AUTOWARE

European Commission

TECHNOLOGY CATALOGUE

SIMPLIFIED VERSION

THE PURPOSE OF THIS CATALOGUE IS TO PROVIDE AN OVERVIEW OF THE INDUSTRY 4.0 SOLUTIONS DEVELOPED WITHIN THE AUTOWARE PROJECT

INTRODUCTION

The purpose of this catalogue is to provide an overview of Industry 4.0 solutions developed within the project. The goal is to help SMEs adopt Industry 4.0 technologies. This catalogue is seen as a valuable asset for SMEs that are interested in adopting technologies within Robotics and Automation, Cyber Physical Systems and IoT.

The catalogue will:

1. Provides an overview of the technologies and certifying platform offered by the AUTOWARE partners in the relevant technology areas.
2. Provides detailed descriptions of the technologies and the certification process which will enable SMEs to identify technologies that would be valuable to implement in their organization.

READING GUIDANCE

This catalogue consists of the technologies developed in AUTOWARE. Each technology is described on one page where each of the technologies has a description and a picture. Furthermore, the technology areas and its target sectors are also listed together with its TRL and contact information. Figure 1 provides an overview of how each technology is described:

- Name and description
- Picture
- Technology Area
- Targeted Sectors
- Technology Readiness Level
- Contact Information

Figure 1: Overview

REFERENCE ARCHITECTURE

The Autoware reference architecture illustrates how different technologies are related. The graphical overview of the AUTOWARE reference architecture is illustrated in Figure 2.

