ITEA 4

Project Results

OPTIMUM

Ground-breaking results in the smart factory domain

Focusing on distributed control, localisation, cyber-security and 3D engineering & visualisation, the ITEA project OPTIMUM (OPTimised Industrial IoT and Distributed Control Platform for Manufacturing and Material Handling) offers greater efficiency, safety and usability in future smart factories.

Project origins

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.

OPTIMUM envisions a clear link between real-time machine-to-machine (M2M) communication utilising distributed control, localisation awareness and 3D engineering & visualisation for smart factory applications. To avoid 2D layout tool limits, the project has enhanced design processes and solution validation using 3D models, simulation and supervision. Application design and development are supported via a common IIoT platform and a distributed control platform (DCP). Integrated context and location awareness enable better control and assistance. These results have now been validated with 15 demonstrators across four countries.

Technology applied

Regarding 3D engineering and visualisation, the project aimed to utilise TARAKOS' 3D engineering tool for complete product lifecycles. From an engineering perspective, this can be used to visualise the manufacturing location to which machinery will be added and subsequently optimise material flow solutions (i.e. by simulating effects of cycle time versus cost). An important innovation was introducing a DCP that integrates secure elements and location awareness capabilities, allowing location-dependent assistance functions. This has been built on suitable real-time communication and interfaces with an IIoT platform. Information is fed back to the 3D engineering tool to close the loop and further optimise future lifecycle management.

From this starting point, OPTIMUM addressed many additional targets, including Human-Machine-Interfaces (HMIs), wearables for operator localisation and 5G technology application. Unlike a typical cascaded approach, control modules are distributed so that each actor – human or machine – can be located within the process in real-time, enabling collaborative assistance functions. The 15 demonstrators effectively showcase the project's diverse technical results. Those implemented as prototypes include DCPs (IFAK), embedded boards (NXP), IIoT (University of Rostock, ERSTE), indoor localisation (COMNOVO), wearables (THORSIS & University of Rostock), digital twins (TARAKOS) and high-level assistance functions (DEMAG, ERMETAL, ETRI, MAGTEL).

In terms of cyber security, the project conducted a detailed STRIDE analysis to identify risks and vulnerabilities. For HMIs, a multi-level authentication concept was implemented to request authentication for different access levels. M2M communication is secured by Secure Elements (SE) used for encryption in the OPC Unified Architecture (UA) protocol and DCP (NXP, IFAK, University of Rostock).

Collaboration between cranes, hoisting devices and machines requires interoperability, but existing standards for cranes are not yet ready for Industry 4.0 and human-machine collaboration.

M2M & HMI communication in the German Material Handling demonstrator

Therefore a cross-company working group was established to prevent a lack of standards from becoming a roadblock to exploitation. An OPC UA companion profile for cranes and hoists will be published shortly. The partners also contributed to standardisation regarding Cyber Security and Functional Safety.

Making the difference

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, and 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); 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 a 3D print). 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.

Major project outcomes

Dissemination

- Project presentations at Customer Day & Open House at DEMAG in 2019
- 2 Open IEEE Special Sessions at: ICPS 2020 SS-06 & IECON 2020 SS-62
- Exhibition of OPTIMUM at Digital Days of Hannover Messe 2020
- 43 Master thesis, Bachelor thesis, Student works
- 16 Publications for IEEE Xplore

Exploitation (so far)

- 18 ERTPs published, 38 Exploitation targets and 15 Demonstrators in four countries
- DEMAG sold a crane to the Fraunhofer Institute for Factory Operation and Automation (IFF) in Magdeburg for its new research factory (Elbfabrik) which will be enabled for innovative assistance functions from OPTIMUM
- NXP develops an integrated HW solution based on OPTIMUM results to serve an Industrial Evaluation Kit for the industrial market
- TARAKOS extended their SW solutions (taraVRbuilder & taraVRcontrol) and improved the planning of material handling processes with cranes. Market roll-out took place in August 2022. The extended SW solutions are already sold to a.m. Fraunhofer Institute and to one industrial customer
- BEIA has developed its IoT telemetry solution with OPC UA for cranes to be used by NAVROM, the biggest river shipping company in Romania

Standardisation

- VDMA cross-company working group on OPC UA companion specification for cranes & hoists
- Contribution to Cyber Security and Functional Safety standards

Patents

- 8 patent ideas (9 partners from Germany, Türkiye and Korea)

ITEA is the Eureka R&D&I Cluster on software innovation, enabling a large international community of large industry, SMEs, start-ups, academia and customer organisations, to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth and benefits for society. ITEA is part of the Eureka Clusters Programme (ECP).

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Partners

Germany

- Comnovo GmbH
- Demag Cranes & Components GmbH
- Institut für Automation und Kommunikation e.V. (ifak)
- NXP Semiconductors Germany GmbH
- tarakos GmbH
- Thorsis Technologies GmbH
- University of Rostock

Republic of Korea

- Electronics and Telecommunications Research Institute (ETRI)
- Handysoft Inc.

Romania

- Beia Consult International

Spain

- Ezeris Networks Global Services SL
- Magtel Operaciones S.L.U.
- Sotec Consulting
- UC3M (subcontracted)

Türkiye

- DIA Yazilim San. ve Tic. A.S.
- ERMETAL OTOMOTIV ve ESYA SAN TIC. A.S.
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