low-latency (URLL) capabilities. Due to the fact that Release 16 of 5G (URLL) is still not available, further projects have been set up with the aim of finding alternative solutions for reliable wireless, real-time capable communication. Since September 2022, Demag has been working on the EmKol4.0 research project that relates to the development of modern communication technologies for Industry 4.0.

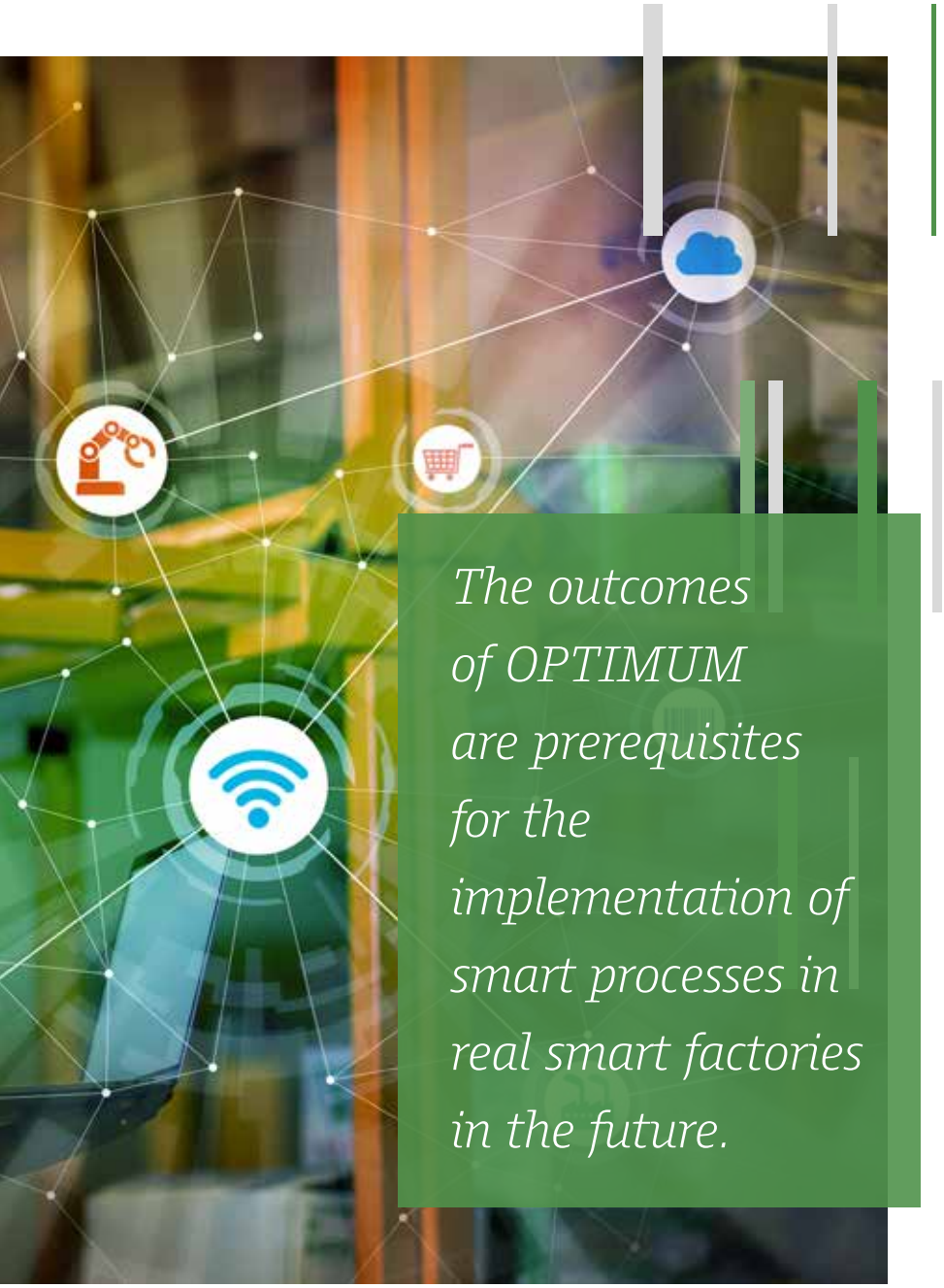
Strong standardisation and exploitation results