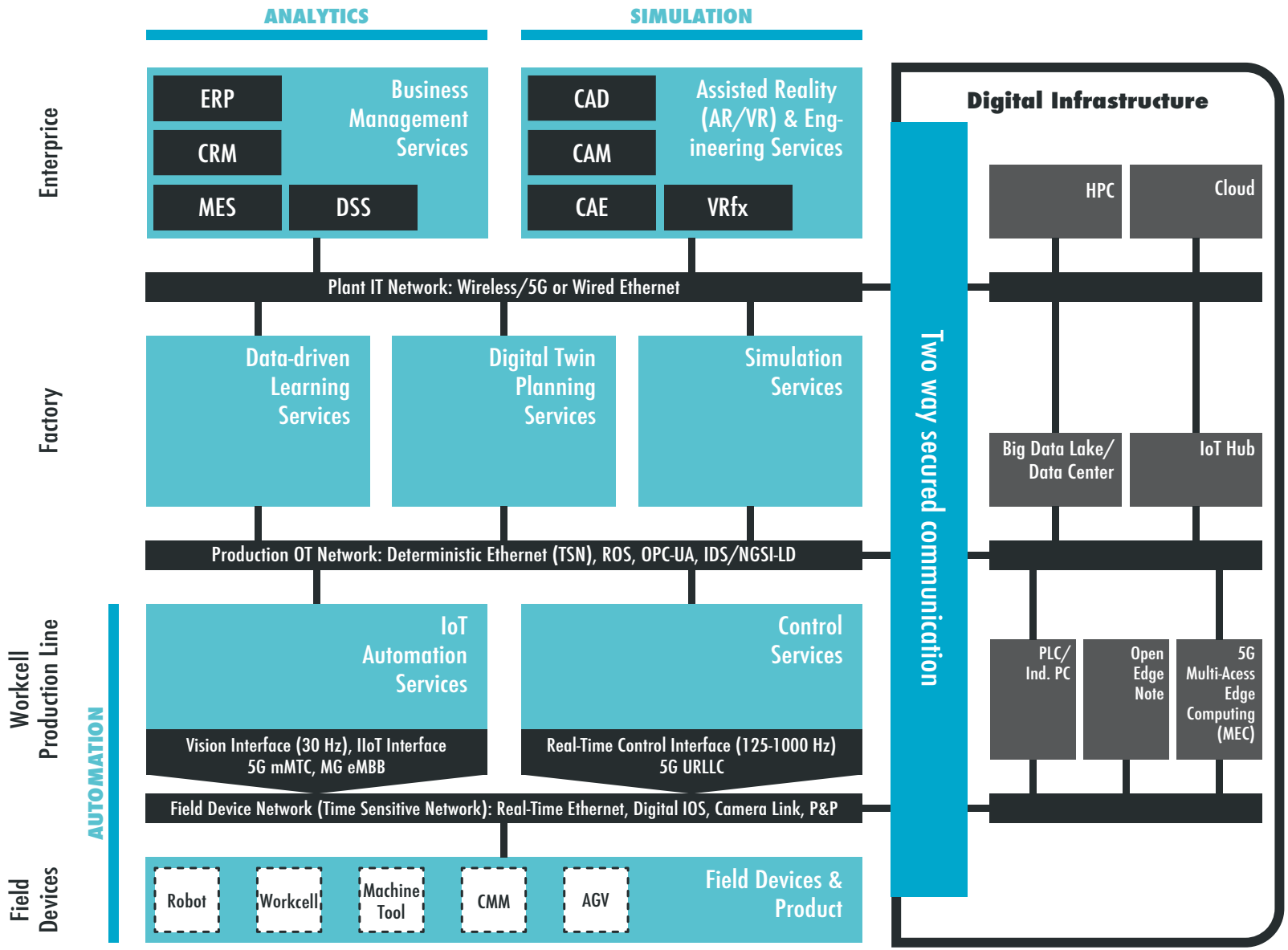

Figure 2: Reference Architecture

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1.0 FOG COMPUTING SOLUTION

PROVIDED BY TTTech

ABOUT THE TECHNOLOGY

The Fog Computing solution is an industrial IoT solution designed to converge and connect automation systems. It provides an open, flexible platform that reduces costs and delivers new value for machine builders, system integrators and plant operators.

It can collect, store and analyze machine data and run multiple functions on one device. You can access real-time data from PLC and IO infrastructure. The Fog Computing Solution can manage and deploy software.

AREA OF THE TECHNOLOGY

- Big data and analytics
- Augmented Reality
- Cyber-Physical-Systems
- Cloud computing
- Fog/Edge Computing

TARGETED INDUSTRIAL SECTORS

- Manufacturing
- Industrial automation
- Production facilities

TECHNOLOGY READINESS LEVEL

TRL 5 - technology validated in relevant environment

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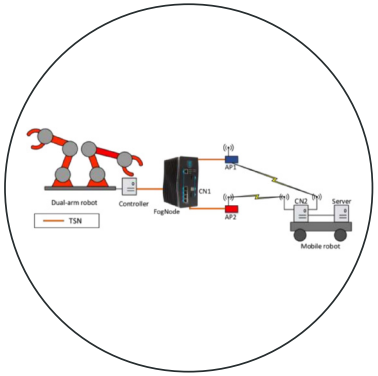
2.0 INTEGRATION OF FOG COMPUTING SOLUTION

PROVIDED BY IK4 TEKNIKER
Research Alliance



ABOUT THE TECHNOLOGY

The open CPPS platform (i.e. Fog Computing Solution) will be integrated as a central station, where the configuration of the open platform will be performed with the usability enablers for programming and controlling the Fog Computing Solution. The Fog Computing Solution will act as a central point, where the different applications (e.g. data management) will be hosted on.

It enables communication between the different components in the production cell and easy multi-platform software communication. Also, it enables you to apply software updates to machines without needing to be on site.

AREA OF THE TECHNOLOGY

- Big data and analytics
- Cyber-Physical-Systems
- Cloud computing

TARGETED INDUSTRIAL SECTORS

- Manufacturing

TECHNOLOGY READINESS LEVEL

TRL 6 - technology demonstrated in relevant environment

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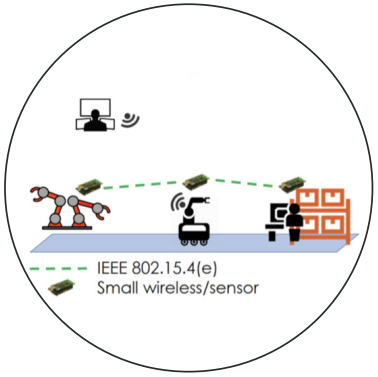
3.0 SMART DATA DISTRIBUTION

