DIGITAL MANUFACTURING PLATFORMS FOR CONNECTED SMART FACTORIES

D1.9 2nd Report on Open Calls

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Author(s):	**Carmen Polcaro, Irune Mato**
Partner(s) contributing:	**EIT Digital, ATOS, ENG, AIT, ATLAS**

Abstract : This deliverable reports on the activities performed from April to September 2020 to carry out and disseminate the open call, and to start the evaluation process. The deliverable also gathers all the documents issued by the QU4LITY consortium for the applicants.

Co-funded by the Horizon 2020 Programme of the European Union

HISTORY

Version	Date	Modification reason	Modified by
0.1	18/09/2020	TOC and first draft	Irune Mato (INNO)
0.2	28/09/2020	Added statistics and details about the evaluation process	Carmen Polcaro (INNO)
0.3	29/09/2020	Version for the reviewers	Carmen Polcaro (INNO)
0.4	30/09/2020	Reviewed and updated	Susanne Kührer (EIT)
0.5	30/09/2020	Reviewed and updated	Diego Esteban (ATOS)

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1 Executive Summary

This deliverable reports on the activities performed to carry out the QU4LITY 1st Call for Proposals, opened on June 8th: complete the support documentation, perform dissemination actions, give support to potential applicants, build the team of experts and finally start the evaluation process. The deliverable also gathers all the documents issued by the QU4LITY Consortium for the applicants.

Next steps are completing the evaluation of the call, publish the results, starting the contracts with the winners and prepare and launch the second open call, in January 2021.

2 Introduction

2.1 Scope of the document

Deliverable 1.9 reports on the work performed by the consortium of the project during the QU4LITY 1st Open Call. The call was open for the reception of proposal from June 8th to September 18th. During the reported period of the corresponding task the consortium has been engaged in the following activities:

- Definition of the QU4LITY assets to be validated within the open call
- Preparation of the documents to give support to the applicants
- Performing dissemination actions
- Giving support to applicants
- Definition of the criteria to build the team of evaluators
- Starting the evaluation process
- Analysing the results and extract lessons for the next open call

The preparation of the open call started in January 2020 and the present report covers the work done until September 30th.

3 Report on the open call

3.1 Introduction

In the previous deliverable D1.8 "First report on the open call" we have described in detail the actions carried out by the consortium to define the scope of the call and preparing a first draft of the documentation, i.e. the guide for applicants and the template of the proposal.

As written in the previous report, the open call aims to involve European SMEs and MidCaps, both as solution developers, integrators and manufacturers, to implement new pilots and/or enhance existing pilots and digital platforms, using QU4LITY digital enablers. In this deliverable, we report on the actions performed from April to September 2020 to carry out, disseminate and follow the open call and, after its closure, the activities needed to start the evaluation process.

3.2 QU4LITY Assets and Requirements

The draft documentation published in the previous deliverable has been expanded during the reported period with information about the assets coming from the project and to be validated by the funded applicants during their experiment. Four assets have been identified:

1. Technological digital enablers developed by partners of the project.
2. Reference architecture as defined and developed in WP3.
3. Autonomous QU4LITY concept as defined and developed in WP4.
4. Marketplace as defined and developed in WP8.

To be eligible for funding the applicants have to satisfy the following requirements associated to the mentioned assets:

1. The applicant is required to make use of at least one of the digital enablers proposed by the consortium.
2. The pilot must demonstrate the alignment with the reference architecture.
3. The workflow of the experiment must be designed according to the Autonomous Quality concept.
4. The developed solution must be integrated into the marketplace, while the applicant will maintain the IP over it.

Additionally, applicants to type B, expansion of existing pilots, are required to address the challenge posed by the pilots of the consortium. For the first open call, the pilot coordinated by Whirlpool has launched a challenge for the development of a visual tool for reading and editing the data models generated in that pilot.

In the annexes to this deliverable the documents issued for the applicant to get familiar with the different assets of the project are attached.

The general slowdown due to the pandemics have delayed the preparation of some of the assets (digital enablers, definition of the market place) and of these documents, so the open call has been opened for reception of proposal on June 8, with one-month delay. The initial deadline fixed on August 7th has been extended to September 18, to allow the reception of more proposal, after the summer period, without delaying the starting of the experiments, forecasted in December 2020.

3.3 Dissemination actions and results of the 1st Open Call

During the timeframe June-September 2020, while the call was opened for the reception of proposal, due to the restriction imposed by the COVID-19 pandemics, events and workshops originally planned for the open call have been cancelled. The dissemination of the call has been carried out exclusively online.

To raise awareness on the open call, the consortium has issued 2 dedicated newsletters, several communications activities on social channels and two webinars, on June, 23rd and August 31st. For details about these actions and the impact generated refer to D9.3 "Report on the dissemination/communication activities and their assessment". The content of the webinars, attached in the annex III, is based on the documentations issued for applicants. Additionally, this interactive system allows participants to make questions and solve doubts.

The open call closed on September 18th with the reception of **14 proposals**, all of them applying to the type A call (new autonomous Quality pilots). Type B proposals received no applications.

The applicants come from seven H2020 countries and have covered all the topics of the type A, as it can be seen in the following graphics.

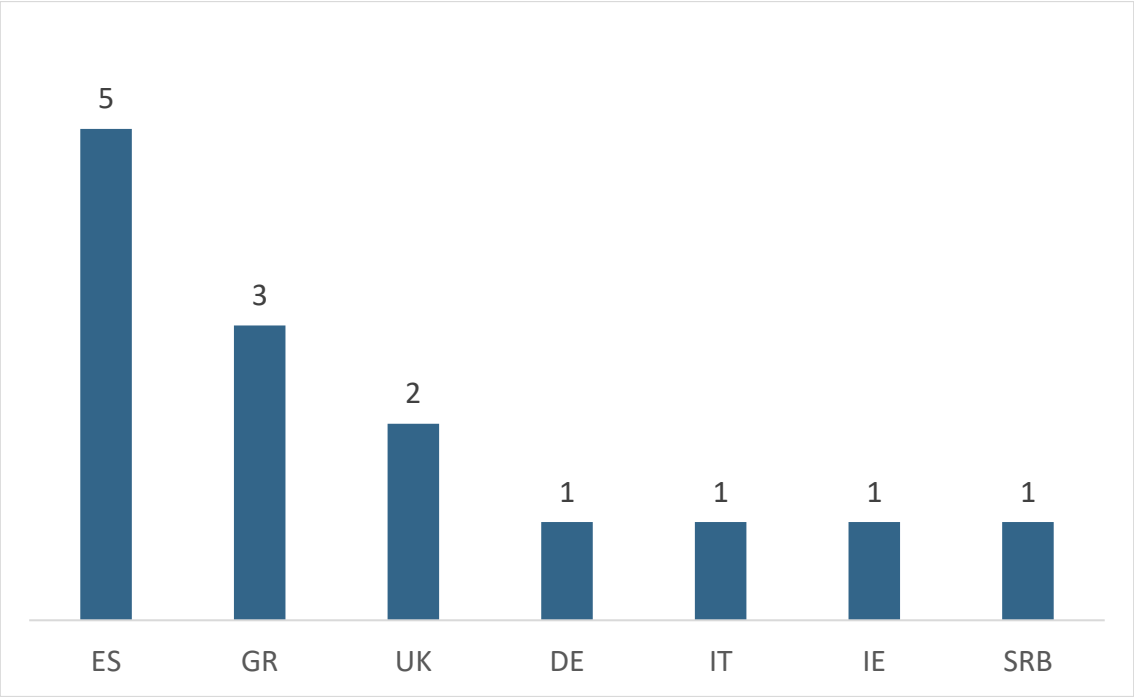


Figure 1 - Proposal received per country

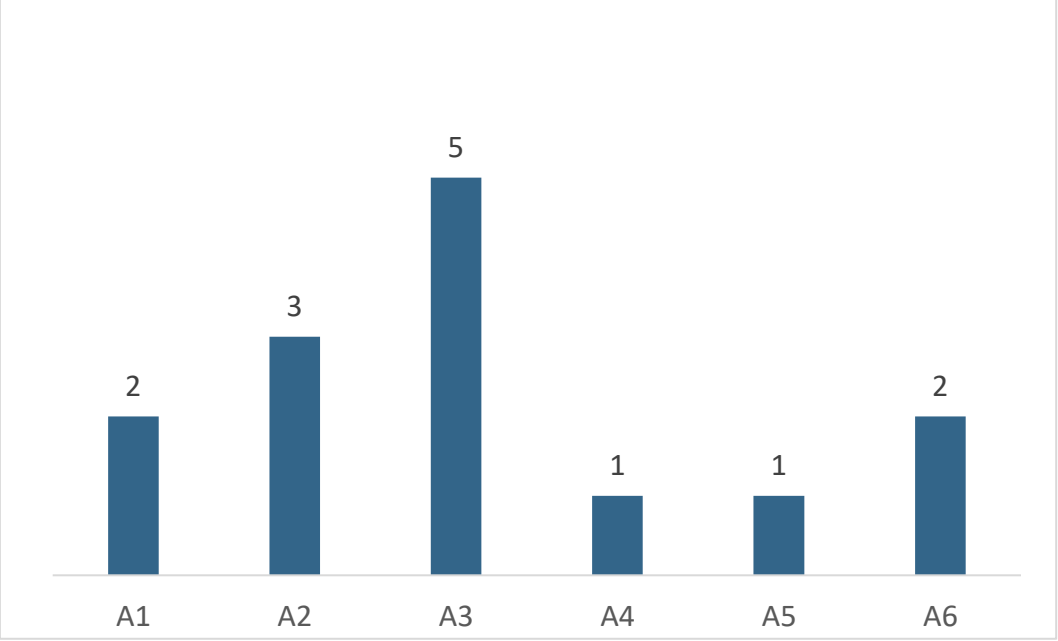


Figure 2 - Proposals received per topic

The evaluation process has started on September 21st. The group of evaluators has been selected among the applicants to the call for external experts opened in parallel with the open call process.

A shortlist of experts has been made based on the following requirements:

- Proven work experience in the topics of the open call
- Experience in evaluation of proposal, experience with H2020 calls is preferred

From this short list a group of experts has been created with the following characteristics:

- It includes experts with academical and business background.
- It has a good representation of different member states
- It is gender balanced

5 experts have been selected, 3 men and 2 women, 2 from Spain, 1 from Greece, 1 from Germany, 1 from Italy. Their identity and CV are not included in this public deliverable, for confidentiality reasons of the evaluation process, but will be disclosed with the EC in a confidential report.

3.4 Lesson learnt

The number of proposals received is not very high, so the consortium has carried out a collective reflection on the achieved results to extract lessons for the next open call. These lessons learnt will be also shared with the partners of the DMP (Digital Manufacturing Platform) cluster coordinated by the CSA Connected Factories II. We have also recollected, when possible, the opinions of potential applicants that registered in our system but eventually decided not to apply. The conclusions of our analysis are resumed in the following points

- The call is challenging for SMEs. The work programme under which QU4LITY is funded requires open calls to involve only SMEs. However, SMEs often prefer to participate together with an RTD or consultancy company that can provide the support needed to carry out the project. SMEs alone, as required in QU4LITY call for single, face particular difficulties. A possible solution could be to allow consortium in the next open call and the participation of an RTD as partner, although the funding contribution is not very high for an experiment that includes a pilot in their development.
- The requirements, such as use of digital enablers, integration in the marketplace and use of the reference architecture, are considered too strict and difficult to be addressed. The integration in the marketplace poses doubts related to the exploitation of the developed solution. For the second open call we are thinking about less restrictive requirements (such as the use of different digital enablers, outside the ones proposed by the consortium) but still with added value for the project. The integration in the marketplace also can be carried out according to several different models.
- There are many EC projects offering funding support to Third Parties and applicants are naturally oriented to open calls that are simpler and more «open».
- A complete pilot in 9 months is not always feasible. In this case we might consider applicants to experiment only a partial technical implementation instead of the complete pilot. This solution, however, might require a revision of the maximum funding for the applicant proportional to the smaller scope of the experiment.

- Online dissemination is dispersive, moreover the limited time does not give the opportunity to deal with more specific questions by applicants. Regarding this, we are planning more focused dissemination actions with less participants and at regional level, in order to address potential applicants in their mother tongue and allow for specific questions with a smaller audience. We are also considering asking for support to the network of DIHs for a capillary dissemination.

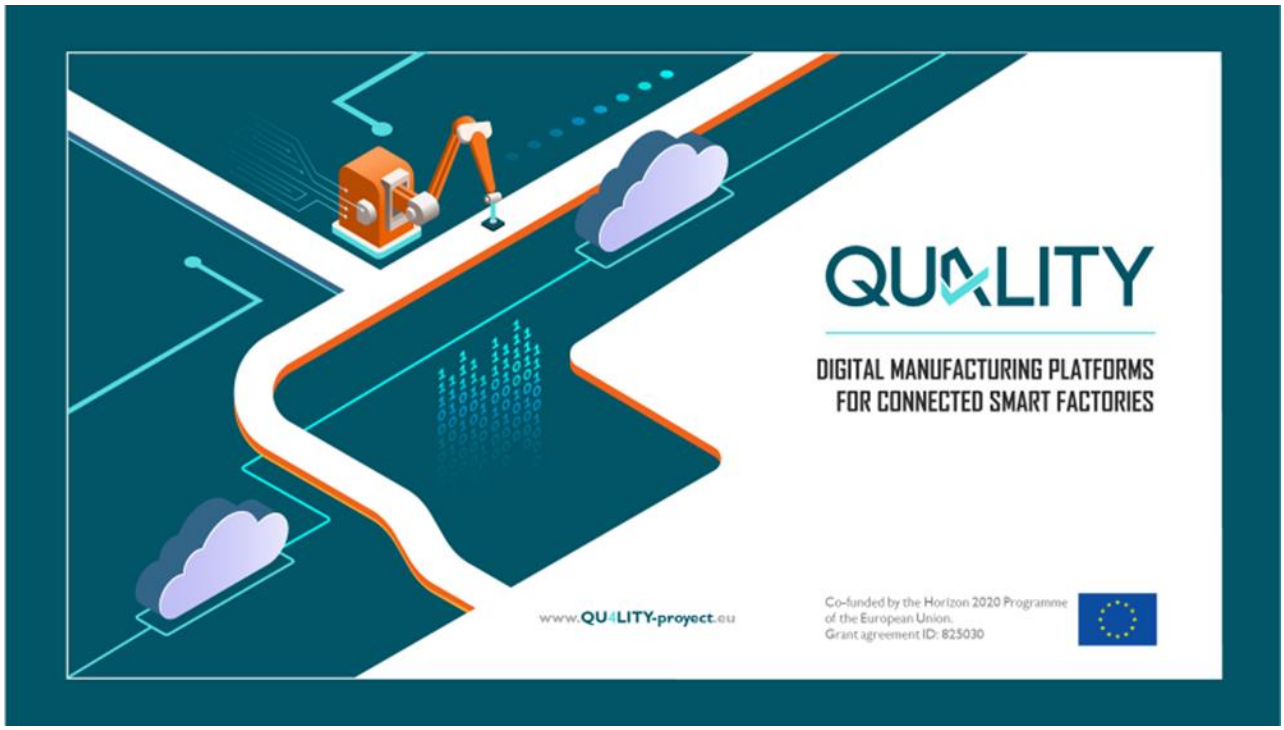
3.5 Conclusions and next steps

In the reported period the consortium has carried out the 1st open call of QU4LITY and started the operations for the evaluation of the received proposals. A series of lessons learnt has been extracted from the whole process, these will be shared with partners of the DMP cluster and will be considered in the design of the next open call.

The evaluation process should be completed by mid-October 2020, results published in November and finally the experiments should start on December 2020.

The next report, due on June 2021, will report on the results of the evaluation of the 1st open call and on the whole process, from publication to evaluation, of the second open call that should start in January 2021.

4 Annex I: QU4LITY Open Call 1 guide for applicants



QU4LITY 1st Open Call

(Guidelines and Rules for Participation)

Co-funded by the Horizon 2020 Programme
of the European Union

1 Table of Contents

1 Introduction

As part of the DT-ICT-07-2018-2019 (IA) call considerations, financial support to third parties is foreseen for the incorporation of third-parties (notably SMEs) that will take advantage of the platforms and pilots of the project and the Open APIs provided on top of them, towards enhancing the QU4LITY compliant systems (i.e. pilots/platforms) with additional functionalities and features. In particular, as listed in the call text, QU4LITY should address the following aspect: "*For large-scale piloting and ecosystem building activities, proposals may involve financial support to third parties, as explained in the introductory section 'Platforms and Pilots', to support SMEs in piloting and developing prototype applications on top of digital manufacturing platforms".*

QU4LITY will exploit this opportunity as a means of attracting SMEs in the project, as user and validators of the project's autonomous quality paradigm, but also as additional participants to the project's virtualized innovation hub and ecosystem. In particular, QU4LITY will provide financial support to SMEs that will engage in the following type of activities:

- ZDM Pilots for SME manufacturers, aiming at customizing and deploying the project's autonomous quality paradigm according to the needs of SMEs. In this direction, SMEs may take advantage of technologies developed in QU4LITY through their (Open) APIs (Application Programming Interfaces).