With the demonstrators, the consortium has proven the scalability of the results. These demonstrators range from small mobile robots to table-top demonstrators, laboratory demonstrators and real factory applications with demo assembly processes. Three out of eight patent ideas are already registered at a national level, building the grounds for future market approaches. Remaining patent ideas are under review or in the process of submission.

The development of a globally standardised Open Platform Communication Unified Architecture (OPC UA) data model for cranes and hoists (OPC 40020-1 companion specification) was actively driven by the project partners and evaluated in the OPTIMUM project. The finalisation of this companion specification makes it possible to create flexible, standardised, interoperable and secure solutions across the entire material handling domain, as well as beyond in mechanical and plant engineering.

The current successes in market exploitation following the finalisation of the OPTIMUM research project are as follows:

1. In August 2023, Demag supplied a crane to the Fraunhofer Institute for Factory Operation and Automation (IFF) in Magdeburg for its new research facility, the Elbfabrik. This crane, known as the OPTIMUM Crane, will feature innovative assistance functions developed as part of the OPTIMUM project. The implementation of these advanced



The outcomes of OPTIMUM are prerequisites for the implementation of smart processes in real smart factories in the future.

functionalities is being supported by project consortia partners. The Elbfabrik serves as a research and demonstration space for Industry 4.0 solutions, where the OPTIMUM Crane will play a key role in smart factory scenarios, facilitating collaboration between machines and humans in a shared environment.

2. NXP is developing an integrated hardware solution based on OPTIMUM results to serve as an evaluation kit for the industrial market.
3. Tarakos has extended their software solutions (taraVRbuilder and taraVRcontrol) and has significantly improved the planning of material handling processes with cranes. The roll-out to the market took place in August 2022 and the extended software is also being sold to the Fraunhofer Institute for the Elbfabrik. In addition, OPTIMUM's results have so far led to the acquisition of two industrial customers from the crane sector for software licenses and services.
4. BEIA has developed its IoT telemetry solution with OPC UA for cranes to be used by NAVROM, the biggest river shipping company in Romania.

Thanks to high levels of collaboration within the consortium and the support of ITEA, OPTIMUM has overachieved in various ways. For technical outputs, a clear highlight is the development and implementation of five DCPs across 15 machines (versus a target of three devices), including cranes, automated guided vehicles and forklifts. Runtime visualisation has been created, while contextual awareness is another unique, ground-breaking result. Against an initial goal of two market approaches, the consortium has now developed 38 short, mid or long-term exploitation approaches to bring such innovations to market.

OPTIMUM's competitive advantages are clear: the localisation of all actors will increase the safety of manufacturing environments, assistance functions result in a significant reduction in assembly times (thereby improving resource utilisation and overall sustainability), and the closed loop of optimisation can reduce development times and costs. Eighteen tools for third-party exploitation have reached TRL 4 (lab validation) or higher; a notable example is a software tool to support layout-based engineering and the visualisation of overhead travelling cranes.

OPTIMUM has seen further successes in dissemination and human capital, resulting in the hiring of 12 permanent staff and the completion of 43 bachelor's or master's theses and student works related to the project. Students have also played a unique role in the demonstrators, including scaling the German demonstrator down to create two fully functioning 3D printed desktop demonstrators at the University of Rostock and Demag. The University of Rostock has integrated knowledge gained from the project into its courses. Having reached over 30,000 people via newsletters, guided tours and social media, the OPTIMUM consortium is highly committed to further developing the project's results, including transforming eight patent ideas into marketable outputs. This spirit of collaboration is set to increase efficiency, competitiveness, safety and security and reduce manufacturing waste for many years to come.