PROVIDED BY Consiglio Nazionale delle Ricerche



ABOUT THE TECHNOLOGY

Novel smart data distribution technological solutions which cooperate with cloud-based service provisioning and communication technologies. The solutions presented in AUTOWARE determine when it is appropriate to move data towards locations where services can be provided. In this context, AUTOWARE exploits storage and computation resources on various elements of the industrial network. AUTOWARE decentralized data management and distribution proposals also contribute towards the design of automation processes that are more capable to dynamically reconfigure. To achieve these objectives, the designed data management and distribution schemes provide distributed methodologies and smart algorithms to dynamically move data based on the requirements of the applications (e.g., time-sensitive control tasks), while optimizing resources of the manufacturing environment (e.g., the energy consumption of industrial IoT devices).

AREA OF THE TECHNOLOGY

- Internet of Things
- Cyber-Physical-Systems
- Big Data
- Industrial Networks

TARGETED INDUSTRIAL SECTORS

- Manufacturing
- Agriculture
- Asset Tracking
- Production Control

TECHNOLOGY READINESS LEVEL

TRL 6 - technology demonstrated in relevant environment

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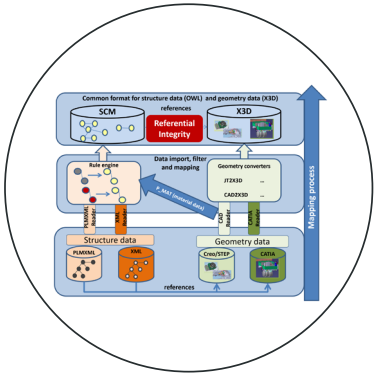
4.0 SEMANTIC WORKFLOW MODELLING

PROVIDED BY Fraunhofer



ABOUT THE TECHNOLOGY

The semantic workflow modelling service foresees to make existing product engineering and production planning data available for secondary use, namely for cooperative assembly tasks. By retrieving product engineering data (i.e. 3D CAD files) and production planning data (i.e. structured textual data describing the manufacturing execution and the assembly process) from a company's Product Lifecycle Management (PLM) system, the service will generate a semantic description of the assembly process incorporating the 3D representations of the assembly steps.

AREA OF THE TECHNOLOGY

- Cyber-Physical-Systems

TARGETED INDUSTRIAL SECTORS

- Research & Development
- Manufacturing
- Production facilities
- Computer - Software

TECHNOLOGY READINESS LEVEL

TRL 7 - system prototype demonstration in operational environment

CONTACT INFORMATION

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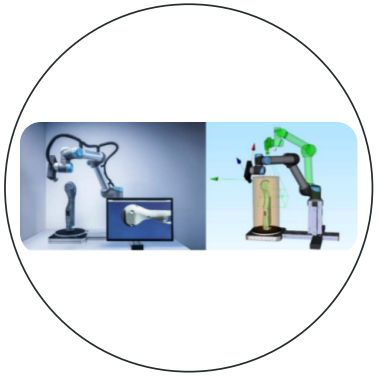
5.0 DUAL REALITY MODELLING

PROVIDED BY Fraunhofer



ABOUT THE TECHNOLOGY

The dual reality modelling service allows enriching dynamic virtual environments with virtualized physical production environments (Augmented Virtuality). In doing so, it uses 2D/3D sensor data and relies on a continuous mapping of the current state of the real world onto the virtual world and vice versa. This includes virtualizing the behaviour of objects from the real world and realizing the behaviour of objects from the virtual world. Realizing virtual objects does not necessarily mean to materialize virtual objects using additive manufacturing technologies. Realizing the behaviour of virtual objects can also mean that real physical production environments directly react to virtual objects.

AREA OF THE TECHNOLOGY

- Augmented Reality
- Cyber-Physical-Systems

TARGETED INDUSTRIAL SECTORS

- Research & Development
- Manufacturing
- Production facilities
- Computer - Software

TECHNOLOGY READINESS LEVEL

TRL 7 - system prototype demonstration in operational environment

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6.0 SENSOR PROCESSING

PROVIDED BY Fraunhofer

ABOUT THE TECHNOLOGY

A 3D optical sensor based on structured laser light (line sectioning and space-time analysis) that supports two different scanning modes: the first for coarse and fast scanning of larger parts and the second for slower but precise scanning at marked positions. The technology includes an initial self-configuration of the system and is essential for robot trajectory and view planning that enables autonomous 3D scanning.