- Enhancements to QU4LITY digital platforms and pilots by SMEs, which will give SMEs the opportunity to further develop the project's systems using the Open APIs provided by the project.

SMEs participating in both of the above types of activities will also engage in the project's virtualized innovation hub and related market platform. Specifically, Open Call Winners will be asked to describe and make available the technologies that they will use in the project in the QU4LITY market platform. In this way the project will take advantage of the open calls processes to build its community (i.e. ecosystem building) and to establish a critical mass of participants in the project's ecosystem.

2 Objectives of the call

2.1 Context and Motivation

Any European manufacturing company has a constant need to strive for excellence. This requires producing top quality goods, being highly efficient in terms of costs and resources, while being extremely responsive to market and customer needs, and using and offering creative and innovative solutions. Moreover, there is an increasingly pressure on European industry to build sustainable, green and circular processes and products that ensure not just business goals but also societal and environmental ones for future generations – see European Green Deal[1].

However, due to increased product mass customization and the proliferation of global manufacturing networks, scalable first-time right manufacturing is becoming also increasingly complex. Products are increasingly complex, feature an increasing amount of electronics or micro-features and are increasing composed of advanced (multi-) materials - becoming stronger, lighter and smarter whilst remaining at least as safe or secure as previous versions. While a clear benefit for the end customer, such process variation is the enemy of competitiveness and profitability. It causes waste and inefficiency, leads to high quality costs and manning levels, and results in late deliveries and poor traceability. Hence, with new product features, new manufacturing processes and techniques will emerge, which in turn will call for evolution of quality control and quality assurance procedures capable to effectively deal with the inherent variability of Factory 4.0 manufacturing processes, ultimately reducing scrap levels and raising productivity.

Traditional quality control models such as TQC (Total Quality Control), end-of-line SPC (Statistical Process Control) or in-line multi-stage quality control solutions are not fully capable to deal with the dynamism of such new manufacturing scenarios, calling for effective support to control smart and connected excellent and responsive production processes that combine speed, precision, quality and reliability with flexibility and agility. Manufacturing companies need to produce from very small lot-sizes to big volumes and there is a growing need for the ability to quickly scale up from small to big lot-sizes whilst retaining the required quality. Traditional quality methods are rigid and still do not deliver learning and adaptation capabilities. In such connected production environments to determine the root causes or sources of variance of bad quality in supply chains is usually more difficult because multiple parties are involved in the current global manufacturing environment.

2.2 Vision

QU4LITY does not call for abandoning well established and sound quality control methods, but on the contrary calls for extending such methods with a multi-dimensional, multi-stage and systematic framework for cognitive collaborative

[1] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

quality assurance throughout an entire supply chain; i.e. autonomous quality control framework.

QU4LITY is leveraging on the modular and composable digital enablers to support the implementation of a **closed loop (feedback and feedforward) quality assurance and improvement framework to unlock the key to predictable, productive manufacturing** within which to anticipate and naturally control quality variation in the factory, backed by traceable, supply chain and process centric information view and information flow support and with innovative technology, proven methods and expert human-in the-loop support for cognitive manufacturing. Artificial Intelligence in QU4LITY is used to learn complex behaviours as perception, self-reasoning or action from experience (data acquired and simulated) in federated and privacy-preserving distributed manufacturing environments, barrier that conventional Artificial Intelligence used to overcome only with expert knowledge. QU4LITY is proposing to spread intelligence across the various levels of the smart connected factory (field, edge, factory and cloud) with suitable networking, computing and analytic enablers (including visualization) that are able to meet volume, variety, velocity of decisions in the shop floor.

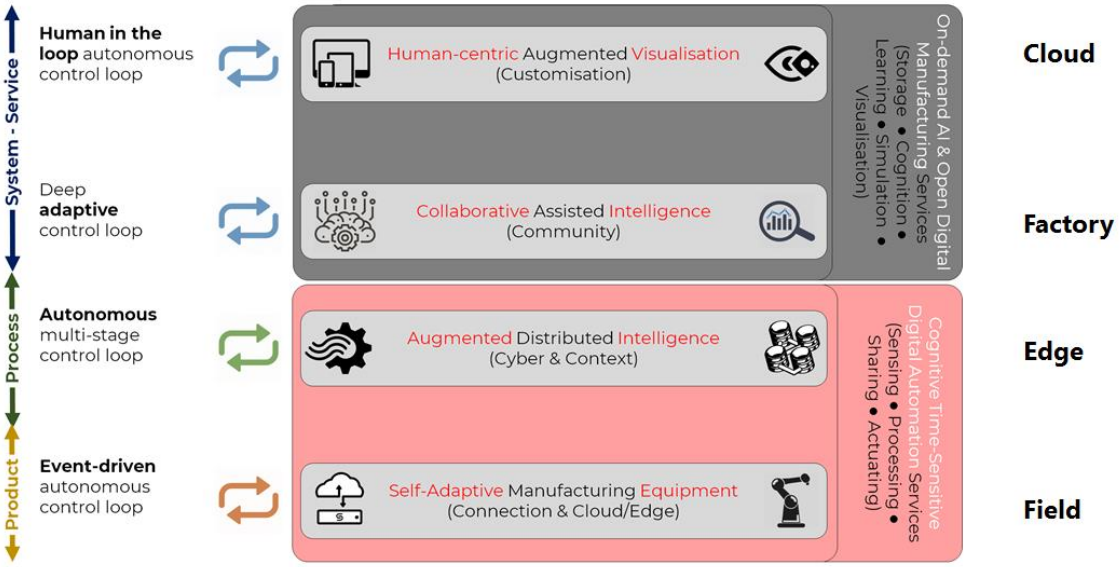
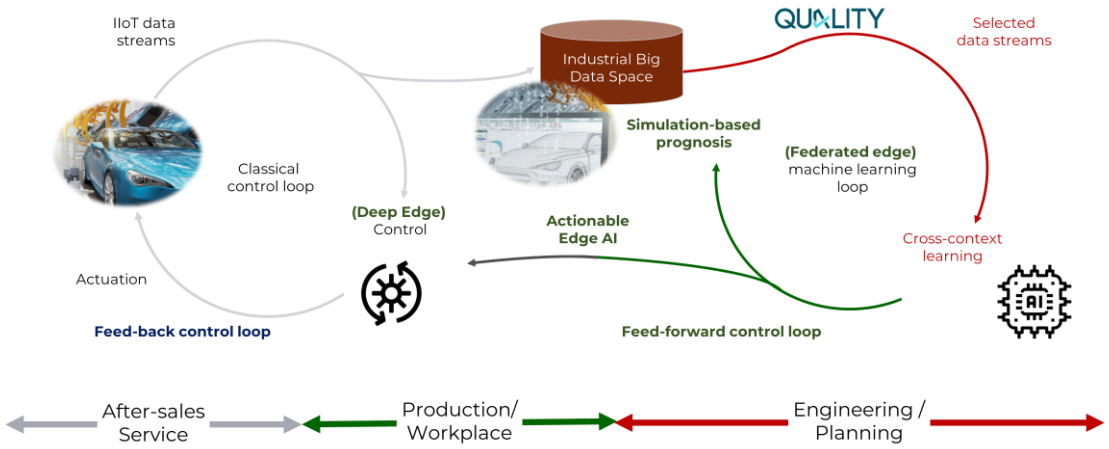


Figure 1 – QU4LITY AI distribution model and types of decision and control workflows,

QU4LITY brings quality control to new levels of automation, adaptation, actuation, cognition and collaboration. The goal is to get quick, comprehensive feedback about the whole production process, looking at both the production means, the part and all of the elements contributing to manufacturing in that final workpiece.



2.3 Types of Call and topics

According to the objectives denoted above, the main financing targets for additional third parties through the QU4LITY open calls will be:

2.3.1 TYPE A: New Autonomous Quality Pilot

Calls for new autonomous quality pilots . The calls will invite candidates to propose novel pilots that align to the QU4LITY autonomous quality concept, notably pilots that implement features and functionalities that are not available as part of the large-scale pilots of the consortium partners.

OBJECTIVES:

Pilots should be aligned to one or both of the following two objectives/themes:

- **Validate the QU4LITY concept, digital enablers/technologies in areas beyond the pilots of the consortium partners**: Proposers should present novel pilots in-line with the QU4LITY concept of Autonomous Quality, the QU4LITY Reference Architecture for (Digital) Zero Defect Manufacturing (ZDM).
- **Demonstrate end-to-end Autonomous quality in a cross-border supply Chain pilot**: Proposers should present digital quality management across a supply chain i.e. beyond a single industrial plant.

All pilots should contribute to:

- **Attracting SME Manufacturers and Solution Providers to the project's multi-side platform and ecosystem**: The proposed pilot solutions should be integrated in the QU4LITY marketplace and virtual innovation hub.

CONDITIONS:

- Proposal must address one of the topics listed in 2.3.2
- Proposed pilots should align to the QU4LITY Reference Architecture.

- Proposed pilots should use QU4LITY digital enablers/technologies listed in 2.3.3 such as Machine Learning Algorithms and Data Collection Platforms. Nevertheless, pilots may include technologies of the proposers as soon as they align to the QU4LITY ZDM architecture.
- Pilots and their technologies should be described and become integrated in the project's market platform and Virtualized Digital Innovation Hub, based on relevant specifications provided by the QU4LITY consortium. This does not imply or require any IP transfer to the QU4LITY consortium, but rather making accessible the pilot solution through the project's market platform.

2.3.2 Topics for applicants to the Type A call

QU4LITY Type A 1 targets the development of pilots that address advanced production process and systems which incorporate AI-based solution to implement the QU4LITY value chain. The open call aims at complementing existing pilots currently running in 14 industrial companies and to expand the scope of existing digital platforms and pilots will new functionalities and features. Applicants are required to apply one or more of the digital technologies mentioned in the topics, such as AI, robotics, edge computing and others to improve quality control in any of the points of the quality value chain.

QU4LITY is looking for SMEs to provide technologies and innovations that could help European manufacturing industry in a **faster recovery from COVID-19 pandemic** with a focus both on new digital solutions for zero defect manufacturing working practices taking advantage of Qu4LITY digital continuity enabling technologies and platforms. Solutions that help reduce defects, improve product quality and reduce ramp up times are particularly welcome.

QU4LITY is looking also for experiments supporting automation and autonomy in trusted and fair procurement and manufacturing of innovative treatment, testing, monitoring of progress and protecting people in the next phases of the COVID-19 pandemic. At the same time, QU4lity Open Call would like to contribute to the recovering of the European SMEs during the next months, providing support to and fostering the development of technologies to cover particularly new zero defect manufacturing strategies in the context of: manufacturing repurposing, cost reduction, good first time production, business to business collaboration, and, more in general, development of autonomous quality solutions as a service for key sectors of European activity such as Food, Logistics, Automotive, Aeronautics, Healthcare, Life Science.

- **Topic A1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product**

Pattern recognition is the process of recognizing patterns by using an Artificial Intelligence algorithm, it can be defined as the classification of data based on

knowledge already acquired or on statistical information extracted from patterns or their representation. Pattern recognition is able to detect arrangements of characteristics or data that provide value information about a given system or data set.

Applicants to topic Q1 are required to design, implement and experiment data driven algorithms for pattern recognition related to Zero Defect Manufacturing for identification of defects, proactive quality control, reverse engineering for high performance products. The aim is to demonstrate the potential of this technology to improve the quality control in any of the critical point of their quality value chain and to analyse its connection and impact on the whole manufacturing process.

- **Topic A2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing**

Partnering with machines is integral to the future of how we live and work. A new era of intelligent systems will be characterized by trust and understanding between humans and machine. This collaboration can provide many benefits. Machines or robot can assemble and consider more data points than humans, can incorporate and often provide a less biased support to decision and improve the productivity.

Applicants to topic Q2 are required to demonstrate the potential of the human machine collaboration for quality control in manufacturing, developing autonomous learning or decision-making algorithms to improve the quality in any of the critical point of their quality value chain and analyse its connection and impact on the whole manufacturing process.

- **Topic A3: Integration of Data driven inline Autonomous Quality in solutions for Zero Defect Manufacturing**

Traditional quality control models such as Total Quality Control, end-of-line Statistical process control or in-line multi-stage quality control solutions are not fully capable to deal with the dynamism of the Smart Factory Scenario scenarios, calling for effective support to control smart and connected production processes.

Data Driven inline Autonomous Quality solutions can deliver learning and adaptation capabilities to manufacturing companies that need to quickly scale up from small to big lot-sizes, or between different parts whilst retaining the required quality.

Applicants to topic Q3 are required to demonstrate the potential of the Data driven inline Autonomous Quality solution in highly flexible manufacturing scenarios to cover the whole quality value chain.

- **Topic A4: Edge and/or real time solutions for Zero defect Manufacturing**

Edge is how is known the computing infrastructure that exists close to the sources of data, such as industrial machines, industrial controllers e.g. SCADA systems, and databases aggregating data from a variety of equipment and sensors.

Applicants to topic Q4 are required to demonstrate the potential of the Data Driven edge computing enabled applications based on e.g. analytics, machine learning etc. to improve the quality in any of the critical point of their quality value chain and analyse its connection and impact on the whole manufacturing process.

- **Topic A5: Ensuring Quality Management in supply chain trough blockchain based technologies.**

Quality assurance in complex production systems is a difficult problem to tackle, given the number of parties involved in the sourcing of raw materials and parts and the extreme customization of products. Moreover, Zero Defect Manufacturing goals require that Autonomous Quality solutions are extended to the entire supply chain, possibly including logistics. This objective poses unique challenges, as it implies that some suppliers, although being autonomous businesses, are fully integrated into the control loop. Blockchain technology can help by providing a common, company-neutral data exchange infrastructure where key information can travel between all stakeholders of a process with top guarantees of provenance, integrity and transparency.

Applicants to topic Q5 are required to develop novel distributed applications to control the quality and traceability of materials and products along the supply chain and analyse their connections and impact on the whole manufacturing process.

Reference Documents specific for the topic Q5:

  - D3.11 Permissioned Blockchain for ZDM (Version 1)

- **Topic A6 Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes**

Mass customization as a strategy that allows the production of small lots (even as small as lot size one) is becoming more and more popular and is one of the main implementations of the concept of Industry 4.0. Mass customized products, though are complex, feature a significant amount of electronics or micro-features and are composed of advanced (multi-) materials - becoming stronger, lighter and smarter whilst remaining at least as safe or secure as previous versions.

Applicants to topic Q6 are required to develop novel applications for a Zero-Defect Manufacturing through the integration of Autonomous Quality (AQ) Control Loops into Mass Customization and Lot Size One processes, using data driven technologies.

2.3.3 Qu4lity Digital enablers

Pilots proposed by applicants must address at least one of the topics listed in the section 2.3.2 and make use of one of the digital enablers listed in the following table.

Enabler	Description	IP Owner / Partner
INTRASOFT DDA Platform - QARMA ML Algorithms	Platform for Data Collection and Analytics in Industrial Environments	INTRASOFT
RUL Prediction Solution	Deep Learning Systems for Remaining Useful Life Prediction	ATLANTIS
DSS and ZDM Strategies	Manages zero-defect processes, by filtering out false alarms originated from predictive analytics and deciding mitigation actions to cope with defects	ATLANTIS
DLT Service: Quality Clearing House	Decentralized Workflow Management for Quality Management and ZDM scenarios in the supply chain	ENG
DLT Service: Decentralized Analytics Engine Configuration	Secure distributed processing of data analytics directives, represented via appropriate manifests in an edge computing environment	ENG
Secure Analytics Results Publishing	Enables distributed edge computing nodes to publish and share their analytics results in a decentralized fashion, towards creating a common analytics dataset	ENG

Table 1 - QU4LITY Digital Enablers to be Packaged and Distributed

RELEVANT DOCUMENTS:

- QU4LITY Deliverable D2.11 Reference Architecture and Blueprints (Version 1)
- QU4LITY Deliverable D3.5 Big Data and Analytics Infrastructure (Version 1)
- QU4LITY DeliverableD3.13 Library of Integrated, Interoperable Digital Enablers (Version 1)
- QU4LITY D8.1 Market platform and Virtualized Digital Innovation Hub

Specific to topic Q5:

- QU4LITY Deliverable D3.11 Permissioned Blockchain for ZDM (Version 1)

ALLOCATED BUDGET: €290.000 for the funding of 4 proposals (max budget: 72.500 € for proposal)

Each proposal must be submitted by a single applicant, consortia are not allowed.

2.3.4 TYPE B: Expansion of QU4LITY pilot systems

The objective of the TYPE B call is to expand the scope of existing digital platforms and pilots with new functionalities and features and address one or more challenges posed by Qu4lity pilots. The SMEs selected for funding will be given the opportunity to validate their solutions in the project's experimental infrastructures and testbeds.

OBJECTIVES:

Proposed solutions should align to one or both of the following two objectives/themes:

- **Validate the expandability of the QU4LITY digital platforms**: Proposers should propose and implement extensions to the QU4LITY technologies, notably to the QU4LITY platforms used in the project's pilots.
- **Complement existing pilots and platforms with added-value features and functionalities**: Proposer should propose extensions to existing pilot systems to address specific challenges posed by the pilot

Solutions should contribute to:

- **Expanding the QU4LITY ecosystem and broadening the solutions QU4LITY portfolio in the market platform**: Proposers should describe their solution and how it will be made available through the QU4LITY market platform and Virtualized Innovation Hub.

CONDITIONS:

- Solutions should align to the QU4LITY Reference Architecture.
- Solutions must addressing challenges raised by the Qu4lity extend existing QU4LITY Digital Platform or Pilots addressing challenges raised by the

ALLOCATED BUDGET: € 75,000 for the funding of 1 proposal (max budget: 75.000 € for proposal)

Each proposal must be submitted by a single applicant, consortia are not allowed.

2.3.5 Challenge for applicants to the Type B call

- **Topic B1: Dryer Factory Holistic Quality Platform (Whirlpool)**

The pilot carried out by Whirlpool will integrate the QU4LITY digital enablers and platforms and the AQ (Autonomous Quality) control loops. The main innovation will be represented by the introduction in production of MPFQ (Material Process Function Quality) model fused with AQ control loops: Functional Integration and Correlation between Material, Quality, Process and Appliance Functions. This innovative way to control quality and model data inherent to quality will be the fundamental approach that will lead to the vision of holistic Quality system. Also, it will deploy AQ reference implementations to address unresolved problems in the vertical integration of data management (from data gathering to visualization and decision making), enabling a holistic vision to be achieved.

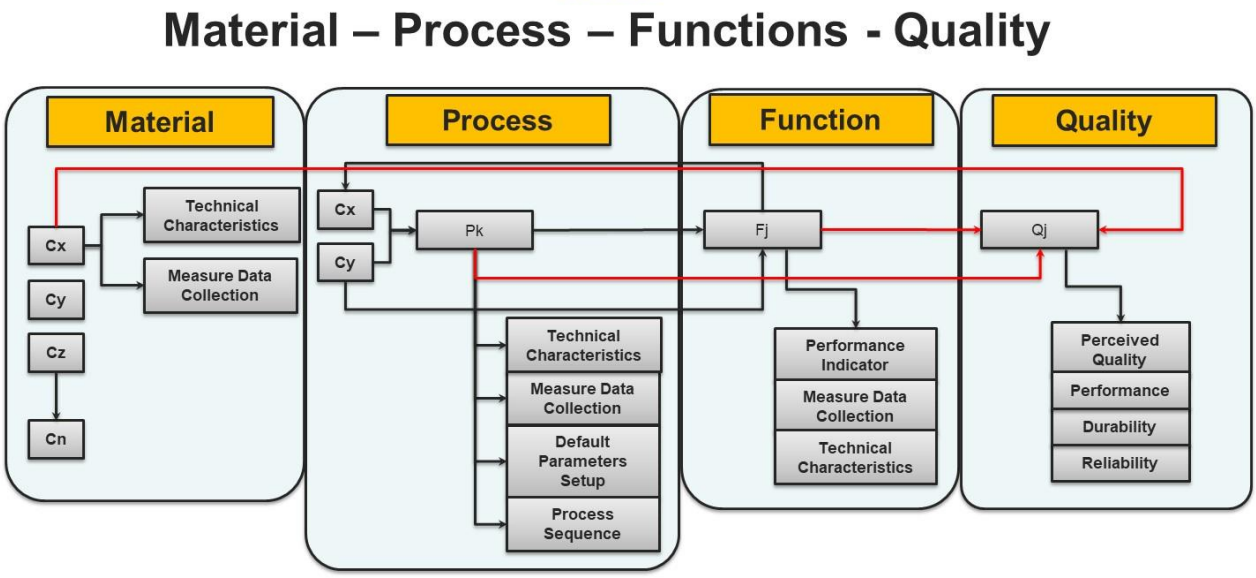
The White Good use case in QU4LITY is based on a complete production line for Dishwashing Machines and has the objectives of developing a Quality system characterized by these results:

- Common and holistic semantic model able to represent concepts at different stages of product lifecycle.
- Standard methods and tool to gather, store and share data, flexible and user-friendly.
- Analytical tools and a comprehensive way to share results to different management roles
- Addressing, at different management levels, the solution of appliance and production equipment issues, based on the analysis of the data coming from the production and testing equipment
- Automatic re-setting of the testing and production equipment parameters in order to compensate deviation in production quality

The basis of this holistic view is the semantic model which enable to create a cause – effect correlation between components, process and customer quality perception through the mediation of the physical interrelation occurring between the entities, namely the set of functions.

The basic syntax of this model, named MPFQ (Material, Process, Function and Quality) is represented by this diagram:

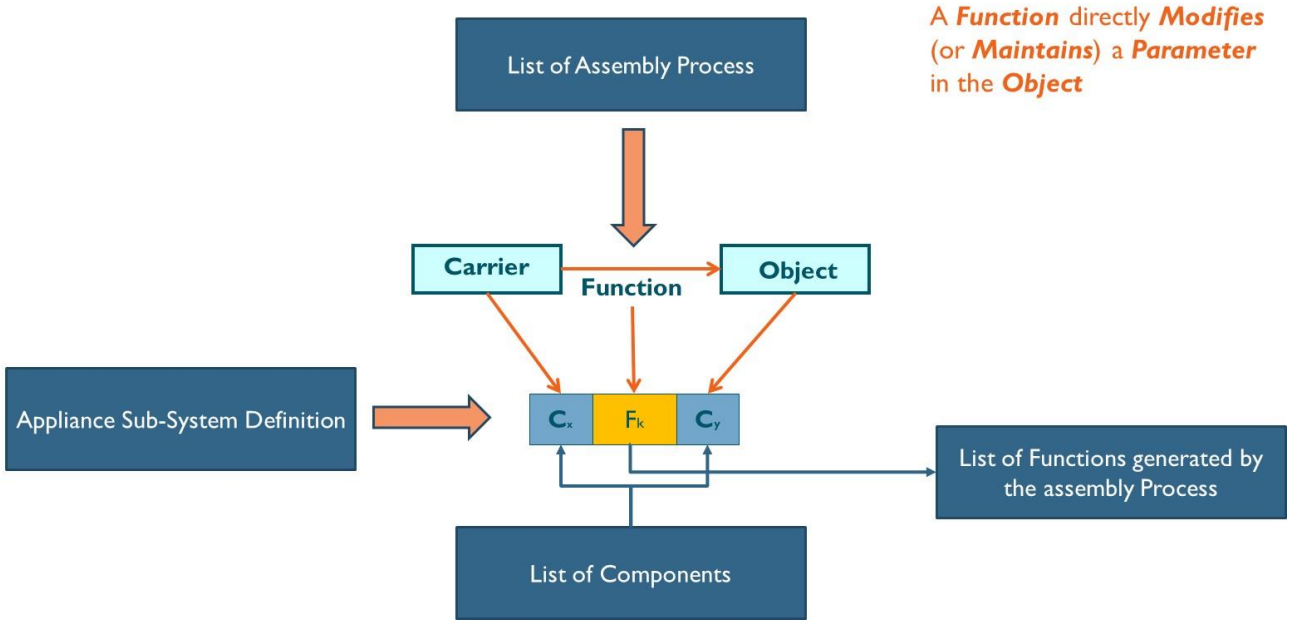
The MPFQ Model is the integration in term of data and methodology of four different entities



This model enable the possibility to correlate data gathered in the production (e.g results of component gauge systems, process sensors, production data, human generated data) with effective or simulated effect on Quality of the product.

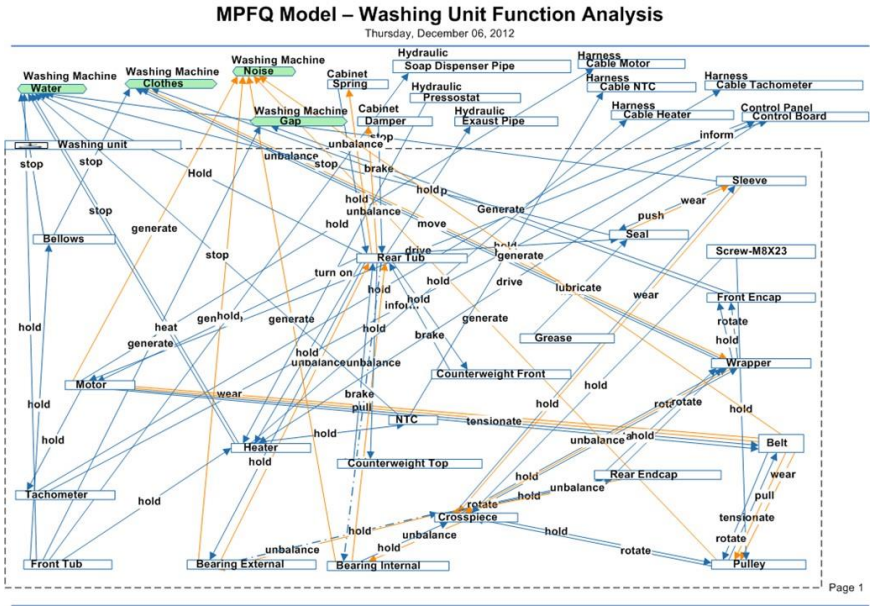
<u>The challenge faced by the pilot that should be addressed by the applicant</u> is related with the absence on the market of <u>a graphical editor</u> tool allowing industrial engineers to:

- Edit the functional model of a system of components and store the result of the graph in a machine readable format. The graph consist in two type of elements: materials and external entities (represented by rectangles and hexagons) and functions, represented by named arrows.



- Edit the Process Map of a production system using IDEF-0 or other suitable standard representations
- Associate each Function mapped with a specific process step
- Define a set of Quality performances and associate them to a set of components, functions, process.

In the following picture a typical representation of a complex Functional model is reported:


MPFQ Model – Washing Unit Function Analysis
Thursday, December 06, 2012
Washing Machine Water
Washing Machine Clothes
Washing Machine Noise
Cabinet Spring
Hydraulic Soap Dispenser Pipe
Hydraulic Pressostat
Harness Cable Motor
Harness Cable NTC
Harness Cable Tachometer
Harness Cable Heater
Control Panel Control Board
Washing Machine Gap
Cabinet Damper
Hydraulic Exaust Pipe
Washing unit
Sleeve
Bellows
Seal
Screw-M8X23
Rear Tub
Front Encap
Grease
Wrapper
Motor
Counterweight Front
NTC
Heater
Belt
Counterweight Top
Rear Endcap
Tachometer
Crosspiece
Front Tub
Bearing External
Bearing Internal
Pulley
Page 1

3 Open Call Information

The announcement has been published on the portal of the European Commission and contains the main details of the topic.

Project Acronym: QU4LITY

Project full name: Digital Reality in Zero Defect Manufacturing

Grant agreement number: 825030

Call Identifier: QU4LITY OC1

Call title: Call for Proposals for pilots and digital platform in the field of Zero Defect Manufacturing (ZDM) by SMEs and MidCaps

Publication Date: April 15th, 2020

Open for submission: June 8th, 2020

Deadline: August 7th, 2020

Expected duration of the activities: 9 Months

Total budget: € 365,000

Maximum funding request per proposal Type A: € 72,500

Maximum funding request per proposal Type B: € 75,000

Project web address: https://qu4lity-project.eu/

Submission site: https://qu4lity.ems-innovalia.org/

Mail: qu4lity_opencall@innovalia.org

The submission site will be available from June 8th

A contact tool is available also inside the submission site.

4 Submission of proposals

General information

Submission deadline: All submissions must be made by August 7th at 17.00 Brussels local time

Electronic submission: Proposal submission is exclusively in electronic form using the proposal submission tool accessible via the QU4LITY open call web-site: https://qu4lity.ems-innovalia.org/

The central component of proposal submission is the uploading of a PDF-document (whose size must not exceed 5.0 MB) compliant with the instructions on the proposal structure given below.

Proposal format and structure: Proposals must be submitted in English. The main section of the proposal must not exceed 10 pages in length (with text no smaller than 11-point Times New Roman font). Thus, with the inclusion of the cover page and administrative pages (discussed below), the maximum page count is 13 pages. **Proposals will be truncated to this page count and the independent expert evaluators will only be provided with the truncated version.**

The structure of the proposal (and indicative length per section) should be as follows:

1. Summary (0.5 pages)
2. Concept and innovation (2,5 pages)
3. Industrial relevance, potential impact and exploitation plans (3 pages)
4. Description of the workplan (1 page)
5. Background and qualification (1 page)
6. Justification of costs and resources (1 page)

As indicated above, the overall length of the above 5 sections must not exceed 10 pages.

In addition to the 10-page proposal description, a cover page and 2 pages of administrative data for statistics analysis, including, if already available, the Participant Identification Code (PIC) issued by the European Commission (http://ec.europa.eu/research/participants/portal/desktop/en/organisations/register.html).

5 Proposal Evaluation and selection

5.1 Eligibility criteria

The call for third-parties support will be addressed to SMEs and Mid-Caps, as defined in the EU law: (EC recommendation 2003/361/EC as published in the Official Journal of the European Union L 124, p. 36 of 20 May 2003). All SMEs and MidCaps eligible for Horizon 2020 will be eligible to submit proposals for the open calls, except for the consortium's partners and other parties that may have conflicts of interest.

The call for third-part support will be also open to SMEs and MidCaps outside the EU, which will however have to bear their project costs.

The criteria for financial support will include:

A. The Innovation of the application (i.e. in terms of its Scientific and Technological Excellence) to be implemented/integrated based on QU4LITY,
B. Its impact on the QU4LITY ecosystem and its contribution to meeting QU4LITY's goals and objectives. Alignment to the Conditions and Objectives outlined above in Section 2 will be considered as part of this Criterion.
C. The ability of the SME and MidCaps to implement the experiments and/or integrate its new services, based on the proposer's team and company profile, background infrastructures, experience, but also based on its proposed implementation plan.

The financial support will be given upon presentation of specific deliverables by the selected partners. Each proposal must be submitted by a single applicant, consortia are not allowed

5.2 Evaluation criteria

The ranking of selected projects will be created assessing the following criteria:

- **Excellence and innovation**: The Innovation of the application (i.e. in terms of its Scientific and Technological Excellence) to be implemented/integrated based on QU4LITY-

- **Impact including industrial relevance and business strategy**: Its impact on the QU4LITY ecosystem and its contribution to meeting QU4LITY's goals and objectives.

- **Implementation and deployment of resources**: The ability of the proposer to implement the experiments and/or integrate its new services, on the basis of the team and company profile, background infrastructures, experience, but also based on its proposed implementation plan.

Evaluation scores will be awarded for each of the criteria. Each criterion will be scored out of 5 and decimal numbers can be given. The second criterion, Impact and Industrial relevance, will have a threshold of 4, while for the first and last a threshold of 3 will apply. The overall threshold, applying to the sum of the four individual scores, will be 15. If two or more proposals are tied with the same overall score, priority will be given as illustrated in Table 2 below

Criterion	Priority if ex aequo	Threshold
Excellence and innovation	2	3/5
Impact including industrial relevance and business strategy	1	4/5
Implementation and deployment of resources	3	3/5

Table 2: Ranking in case of equal scoring and thresholds

5.3 Evaluation process

External experts who will be appointed and approved by the QU4LITY consortium will be in charge of selecting the third parties that will develop new solutions over the QU4LITY software and pilot infrastructure.
Each proposal will be assessed according to the three criteria presented in Section 5.2, through the usual 0 – 5 score scales for H2020:

- 0: The proposal fails to address the criterion under examination or cannot be judged due to missing or incomplete information;

- 1 (Poor): The criterion is addressed in an inadequate manner, or there are serious inherent weaknesses;

- 2 (Fair): While the proposal broadly addresses the criterion, there are significant weaknesses;

- 3 Good The proposal addresses the criterion well, although improvements would be necessary;

- 4 (Very good): The proposal addresses the criterion very well, although certain improvements are still possible;

- 5 (Excellent): The proposal successfully addresses all relevant aspects of the criterion in question.

The final approval of the selected third parties to receive financing will be done by the PCT, considering the best fit to the specific project objectives and possible conflict of interest issues.

6 Funding and reporting

6.1 Eligible costs

Eligible costs consist of

- Personnel Costs
- Equipment Costs
- Travel expenses
- Software licenses
- Subcontracting
- Indirect cost (25% of direct costs)

The funding of Third Parties must follow the same principles as used for existing project beneficiaries of Qu4liyt, which receives European Commission funding as an "Innovation Action". Thus, Third Parties will receive 70% funding of eligible costs arising.