The required user interaction is reduced to placing a known calibration target board on the turntable. Then the robot autonomously carries out the calibration procedure. After the calculation, 3D scanning data can be reconstructed and merged within the common turntable coordinate system and forwarded to other processing services.

AREA OF THE TECHNOLOGY

- Autonomous Robots
- Cyber-Physical-Systems
- 3D Scanning

TARGETED INDUSTRIAL SECTORS

- Research & Development
- Manufacturing
- Production facilities
- Computer - Software

TECHNOLOGY READINESS LEVEL

TRL 4 - technology validated in lab

CONTACT INFORMATION

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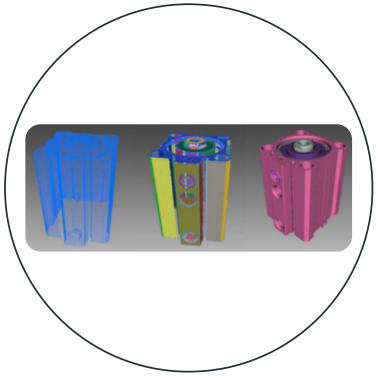
7.0 3D OBJECT RETRIEVAL & RECOGNITION

PROVIDED BY Fraunhofer



ABOUT THE TECHNOLOGY

Many existing shape representations describe actual shapes, with visual and material properties. However, applications often require enhanced shape properties. For example, shape structure information, such as segmentation or label information, can help to relate the parts of a shape to each other. The 3D Object Retrieval and Object Recognition service can use engineered but also learned features in order to classify and recognize 3D objects. This involves also semantic segmentation by fitting geometric primitives in discrete geometric representations. This allows for automatic state recognition and enables the alignment of real-world conditions with the digital world.

AREA OF THE TECHNOLOGY

- Big data and analytics

TARGETED INDUSTRIAL SECTORS

- Research & Development
- Manufacturing
- Production facilities
- Computer - Software

TECHNOLOGY READINESS LEVEL

TRL 4 - technology validated in lab

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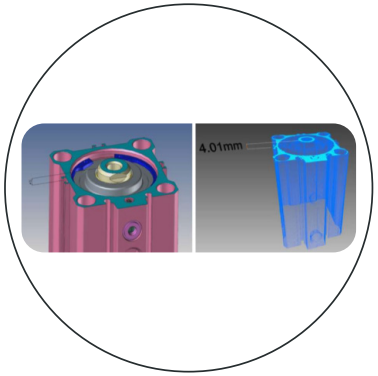
8.0 3D QUALITY CONTROL

PROVIDED BY Fraunhofer



ABOUT THE TECHNOLOGY

With this service, the user is relieved from doing a manual check of dimensions after the completion of assembly steps. The quality control service requires an annotated 3D CAD model with measurement details and a 3D point cloud of the real object. The service automatically retrieves the measurement details, which are involved primitives e.g. planar segments, the expected distance between the primitives and allowed tolerances. Therefore, this service realizes the automatic transfer of information embedded in CAD models to qualify the services. As an output, the user receives the results of the measurement and a statement of whether the measurement result is in the predefined tolerance range.

AREA OF THE TECHNOLOGY

- Big data and analytics
- Cyber-Physical-Systems

TARGETED INDUSTRIAL SECTORS

- Research & Development
- Manufacturing
- Production facilities
- Computer - Software

TECHNOLOGY READINESS LEVEL

TRL 4 - technology validated in lab

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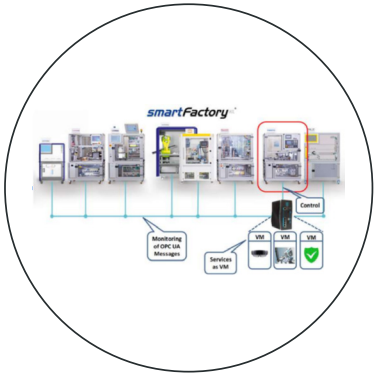
9.0 NEUTRAL COGNITIVE DIGITAL AUTOMATION PROCESS EXPERIMENTATION INFRASTRUCTURE



PROVIDED BY smartFactory KL

WILLKOMMEN IN DER ZUKUNFT DER INDUSTRIELLEN REVOLUTION

ABOUT THE TECHNOLOGY

In the neutral test factory SmartFactoryKL, the Fog Computing Solution is attached in the edge layer. This is integrated with the infrastructure of the individual production modules, more precisely with the industrial M2M (Machine-to-Machine) communication protocol according to the OPC (Open Platform Communication) specification, with which the production modules communicate with the higher-level MES (Manufacturing Execution System) system. These transmitted messages can be evaluated and processed in the Fog Computing Solution.