6.2 Reporting and deliverables

The administrative tasks for the funded third parties including cost and activity reporting obligations and related templates will be provided during the negotiation and contracting phase. Qu4lity will apply the pilot maturity levels methodology in the implementation of the selected projects.
Funded third parties will be requested to submit several deliverables to demonstrate the reached maturity level according to Table 3.

Status of development	Timing	TYPE A Deliverables	TYPE B Deliverables
Pilot Maturity Level 1	M2	• Proof of concept • Alignment with the reference architecture • Alignment with the Qu4lity Autonomous Quality concept • M2 cost statement	• Proof of concept • Alignment with the Qu4lity Autonomous Quality concept • Integration strategy in the reference pilot • M2 cost statement
Pilot Maturity Level 2	M7	• Complete development of the pilot • Demo and dissemination material (video, ppt) • Participation to demo event organized by the consortium	• Complete development and integration in the Q of the pilot • Demo and dissemination material (video, ppt) • Participation to demo event organized by the consortium
Pilot Maturity Level 3	M9	• Business model • Integration in the Quality marketplace • Business Plan • M9 cost statement	• Business model • Integration in the Quality marketplace • Business Plan • M9 report

Table 3 - Pilots Maturity level

o

6.3 Funding Scheme

The following payment scheme will apply:

- Max 20% of the budget, according to cost statement, at M2, once the third party has produced all the relevant documentation specified in the contract, in particular cost statements for the period and deliverables, as indicated in Section 6.2 and the contractor (Innovalia), after discussion with the consortium, has accepted them
- Max 60% of the budget, according to cost statement, at the end of the project on M9, once the third party has produced all the relevant documentation specified in the contract, in particular cost statements, deliverables and material for dissemination, as indicated in Section 6.2 and the contractor (Innovalia), after discussion with the consortium, has accepted them. Moreover, the participation to an event for dissemination purpose is mandatory.
- Max 20% of the budget, according to cost statement, at the final installation approval of the pilots' outcomes by the Commission

Partners

5 Annex II: Digital enablers

Title / Acronym of Digital Enabler

Quality Clearing House / QCH.

Value/Functionality

QCH enables a decentralized workflow for quality management in supply chain scenarios. Deployed as a *smart contract* on the Hyperledger Fabric blockchain platform, it provides a common system of record for a manufacturing ecosystem where actors need to continuously assess the quality of raw material, parts and final products and match the results against contractual standards that may change frequently. Thanks to distributed ledger technology, QCH records are secure and trustworthy: they are timestamped, immutable and non-repudiable. Data storage and business logic are replicated on all the nodes of the system, which are operated equally by all participants, so that no single "owner" of the system exists who may introduce bias in the process

How it can be accessed and used by third-parties

For experimentation in the scope of the QU4LITY project, the QCH smart contract is deployed on a Hyperledger Fabric instance which is operated by ENG and is accessible – to authorized users only – from the public Internet. A Java-based client library, packaged as a JAR file, is also provided as part of the enabler's distribution. The library exposes to client applications an in-process API, which is actually a higher-level abstraction of the smart contract's API. All platform-specific details, including those related to security (user identification, authentication and authorization), are hidden from the application.

Contact Point for more information

Mauro Isaja [ENG] – mauro.isaja@eng.it

Possible Use in an Open Call Experiment

The supply chain processes supported by QCH follow a simple pattern, the workflow of which is described below. To exemplify the pattern and for the sake of simplicity, we have identified distinct "actors" playing the three roles embodied in the system (Quality Master, Provider, Quality Assessor); however, in real-world supply chain processes it is likely that multiple organizations will play the Provider role, and/or that one single organization will play the remaining ones.

Records

All records have their own unique identifier, which is used internally for cross-reference, and are owned by the party that creates them.

- Quality Assessment Data Model (QADM): a structured digital document that defines the standard of quality that applies to a given material, part or product, as stipulated by a commercial agreement (which is out of this scope). The standard is expressed in terms of a list of measurements, each consisting of a qualitative definition[1] and a quantitative range. One QADM document may exist for the entire duration of a contract, or new versions may be created that override previous ones in order to follow along the evolution of quality requirements.
- Shipping Unit Manifest (SUM): a digital record that identifies a shipped batch of materials, parts or products as subject to a given quality agreement. It consists of a pointer to an existing QADM and of a list of IDs, each associated to a physical item in the batch.
- Quality Assessment (QA): a digital record that reports the quality measurements taken on a received batch of materials, parts or products, along the guidelines of their agreed standard. It consists of pointers to an existing QADM and SUM, plus the actual values of all the measurements taken. Depending on the quality agreement in place, measurements may be reported per-batch (average values) or per-item.

Roles

- Quality Master: typically, it's the manufacturing company that manages the supply chain. It creates the QADM document(s).
- Provider: it's always a provider of the supply chain (seller of goods). It creates SUM records.
- Quality Assessor: it is responsible of measuring the quality parameters on physical items with respect to the standard. It may be the same entity as the Quality Master or a different one – i.e., a third party in charge of independent assessment. In the latter case, it should be trusted by all the involved parties. The Quality Assessor creates QA reports.

Actors in the example

- Factory A: plays the role of Quality Master.
- Factory B: plays the role of Producer.
- Company C: plays the role of Quality Assessor.

[1] The vocabulary used to identify measurements must be in common between all parties involved: the meaning of each measurement declaration, which includes not only the "what" but also the "how" and possibly the "when", must be unambiguous for everyone. To this goal, a formal ontology may be defined.

Example workflow

1. When a commercial agreement is first defined, Factory A defines the quality standard and creates a new QADM, which is published on the QCH. Factory A also sets up and configures its quality assessment process and tools in collaboration with Company C, which provides the metrology equipment that is deployed on Factory A's premises.
2. Factory B prepares a batch of goods under the aforementioned agreement. The physical items in the batch are tagged with individual IDs. When the batch is shipped, Factory B publishes a new SUM record on the QHC that points to the reference QADM and lists all the IDs contained in the shipment.
3. Factory A receives the shipment. As the individual items herein contained are unloaded, they are sent to a quality assessment facility where the equipment provided by Company C is in use. The metrology tool read the tag, identifies the item and execute the appropriate measurements.
4. When the shipment has been entirely processed, a QA report is generated by the metrology tool and published on the QCH on behalf of Company C2.
5. The process can now iterate any number of times, starting from point #2.

When payment to Factory B is due, Factory A will apply any penalties and discounts defined in the agreement for missed quality targets documented in the QCH.

[2] The tool digitally signs the QA record with a private key that matches a public key that is known to belong to Company C.

Moving Towards ZDM with Data Mining Methods

Value/Functionality of Enabler

We propose a digital enabler for Predictive Maintenance (PdM) based on the use of Quantitative Association Rule Mining (QARM) with the added benefit of the automatic detection on the fly of those sensors whose readings are most important for the accurate estimation of Remaining Useful Life (RUL) measured in parts to be made before a breakage occurs. The importance of this functionality has already been established in the Jaguar Land-Rover Use-Case of the PROPHESY [1] project that is coming to an end in September 2020, as well as in the QU4LITY [2] project that is still in its second year. The CHIST-ERA FIREMAN project [3] (in its 1st year of progress) has also showed the value of this approach in detecting faults and other rare events in the manufacturing process that can be of great importance in preventing defects in manufactured final products.

The data mining methods employed for the above task are the QARMA and R4RE family of algorithms [4-8] that allow mining of such rules in multi-dimensional datasets where the features in the dataset are in general numerical vectors of varying lengths per feature. QARMA operates in parallel using as many cores as there are available in a cluster of machines that can have hundreds of machines connected to it.

Possible Use in an Open Call Experiment

The enabler will work as a two step process. An outside manufacturing company must provide a dataset containing sensor measurements from one or more of its production machines and/or tools configured on those machines along with information about tool breakages and parts made since last breakage using a particular tool. This will comprise the input of the enabler. The dataset can be arbitrarily large, but cannot be arbitrarily small. A few thousand datapoints are needed for the models to be properly trained. Further, sparse datasets (few non-empty data attributes per instance) are likely better suited to the enabler than fully dense datasets (that are usually artificially created.) The QARMA family of algorithms will then run and the output predictions of the overall model will be made available via a REST API described immediately below.

Accessing the Enabler

A REST API on an INTRASOFT Intl URL will be defined once the open call experiment is approved.

Contact Point

Dr. Ioannis T. Christou, Ioannis.Christou@intrasoft-intl.com

Dr. John Soldatos, Ioannis.Soldatos@intrasoft-intl.com

Links

[1] https://prophesy.eu/

[2] https://qu4lity-project.eu/

[3] https://fireman-project.eu/

[4] I.T. Christou, E. Amolochitis, Z.-H. Tan, "A Parallel/Distributed Algorithmic Framework for Mining All Quantitative Association Rules", *arXiv preprint arXiv:1804.06764,* Apr. 2018
[5] I.T. Christou, "Avoiding the Hay for the Needle in the Stack: Online Rule Pruning in Rare Events Detection", *IEEE Intl. Symp. On Wireless Communication Systems, Special Session, IoT in Energy Systems & Industrial Environments,* Oulu, Finland, Aug. 27-30, 2019.
[6] I.T. Christou, N. Kefalakis, A. Zalonis, J. Soldatos, R. Bruchler, "End-to-End Industrial IoT Platform for Actionable Predictive Maintenance*", 4th IFAC Workshop on Advanced Maintenance Engineering, Services and Technologies*, Cambridge, UK, Sep. 10-11, 2020
[7] I.T. Christou, N. Kefalakis, A. Zalonis, J. Soldatos, "Predictive and Explainable Machine Learning for Industrial Internet of Things Applications*", IEEE Distributed Computing on Sensor Systems Conf., Workshop on IoT Applications and Industry 4.0,* June 15-17, 2020.
[8] J. Soldatos and Ioannis T. Christou, "IoT Analytics: From Data Collection to Deployment and Operationalization", *in J. Soldatos (ed.) "Building Blocks for IoT Analytics"*, River Publishers, 2016.

Experiment: Data driven Remaining Useful Life (RUL) evaluation for Zero Defect Manufacturing for high performance and predictive maintenance

What is the Remaining Useful Life?

The Remaining Useful Life (RUL) metric is defined as the length from the current time to the end of the useful life of an asset. However, the definition of the end of life of an asset might be literal meaning when the asset is damaged, or it might refer to the violation of the standard quality of the end product (i.e. a point at which produced parts start to have lower quality than that expected). No matter the selected definition, RUL analysis provides valuable information regarding the deterioration rate of the equipment and enables the informed planning of maintenance activities, minimizes negative impact on productivity and contributes to the avoidance of any quality issues in the manufacturing plant.

What does the proposed solution do?

An advanced data-driven approach for RUL estimation of critical components based on deep learning (i.e. Long Short-Term Memory (LSTM) algorithm) and Complex Event processing (CEP) is available from QU4LITY. The approach relies on historical data for the training of the LSTM models and on real-time data for the online evaluation of the RUL. The added value of the selected algorithm is based on its inherited capability to identify relationships both among various sensor measurements and from different points of time; thus, addressing the challenge of long-term dependencies. The CEP technique is utilised to identify product cycles to train models capable of reporting reliable time-independent results.

In simple words, the solution estimates the RUL of the equipment until the next hardware or quality failure, giving the company that uses it time to schedule stops, avoid major failures and reduce downtime.

How can you use it?

Applicants to this experiment are required to demonstrate the potential of the abovementioned data driven method for RUL estimation to ensure improved quality of produced parts as well as quality in any other critical points of the value chain. Provision of access in historical sensor measurements and failure logs from the shop-floor is expected.

In short, this solution is suitable for an applicant (e.g. a manufacturing company). If they have:

1. Real-time sensor data
2. Historical data
3. Log files with previous hardware or quality faults (Fault and timestamp), in order to train the algorithms (link sensorial data with faults).
4. Correlation between faults and signals

The RUL tool is provided as a dockerized solution, which can be deployed either on premises or on a remote location. Default parametrisations for model training will be provided, however custom solutions can be built through mentoring. For the training process historical sensorial data along with maintenance

and/or quality logs need to be available for analysis. A generic approach for data fetching is offered through the tool, however custom data transfer bridges can be developed with any available data handling system install on premises, in order to provide streams of data to the tool for the online evaluation of the RUL.

What benefits can you expect?

Knowing when the next failure is predicted to occur with an adequate level of uncertainty can allow optimisation of production schedule and maintenance schedule. Avoiding failures and breakdowns is of outmost importance, as these incidents do not only affect the availability of equipment and production lines, but they affect the health and deterioration status of the machines and they are more costly than preventive actions. Areas you can expect benefits in:

- Reduction of operation and maintenance costs
- Increase of productivity
- Increase of Remaining Useful Life
- Reduction of downtime
- Increase of MTBF (Mean Time Between Failures)
- Reduction of MTTR (Mean Time To Repair)

Contact Point:

Ifegeneia Metaxa (metaxa@abe.gr)

6 Annex III: Webinar presentation

QU4LITY

DIGITAL MANUFACTURING PLATFORMS
FOR CONNECTED SMART FACTORIES

Digital Reality in Zero Defect Manufacturing

Open Call Webinar

23rd of June 2020

Qu4lity Consortium

www.QU4LITY-project.eu

Co-funded by the Horizon 2020 Programme of the European Union. Grant agreement ID: 825030

Agenda

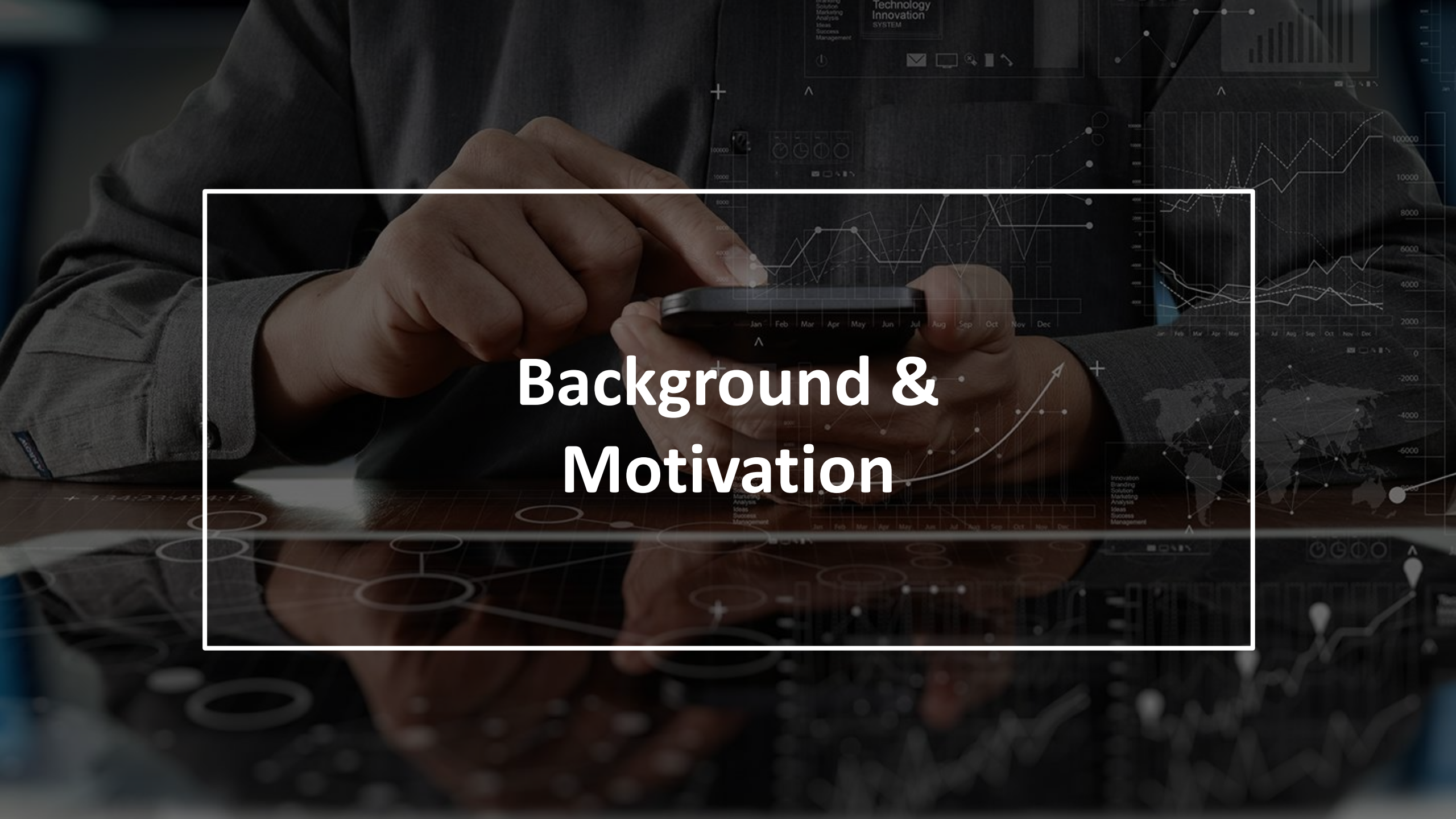
1. Introduction to the Qu4lity project **(J. Rodriguez -** *ATOS***)**
2. Introduction to the call (**C. Polcaro -** *INNO***)**
3. Technical and business aspects
   - Qu4lity Reference Architecture **(A. Marguglio -** *Eng***)**
   - Type A call: Qu4lity Enablers **(J. Soldatos –** *Intrasoft***; I. Metaxa –** *Atlantis;* **M. Isaja –** *Eng***;)**
   - Type B call: Challenge **(P. Petrali, C. Turrin -** *Whirlpool***)**
   - Qu4lity Market platform **(J. Soldatos -** *Intrasoft***)**
4. Questions and answers

Introduction to the Qu4lity project

Jorge Rodriguez - ATOS

QU4LITY in a Nutshell

Project No:	825030
Project Full Name:	Autonomous Quality Platform for Cognitive Zero-defect ManUfacturing 4.0 Processes through DigitaL ContInuity in the ConnecTed FactorY of the Future (QU4LITY)
Duration:	39 months
Start date:	January 1st 2019
Partnership:	45 partners, 13 countries
Strategic Objective:	DT-ICT-07 (Digital Manufacturing Platforms for Connected Smart Factories)
Total Eligible Cost:	19 520 535.28 EURO
EC Contribution:	15 998 180.54 EURO (1 M€ open call)



Background & Motivation

50%

Production ends as scrap

Zero Defect Manufacturing and Industry 4.0

- Costly & time consuming deployment.
- Lack of digital continuity.
- Poor SME engagement.

Enable a radical shift from state of the art production quality methods to the disruptive **Autonomous Quality (AQ)** concept (End-to-End Intelligence & Automation)

Enable manufacturers and solution providers (including SMEs) to adopt **innovative Cognitive Manufacturing solutions for ZDM**.


Key
Outcomes

Digital enhancements to state of the art ZDM equipment and processes

Reference architecture and blueprints for integrating AQ in the factory

Enable the composition of **diverse digital manufacturing platforms** in cognitive ZDM systems that enable AQ

Pan-European innovation ecosystem that will boost the development, validation and wider uptake of ZDM solutions based on the AQ paradigm


ZDM
Pilots

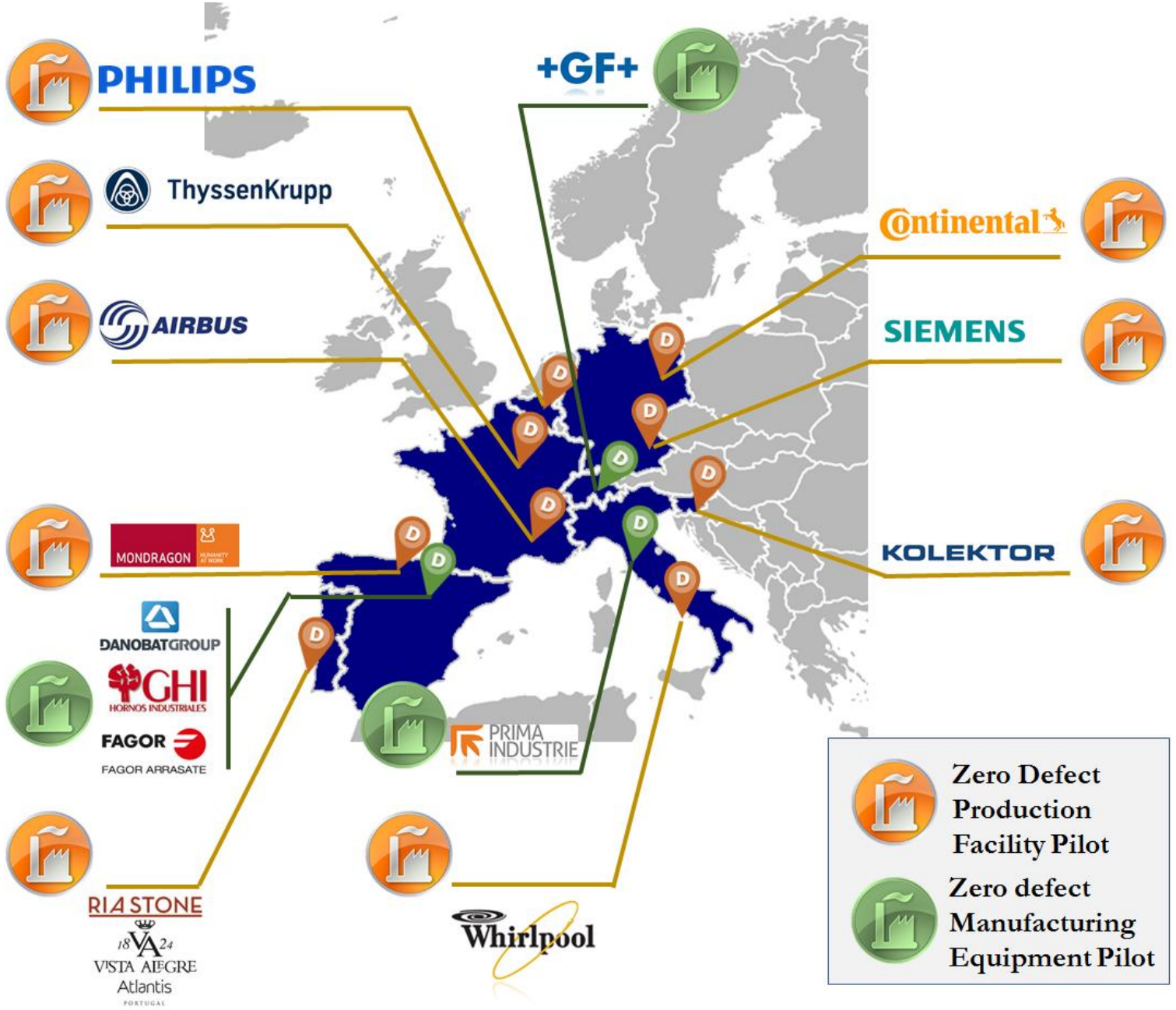
FACTORIES 4.0

9 ZDM Pilot Factories

Automotive & electronics (4)
White Goods & Appliances (2)
Aero (1)
Railway (1)
Ceramics (1)

5 ZDM Equipment Pilots

Milling machines
AGVs
Stamping Press
Additive Manufacturing/Laser Systems
Industrial Furnace



Experimentation Facilities and Testbeds

TNO Regions of Smart Factories (ROSF) Field Lab

FhG-IPA Arena 2036

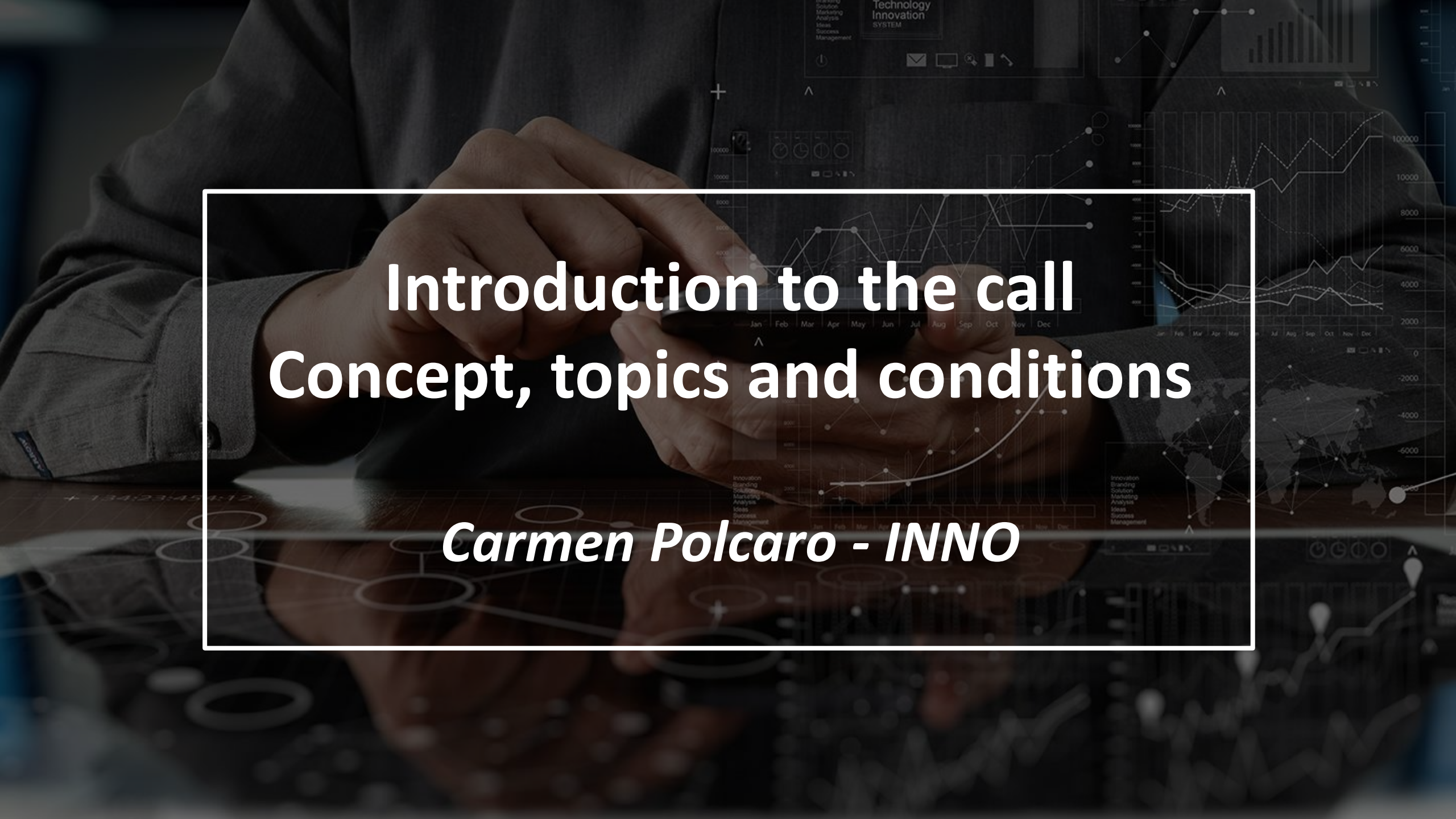
AIC Automotive Smart Factory (ASF)

CEA Factories of the Future Lorraine (FFLOR)

VTT Smart Machines and Manufacturing Competence Centre (SMACC)

POLIMI FoF Lab

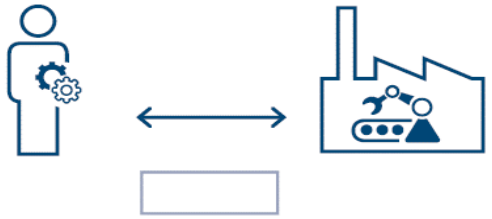
JSI Reconfigurable Cell



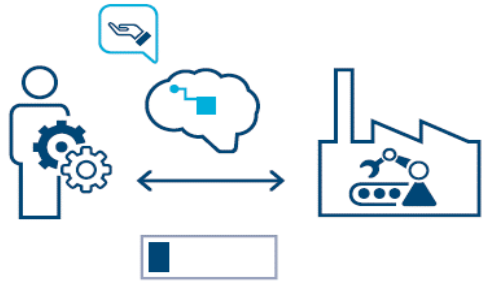
Introduction to the call
Concept, topics and conditions

Carmen Polcaro - INNO

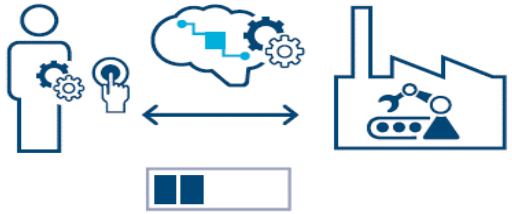
AI for Factories 4.0: Autonomous Factories



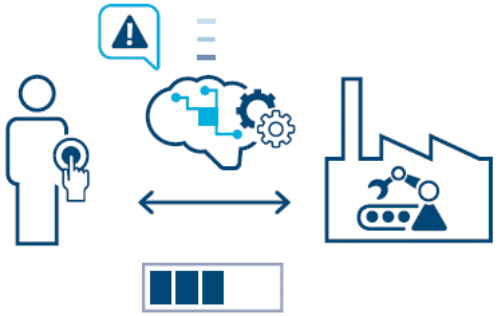
Autonomy Level 0
No autonomy, human beings have full control without any assistance.



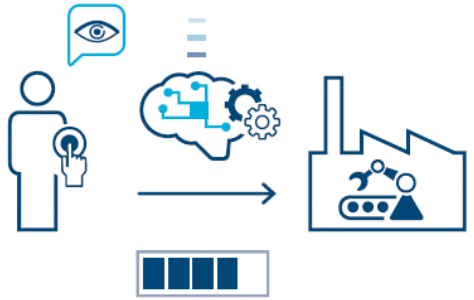
Autonomy Level 1
Assistance with respect to select functions, human beings have full responsibility and make all decisions.



Autonomy Level 2
Partial autonomy in clearly defined areas, human beings have full responsibility and define (some) goals.

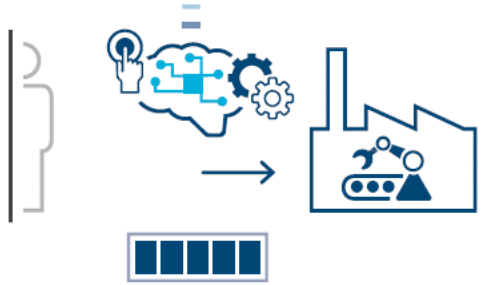


Autonomy Level 3
Delimited autonomy in larger sub-areas, system warns if problems occur, human beings confirm solutions recommended by the system or function at a fall-back level.



Autonomy Level 4
System functions autonomously and adaptively within defined system boundaries, human beings can supervise or intervene in emergency situations.

Production Level 4



Autonomy Level 5
Autonomous operations in all areas, including in cooperation and in fluctuating system boundaries, human beings need not be present.

Reliable IoT & 5G connectivity, ubiquitous edge-cloud integration, cybersecurity, data governance & transaction traceability

Atos

TTTech
Ensuring Reliable Networks

Telefónica

ENGINEERING

AIT
CENTER OF EXCELLENCE FOR RESEARCH AND EDUCATION

UNPARALLEL

OpenFog

AIOTI

HYPERLEDGER

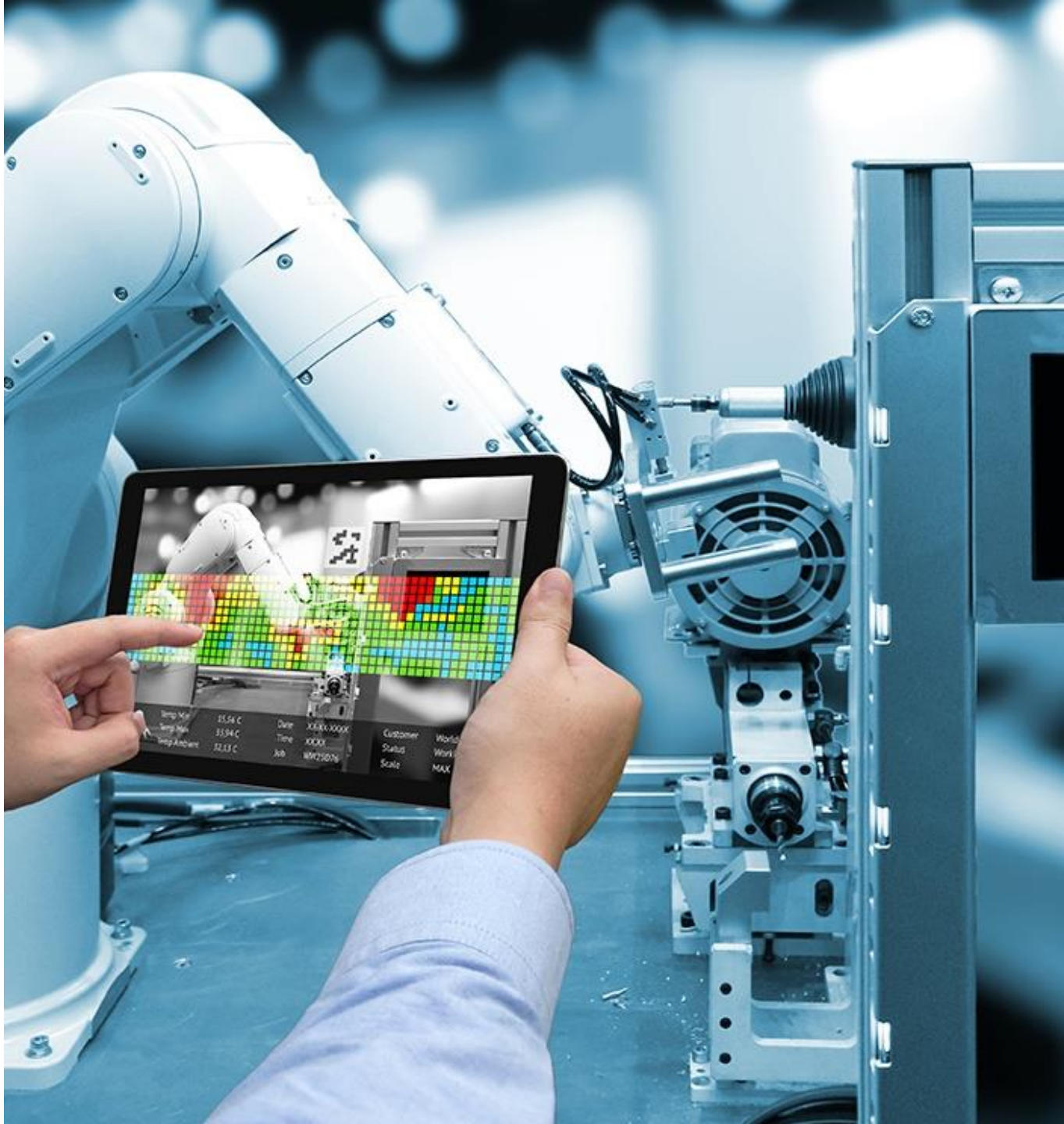
5G

“Plug & Control Manufacturing Equipment”