AREA OF THE TECHNOLOGY

- Big data and analytics
- Augmented Reality
- Cyper-Physical-Systems
- Cloud computing

TARGETED INDUSTRIAL SECTORS

- Research & Development
- Manufacturing

TECHNOLOGY READINESS LEVEL

TRL 5 - technology validated in relevant environment

CONTACT INFORMATION

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10.0 ACTIVE PRODUCT MEMORY

PROVIDED BY smartFactory KL

WILLKOMMEN IN DER ZUKUNFT DER INDUSTRIELLEN REVOLUTION

ABOUT THE TECHNOLOGY

The Active Product Memory services as an extension of the common product memory used in SmartFactory. This consists of an RFID chip attached to the test product. This product memory stores all the information required to manufacture this individual product when an order is received. In the further course of production, RFID readers/writers are attached to the processing stations, which are divided into production modules in the SmartFactory. They read the RFID chip of the product and check which production step they have to carry out and whether they are capable of doing so. Once the associated machining process has been completed, this is recorded in the locally stored product memory of the associated product. In this way, the product independently finds its way through the production process. Missing or superfluous processing steps can therefore not happen. Likewise, no information can be lost or incorrect processes carried out on the product.

AREA OF THE TECHNOLOGY

- Big data and analytics
- Cyber-Physical-Systems
- Internet of Things

TARGETED INDUSTRIAL SECTORS

- Agile manufacturing

TECHNOLOGY READINESS LEVEL

TRL 5 - technology validated in relevant environment

CONTACT INFORMATION

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11.0 MACHINE LEARNING

PROVIDED BY

ABOUT THE TECHNOLOGY

Deep learning based computer vision - ROBOVISION has configured deep learning systems and associated tools to create novel machine vision systems, which are applied in the use-cases. More specifically, in a first phase, the machine learning system data needs to be collected related to the process. This data can be separated into two categories: human annotation (labels) and associated image data. Obtaining relevant labels is a costly process, for this ROBOVISION has developed solutions in its RVAI platform. In a second phase, the system needs to be trained, for which ROBOVISION uses the latest deep learning advances. This novel technology offers the possibility to use vision-based algorithms based on combinations of complex features such as shape, form, colour and can be reconfigured to recognize new products, as demonstrated in the STORA ENSO simulation use case.

AREA OF THE TECHNOLOGY

- Machine and Deep Learning Applied
- Vision Technology
- Artificial Intelligence

TARGETED INDUSTRIAL SECTORS

- Recycling industry
- Carton Sorting and Picking
- Generalized anomaly detection to support process quality control

TECHNOLOGY READINESS LEVEL

TRL 7 - system prototype demonstration in operational environment

CONTACT INFORMATION

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12.0 GPFLOWOPT

PROVIDED BY imec

ABOUT THE TECHNOLOGY

IMEC has developed GpflowOpt, a novel Python framework for Bayesian optimization, which can be viewed as a modern spin-off of the widely used SUMO-toolbox.
GpflowOpt allows the user to speed up expensive simulations or the tuning of deep learning vision systems. In the latter case, it achieves this by replacing such as grid-search by optimized sequential parameter tuning, drastically reducing the training time of such systems while achieving better or equivalent performance.
The software has been adopted to allow more accurate paper-cardboard separation by among others more efficient tuning of deep learning vision technology and the ability to process diverse compositions of paper-cardboard of varying quality by rapid reconfiguration.