Real-time quality control, self-adaptation

+GF+ ghi SMART FURNACES FAGOR FAGOR ARRASATE PRIMA INDUSTRIE

UNIMETRIK METROLOGY AND CALIBRATION DANOBAT ASTI NXT CONTROL Schneider Electric

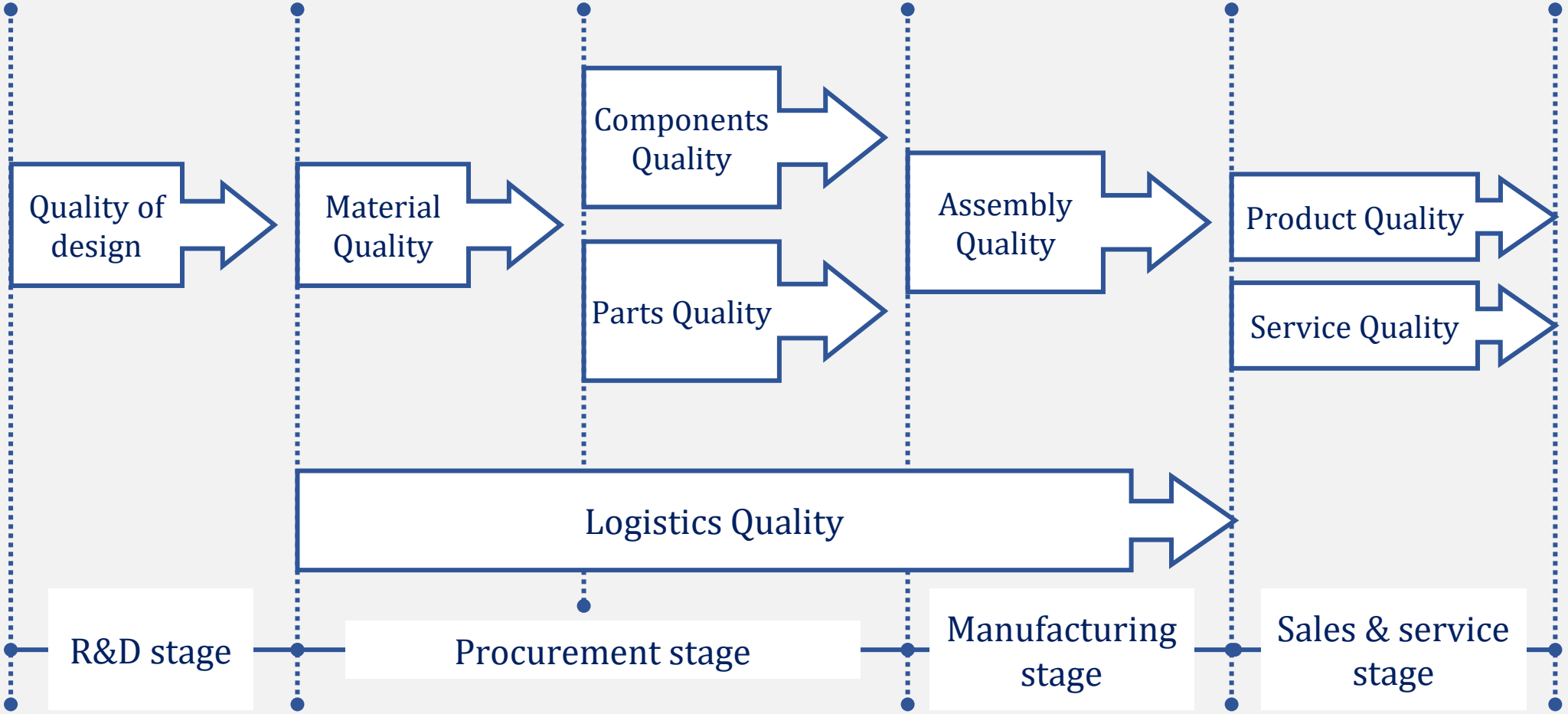


“AI-Powered Certified Digital Automation Shopfloors”

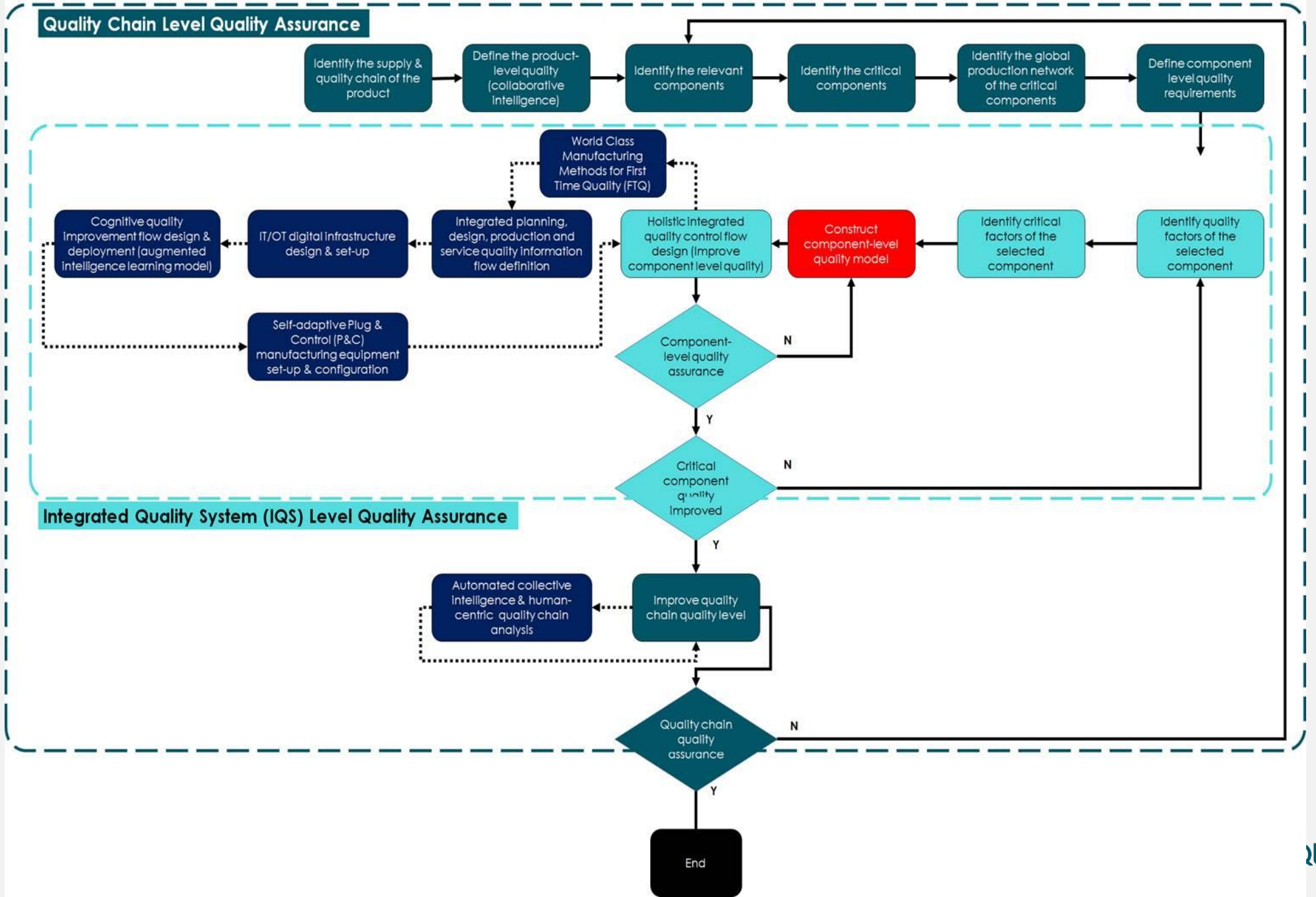
Open Big Data Pipelines, Data Sovereignty, Industrial Data Spaces, Platform Composability, Deep Analytics, Digital Twin Simulation Continuity, Augmented Decision Support.

SIEMENS
VISUAL COMPONENTS
ATLANTIS ENGINEERING
PACE
INTERNATIONAL DATA SPACES ASSOCIATION
ATB Institut für angewandte Systemtechnik Bremen GmbH
Synesis sustainable automation
SCS
Technische Universität Braunschweig
EPFL
tu technische universität dortmund
Technology Transfer System

Topics: Quality value chain



Autonomous Quality Control Model



Open call scheduling

TYPE A: New Autonomous Quality Pilot

Calls for new autonomous quality pilots .The calls will invite candidates to propose novel pilots that align to the QU4LITY autonomous quality concept, notably pilots that implement features and functionalities that are not available as part of the large- scale pilots of the consortium partners.

OBJECTIVES:

Pilots should be aligned to one or both of the following two objectives/themes:

Validate the QU4LITY concept, digital enablers/technologies in areas beyond the pilots of the consortium partners: Proposers should present novel pilots in-line with the QU4LITY concept of Autonomous Quality, the QU4LITY Reference Architecture for (Digital) Zero Defect Manufacturing (ZDM).

Demonstrate end-to-end Autonomous quality in a cross-border supply Chain pilot: Proposers should present digital quality management across a supply chain i.e. beyond a single industrial plant.

Topic A1: Data Driven AI for pattern recognition in Zero Defect Manufacturing for high performance product

Pattern recognition is the process of recognizing patterns by using an Artificial Intelligence algorithm, it can be defined as the classification of data based on knowledge already acquired or on statistical information extracted from patterns or their representation. Pattern recognition is able to detect arrangements of characteristics or data that provide value information about a given system or data set.

Applicants to topic Q1 are required to design, implement and experiment data driven algorithms for pattern recognition related to Zero Defect Manufacturing for identification of defects, proactive quality control, reverse engineering for high performance products. The aim is to demonstrate the potential of this technology to improve the quality control in any of the critical point of their quality value chain and to analyse its connection and impact on the whole manufacturing process.

Topic A2: Data Driven AI in Human Machine Collaboration for Zero Defect manufacturing

Partnering with machines is integral to the future of how we live and work. A new era of intelligent systems will be characterized by trust and understanding between humans and machine. This collaboration can provide many benefits. Machines or robot can assemble and consider more data points than humans, can incorporate and often provide a less biased support to decision and improve the productivity.

Applicants to topic Q2 are required to demonstrate the potential of the human machine collaboration for quality control in manufacturing, developing autonomous learning or decision-making algorithms to improve the quality in any of the critical point of their quality value chain and analyse its connection and impact on the whole manufacturing process.

Topic A3: Integration of Data driven inline Autonomous Quality in solutions for Zero Defect Manufacturing

Traditional quality control models such as Total Quality Control, end-of-line Statistical process control or in-line multi-stage quality control solutions are not fully capable to deal with the dynamism of the Smart Factory Scenario scenarios, calling for effective support to control smart and connected production processes.

Data Driven inline Autonomous Quality solutions can deliver learning and adaptation capabilities to manufacturing companies that need to quickly scale up from small to big lot-sizes, or between different parts whilst retaining the required quality.

Applicants to topic Q3 are required to demonstrate the potential of the Data driven inline Autonomous Quality solution in highly flexible manufacturing scenarios to cover the whole quality value chain.

Topic A5: Ensuring Quality Management in supply chain trough blockchain based technologies.

Quality assurance in complex production systems is a difficult problem to tackle, given the number of parties involved in the sourcing of raw materials and parts and the extreme customization of products. Moreover, Zero Defect Manufacturing goals require that Autonomous Quality solutions are extended to the entire supply chain, possibly including logistics. This objective poses unique challenges, as it implies that some suppliers, although being autonomous businesses, are fully integrated into the control loop. Blockchain technology can help by providing a common, company-neutral data exchange infrastructure where key information can travel between all stakeholders of a process with top guarantees of provenance, integrity and transparency.

Applicants to topic Q5 are required to develop novel distributed applications to control the quality and traceability of materials and products along the supply chain and analyse their connections and impact on the whole manufacturing process.

Topic A6 Integrating ZDM solutions in Mass Customization and Lot Size One Manufacturing processes

Mass customization as a strategy that allows the production of small lots (even as small as lot size one) is becoming more and more popular and is one of the main implementations of the concept of Industry 4.0. Mass customized products, though are complex, feature a significant amount of electronics or micro-features and are composed of advanced (multi-) materials - becoming stronger, lighter and smarter whilst remaining at least as safe or secure as previous versions.

Applicants to topic Q6 are required to develop novel applications for a Zero-Defect Manufacturing through the integration of Autonomous Quality (AQ) Control Loops into Mass Customization and Lot Size One processes, using data driven technologies.

CONDITIONS:

- Proposal must address one of the topics listed in 2.3.2
- Proposed pilots should align to the QU4LITY Reference Architecture.
- Proposed pilots should use QU4LITY digital enablers/technologies presented later. Nevertheless, pilots may include technologies of the proposers as soon as they align to the QU4LITY ZDM architecture.
- Pilots and their technologies should be integrated in the project's market platform

ALLOCATED BUDGET:

- €290.000 for the funding of 4 proposals (max budget: 72.500 € for proposal)
- Each proposal must be submitted by a single applicant, consortia are not allowed.

TYPE B: Expansion of QU4LITY pilot systems

The objective of the TYPE B call is to expand the scope of existing digital platforms and pilots with new functionalities and features and address one or more challenges posed by Qu4lity pilots.

OBJECTIVES:

Proposed solutions should align to one or both of the following two objectives/themes:

Validate the expandability of the QU4LITY digital platforms: Proposers should propose and implement extensions to the QU4LITY technologies, notably to the QU4LITY platforms used in the project's pilots.

Complement existing pilots and platforms with added-value features and functionalities: Proposer should propose extensions to existing pilot systems to address specific challenges posed by the pilot

Solutions should contribute to:

Expanding the QU4LITY ecosystem and broadening the solutions QU4LITY portfolio in the market platform: Proposers should describe their solution and how it will be made available through the QU4LITY market platform and Virtualized Innovation Hub.

CONDITIONS:

Solutions should align to the QU4LITY Reference Architecture.

Solutions must addressing challenges raised by the Qu4lity extend existing QU4LITY Digital Platform or Pilots addressing challenges raised by the pilots

ALLOCATED BUDGET: € 75,000 for the funding of 1 proposal (max budget: 75.000 € for proposal)

Each proposal must be submitted by a single applicant, consortia are not allowed.

Eligible costs

- Personnel Costs
- Equipment Costs
- Travel expenses
- Software licenses
- Subcontracting
- Indirect cost (25% of direct costs)

SMEs will receive as funding max 70% of the costs

Deliverables

Status of development	Timing	TYPE A Deliverables	TYPE B Deliverables
Pilot Maturity Level 1	M2	• Proof of concept • Alignment with the reference architecture • Alignment with the Qu4lity Autonomous Quality concept • M2 cost statement	• Proof of concept • Alignment with the Qu4lity Autonomous Quality concept • Integration strategy in the reference pilot • M2 cost statement
Pilot Maturity Level 2	M7	• Complete development of the pilot • Demo and dissemination material (video, ppt) • Participation to demo event organized by the consortium	• Complete development and integration in the Q of the pilot • Demo and dissemination material (video, ppt) • Participation to demo event organized by the consortium
Pilot Maturity Level 3	M9	• Business model • Integration in the Quality marketplace • Business Plan • M9 cost statement	• Business model • Integration in the Quality marketplace • Business Plan • M9 report

Qu4lity Reference Architecture

Angelo Marguglio - Engineering

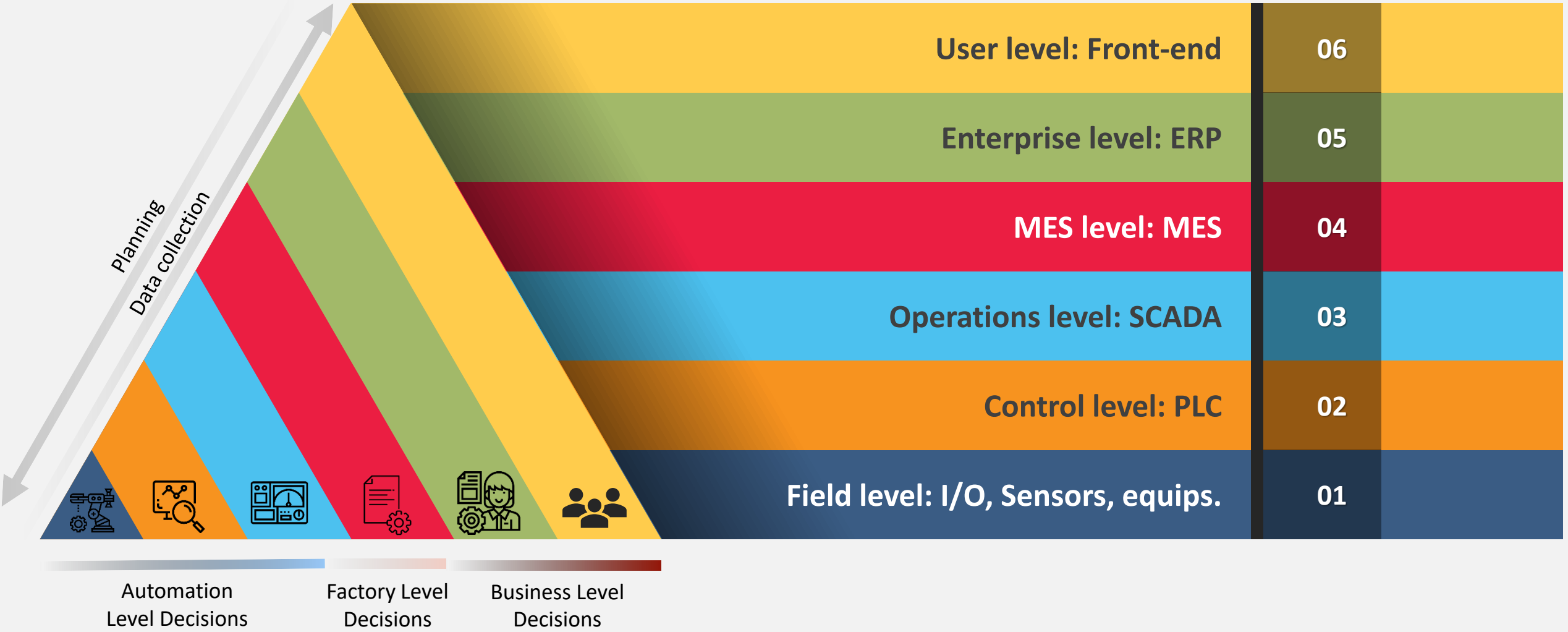

QU4LITY AI-powered Decision Workflow & Control Loops


1. Trusted Digital Infrastructures


3. AI-Powered Certified Digital Automation Shopfloors


2. Plug & Control Manufacturing Equipment

Autonomous Factories 4.0: ZDM Decision & Control Workflows (Data Flows)



QU4LITY approach :: Reference Architectures for Digital Manufacturing Platforms

RAMI 4.0

Reference Architecture Model Industry 4.0

IIRA

Industrial Internet Reference Architecture

DSA

Digital Shopfloor Alliance

FIWARE For Industry

Reference Architecture FIWARE for Industry

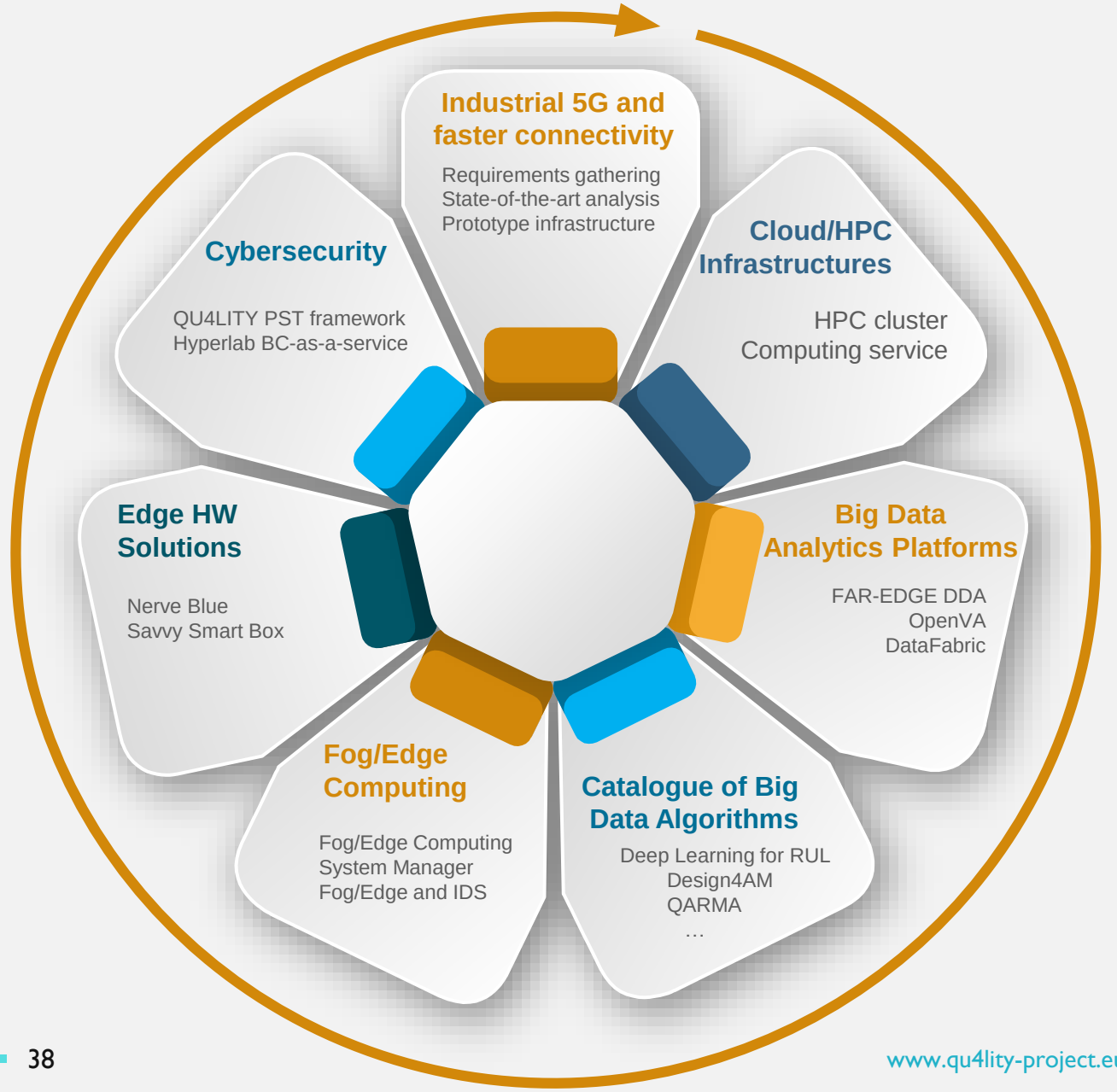
IDSA

Reference Architecture Model of the Industrial Data Space

QU4LITY Reference Architecture (Q-RA)

Based on reference open implementations and standards:

Technical Pillars :: AI-powered Digital Enablers

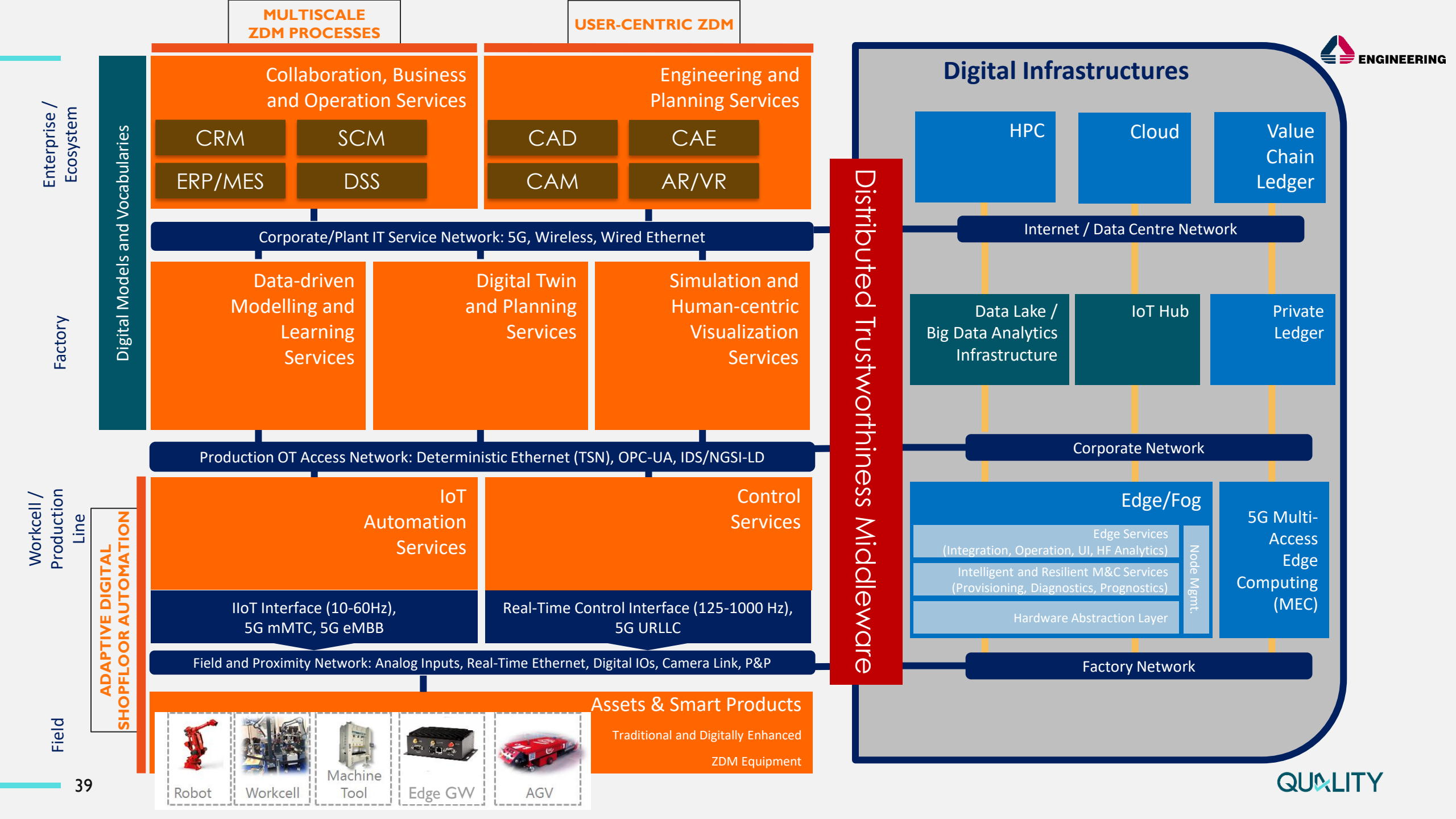


Networking4AI
Industrial Networks
4G Private LTE / Industrial 5G

Edge4AI
Fog/Edge Computing
Industrial IoT
Edge nodes
Distributed learning

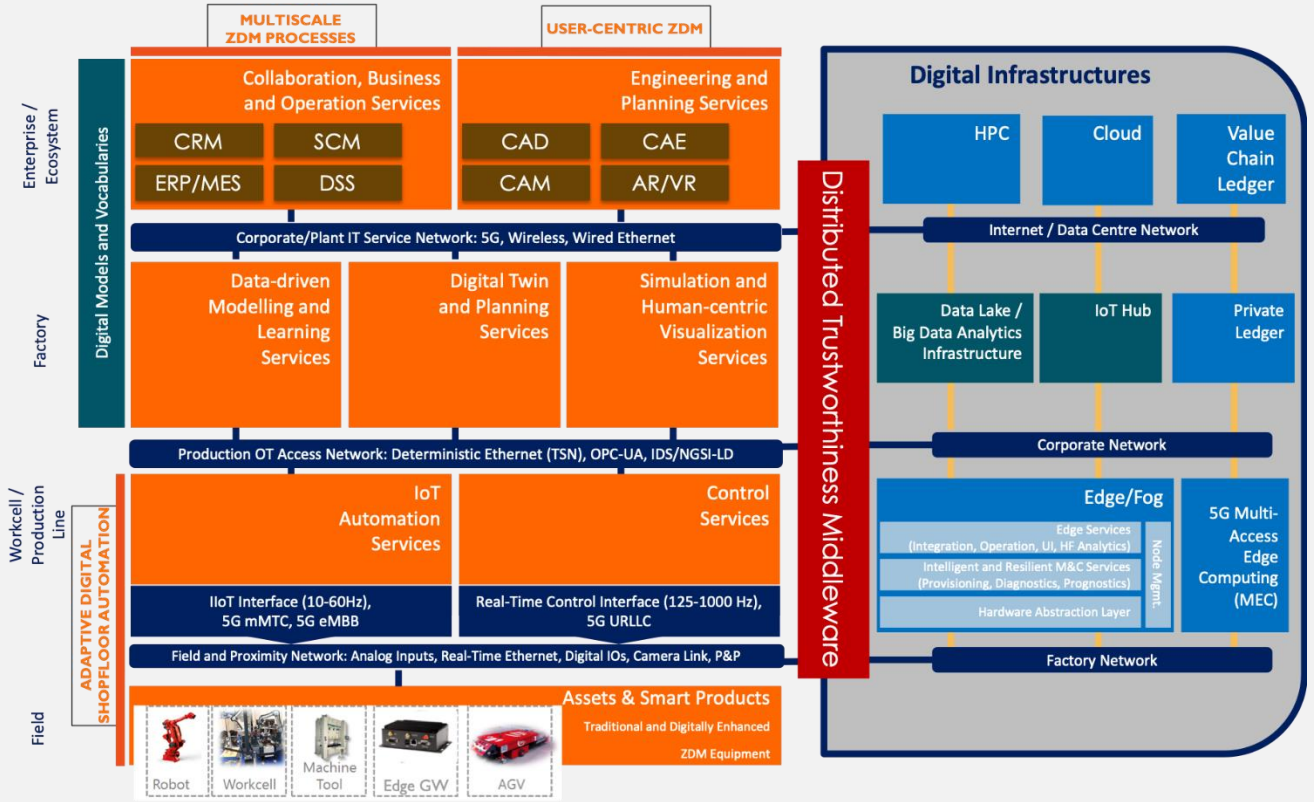
Cloud4AI
Cloud / HPC
Scalable and secure Data Center
Big Data analytics and algorithms

Security4AI
Cybersecurity
Decentralized Ledgers
Smart Contracts


MULTISCALE ZDM PROCESSES
USER-CENTRIC ZDM
ENGINEERING
Enterprise / Ecosystem
Factory
Workcell / Production Line
Field
Digital Models and Vocabularies
ADAPTIVE DIGITAL SHOPFLOOR AUTOMATION
Collaboration, Business and Operation Services
CRM
SCM
ERP/MES
DSS
Engineering and Planning Services
CAD
CAE
CAM
AR/VR
Corporate/Plant IT Service Network: 5G, Wireless, Wired Ethernet
Data-driven Modelling and Learning Services
Digital Twin and Planning Services
Simulation and Human-centric Visualization Services
Production OT Access Network: Deterministic Ethernet (TSN), OPC-UA, IDS/NGSI-LD
IoT Automation Services
Control Services
IIoT Interface (10-60Hz), 5G mMTC, 5G eMBB
Real-Time Control Interface (125-1000 Hz), 5G URLLC
Field and Proximity Network: Analog Inputs, Real-Time Ethernet, Digital IOs, Camera Link, P&P
Assets & Smart Products
Traditional and Digitally Enhanced ZDM Equipment
Robot
Workcell
Machine Tool
Edge GW
AGV
Distributed Trustworthiness Middleware
Digital Infrastructures
HPC
Cloud
Value Chain Ledger
Internet / Data Centre Network
Data Lake / Big Data Analytics Infrastructure
IoT Hub
Private Ledger
Corporate Network
Edge/Fog
Edge Services (Integration, Operation, UI, HF Analytics)
Intelligent and Resilient M&C Services (Provisioning, Diagnostics, Prognostics)
Hardware Abstraction Layer
Node Mgmt.
5G Multi-Access Edge Computing (MEC)
Factory Network