AREA OF THE TECHNOLOGY

- Machine Learning
- Surrogate modelling
- Bayesian Optimization
- Hyperparameter tuning of machine learning systems

TARGETED INDUSTRIAL SECTORS

- Engineering
- 3D printing
- Automotive
- Recycling industry

TECHNOLOGY READINESS LEVEL

TRL 6 - technology demonstrated in relevant environment

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13.0 PROGRAMMING BY KINESTHETIC TEACHING

PROVIDED BY Institut "Jožef Stefan"

ABOUT THE TECHNOLOGY

Programming by kinesthetic teaching allows for specifying and editing complex robot trajectories in a natural, user-friendly way. With the help of incremental learning, only certain parts of the trajectory can be changed. Using this technology does not require any special knowledge of robotics.

The enablers are implemented in the JSI neutral facility cell and the applicability is demonstrated and presented in various use cases provided by manufacturing companies. Nonetheless, the nature of the enablers make them useful and operable in any CPPS scenario using ROS based control and involving robots.

AREA OF THE TECHNOLOGY

- Robotics

TARGETED INDUSTRIAL SECTORS

- Automotive
- Aerospace
- Electronics
- White goods
- Footwear and textile
- Research & Development

TECHNOLOGY READINESS LEVEL

TRL 6 - technology demonstrated in relevant environment

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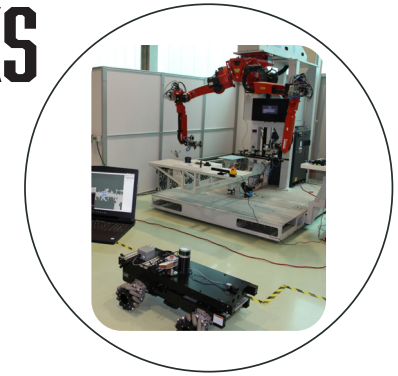
14.0 RELIABLE INDUSTRIAL WIRELESS NETWORKS



PROVIDED BY

UNIVERSITAS Miguel Hernández

ABOUT THE TECHNOLOGY

This service provides reliable wireless communications for industrial IoT applications. The designed solution includes the dimensioning, planning and deployment of WiFi-based industrial wireless networks with the reliability and deterministic latency levels demanded by industrial IoT applications. To this aim, the solution exploits diversity and redundancy to establish diverse wireless links between industrial nodes. The developed solution can be configured to select the link with best communication quality between nodes (diversity) or to establish redundant links for additional robustness (redundancy). Both approaches augment reliability, reduce latency and reduce loss of coverage in industrial environments. The designed solution can also support reliable and low latency communications with mobile nodes in industrial IoT networks. The designed solution includes the integration of Communication Nodes (CN) with the industrial nodes in the shop-floor that must be connected.

AREA OF THE TECHNOLOGY

- Industrial Wireless Communications
- Industrial Internet of Things
- Cyber-Physical-Systems

TARGETED INDUSTRIAL SECTORS

- Agile manufacturing
- Manufacturing
- Production facilities
- Industrial automation

TECHNOLOGY READINESS LEVEL

TRL 6 - technology demonstrated in relevant environment

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15.0 DIGITAL AUTOMATION

PROVIDED BY

ABOUT THE TECHNOLOGY

Digital automation solutions put stress on safe and secure operation of future workplaces. Traditional certification approaches are not well suited for modular production lines and collaborative reconfigurable robotic cells. Existing standards need to be adapted to the new 4.0 reality. Fast and cost-effective validation, verification and certification of new developed technologies for manufacturing 4.0 is a must for their integration in a factory. The certification laboratory takes advantage of previously developed frameworks (e.g. Q-mobile, Mango Apps) and it is fully compliant to ISO 17025 operational procedures. It is flexible to validate performance, scalability, OT/IT safety and security of Industry 4.0 base technologies and can be customized to the validation of application specific deployments in any industrial sector.

AREA OF THE TECHNOLOGY

- Industrial Communications
- Fog/Edge Computing
- Robotic Systems
- Cybersecurity & Safety
- Computer Vision Technologies
- Cloud Computing
- Big data and analytics
- Mobile Solutions

TARGETED INDUSTRIAL SECTORS

- Manufacturing
- Production Facilities
- Metrology
- Industrial Automation
- Railway
- Pharma

TECHNOLOGY READINESS LEVEL

TRL 6 - technology demonstrated in relevant environment

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