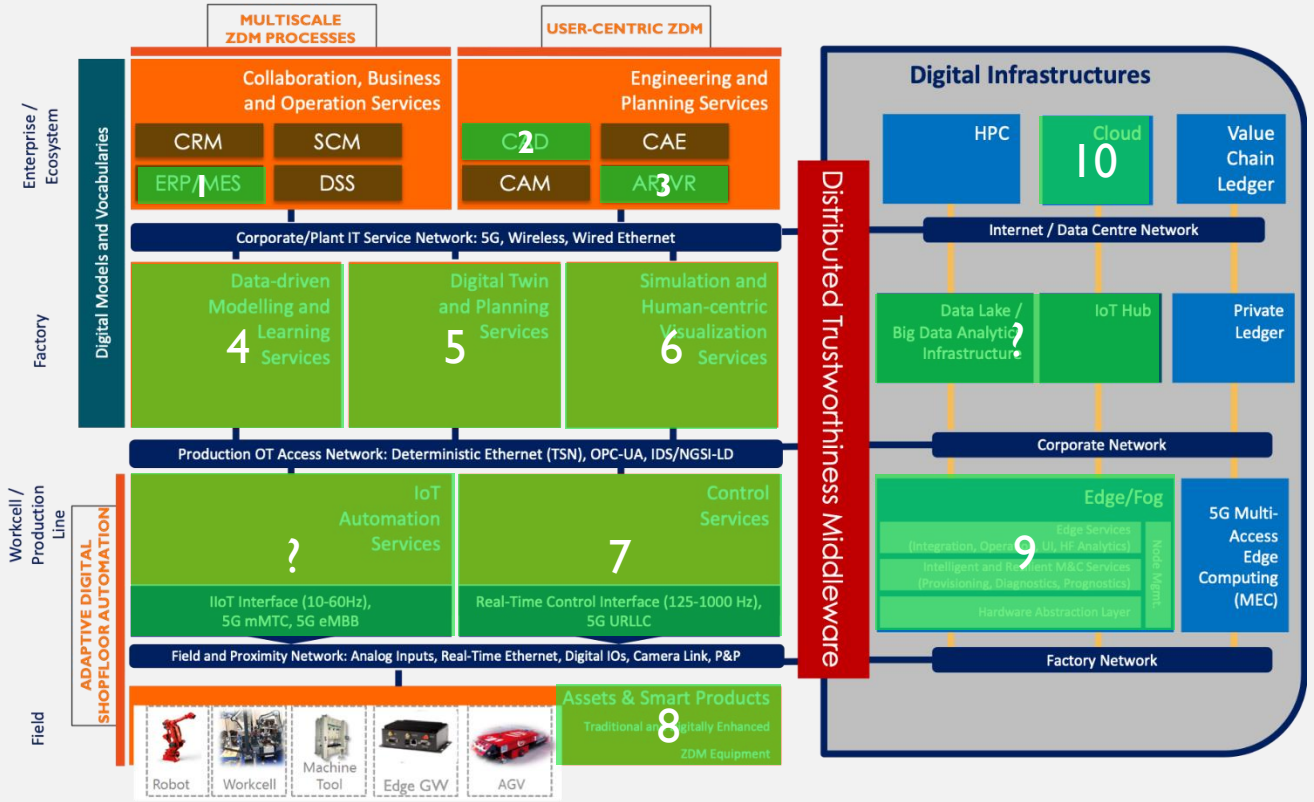
QUALITY

Mapping of OC experiment towards QU4LITY RA



- How to perform the mapping:
  - A. Which components of the OC experiment are related to processes/components of the Q-RA?
    (Please also list components that can not be mapped to the RA properly)
  - B. Please describe the OC experiment components with more details.
  - C. What interoperability standards and data exchange formats are used at the interface of these components?

Mapping of OC experiment towards QU4LITY RA (Example)



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  - B. Please describe the OC experiment components with more details.
  - C. What interoperability standards and data exchange formats are used at the interface of these components?

Qu4lity Enablers: Qarma

John Soldatos - Intrasoft

What is QARMA?

- INTRASOFT's Machine Learning Framework for Data Mining of Large Industrial Data sets
- High-Performance & Able to Identifying Rare Events (e.g., Machine Failures)
- Already Validated in Various EU Projects (e.g., PROPHESY, QU4LITY) and Real-Life Industrial Use Cases

Main Principles:

- Mining of rules in multi-dimensional datasets where the features in the dataset are in general numerical vectors of varying lengths per feature.
- QARMA operates in parallel using as many cores as there are available in a cluster of machines that can have hundreds of machines connected to it.

Added value of the selected algorithm:

- Extract high-confidence rules on industrial datasets, even for events that occur rarely
- Provide explainable representations of the knowledge that boosts transparency and acceptance by stakeholders (e.g.. Plant Managers, Maintenance Engineers, Quality Engineers)

Scenarios of Use (Two steps process):

- **Input:** A manufacturing company must provide a dataset containing sensor measurements from one or more of its production machines and/or tools configured on those machines along with information about tool breakages and parts made since last breakage using a particular tool.
  - The dataset can be arbitrarily large, but cannot be arbitrarily small.
  - A few thousand datapoints are needed for the models to be properly trained.
  - Sparse datasets (few non-empty data attributes per instance) are likely better suited to the enabler than fully dense datasets (that are usually artificially created).
- **Output:** The QARMA family of algorithms will run and the output predictions of the overall model will be made available via a REST API described immediately below.

Accessing the Enabler:

- A REST API on an INTRASOFT Intl URL will be defined and made available to the Open Call winner that will opt for using QARMA

QARMA related Publications

- I.T. Christou, N. Kefalakis, A. Zalonis, J. Soldatos, "Predictive and Explainable Machine Learning for Industrial Internet of Things Applications", IEEE Distributed Computing on Sensor Systems Conf., Workshop on IoT Applications and Industry 4.0, June 15-17, 2020.
- I.T. Christou, N. Kefalakis, A. Zalonis, J. Soldatos, R. Bruchler, "End-to-End Industrial IoT Platform for Actionable Predictive Maintenance", 4th IFAC Workshop on Advanced Maintenance Engineering, Services and Technologies, Cambridge, UK, Sep. 10-11, 2020
- I.T. Christou, "Avoiding the Hay for the Needle in the Stack: Online Rule Pruning in Rare Events Detection", IEEE Intl. Symp. On Wireless Communication Systems, Special Session, IoT in Energy Systems & Industrial Environments, Oulu, Finland, Aug. 27-30, 2019.
- I.T. Christou, E. Amolochitis, Z.-H. Tan, "A Parallel/Distributed Algorithmic Framework for Mining All Quantitative Association Rules", arXiv preprint arXiv:1804.06764, Apr. 2018
- J. Soldatos and Ioannis T. Christou, "IoT Analytics: From Data Collection to Deployment and Operationalization", in J. Soldatos (ed.) "Building Blocks for IoT Analytics", River Publishers, 2016.

Contacts & More Information

- Dr. Ioannis T. Christou, Ioannis.Christou@intrasoft-intl.com
- Dr. John Soldatos, Ioannis.Soldatos@intrasoft-intl.com

Qu4lity Enablers: Rule Metrics

Ifigenia Metaxa - Atlantis

What is the Remaining Useful Life?

- RUL metric: length from now to the end of the useful life of an asset.

What is the end of useful life of an asset?

- literal meaning,
- damage of asset,
- violation of the standard quality of the end product.

RUL analysis (regardless of definition)

- provides information on deterioration rate of equipment,
- enables informed planning of maintenance activities,
- minimizes negative impact on productivity,
- contributes to the avoidance of quality issues in the manufacturing plant.

What does RUL enabler do?

- estimates the RUL of the equipment until the next hardware or quality failure
- gives time to schedule stops, avoid major failures and reduce downtime

How?

- advanced data-driven approach for RUL estimation of critical components based on deep learning (i.e. Long Short-Term Memory (LSTM) algorithm) and Complex Event processing (CEP)
- relies on historical data for training of LSTM models
- relies on real-time data for online evaluation of RUL

Added value of the selected algorithm?

- identify relationships both among various sensor measurements and from different points of time,
- CEP to identify product cycles to train models capable of reporting reliable time-independent results.

How can you use it?

For which Applicants is this solution suitable? Do you have?

- Real-time sensor data,
- Historical data,
- Log files with previous hardware or quality faults (Fault and timestamp),
- Correlation between faults and signal (nice to have),

What will you get?

- dockerized solution (deployable either on premises or on a remote location),
- default parametrisations for model training,
- custom solutions built through mentoring,
- generic approach for data fetching,
- custom data transfer bridges can be developed with any available data handling system,
- improved quality of produced parts and critical points of value chain,
- access to failure logs from the shop-floor is expected.

What benefits can you expect?

- Reduction of operation and maintenance costs
- Increase of productivity
- Increase of Remaining Useful Life
- Reduction of downtime
- Increase of MTBF (Mean Time Between Failures)
- Reduction of MTTR (Mean Time To Repair)

Overall

- estimation on when the next failure is predicted with an adequate level of uncertainty,
- optimise production schedule and maintenance schedule,
- avoid failures and breakdowns,
- improve availability of equipment and production lines,
- improve health of machines,
- avoid deterioration of machines with preventive rather than with corrective actions.

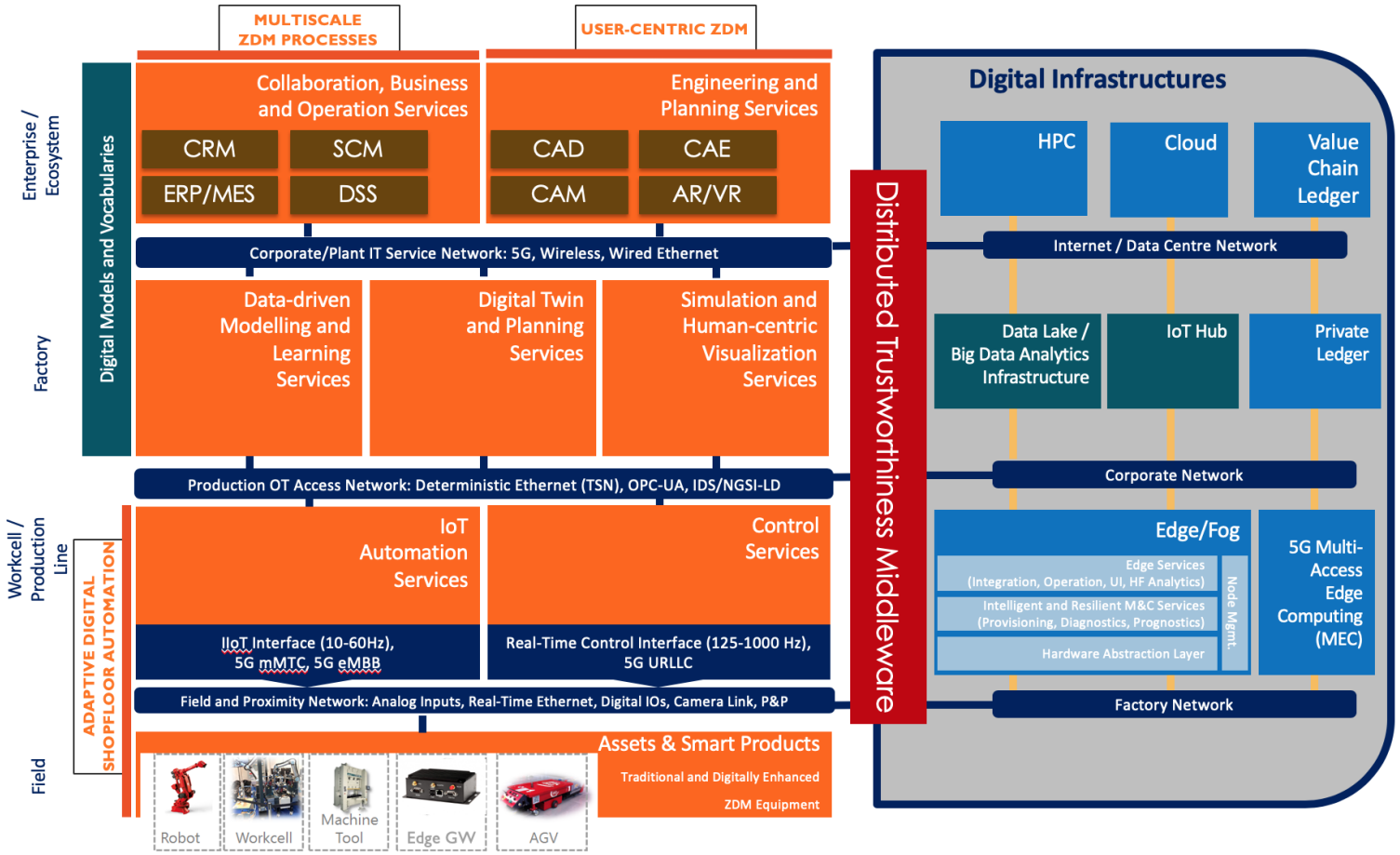
Qu4lity Enablers: Blockchain Infrastructure

Mauro Isaja - ENG

Context

In the QU4LITY Reference Architecture, the DLT Infrastructure is referred to as the Value Chain Ledger (VCL) and also as Private Ledgers (PL).

The VCL is a single common facility used by multiple organizations that belong to the same business ecosystem, while the PL term refers to any private Blockchain instance deployed internally to a specific organization, with no information shared with the outside world.



Context

The use of Blockchain in QU4LITY enables secure state sharing and synchronization of distributed industrial processes involved in ZDM. For instance, *smart contracts* can improve agreements management between manufacturers, customers and other stakeholders in a supply chain.
From the perspective of ZDM applications, there are two important categories of functionality that smart contracts can enable:

- Decentralization of control: processes with multiple autonomous actors can be run safely without the supervision of an authority.
- Trustworthy tracking of events: despite the lack of a central repository, everything written on a Blockchain by a smart contract cannon be altered or removed. Adding digital identities and signatures to the picture results into a system of record that enforces *nonrepudiation*.

DLT Services

A DLT Service is a smart contract deployed on the common VCL instance, plus the client software used by applications to connect and interact with it.
The QU4LITY library of DLT Services provides generic ZDM functionality that runs on the VCL and can be used – on request – by any QU4LITY partner:

- **Quality Clearing House** (QCH) enables a decentralized workflow for quality management in supply chain scenarios.
- **Decentralized Analytics Engine Configuration** (DAEC) enables secure and tracked distribution of data processing directives in a distributed data analytics system based on Edge Computing.
- **Secure Analytics Results Publishing** (SARP) enables the edge nodes of a distributed data analytics system based on Edge Computing to share their "local" results on the DLT Infrastructure, thus contributing to a common data set representing the combined results across the entire network.

Example: the Quality Clearing House

QCH provides a common system of record for a manufacturing ecosystem where actors need to continuously assess the quality of raw material, parts and final products and match the results against contractual standards that may change frequently.

0. Company A is the manufacturer of a final product. Company B is a manufacturer of parts. Company C provides some "smart" metrology equipment that is deployed by Company A.

1. **A** defines the quality standard of the supply chain and configures the QA plan: a *Quality Assessment Model* record is published on the ledger.

2. **B** ships a batch of parts: a *Shipping Unit Manifest* record is published on the ledger.

3. **A** receives and processes the shipment: a *Quality Assessment Report* record is published on the ledger by the metrology smart equipment, on behalf of **C**.

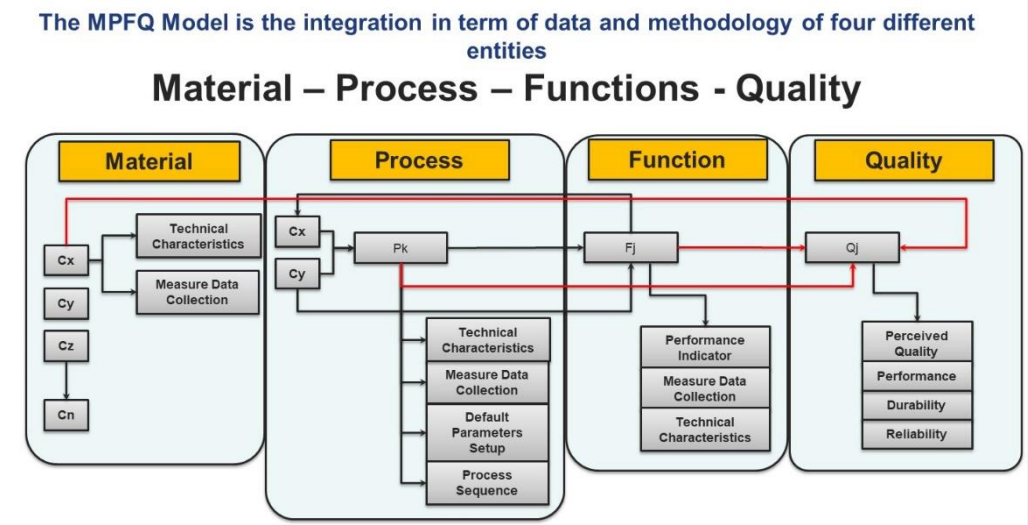
4. When payment to B is due, **A** applies any penalties and discounts defined in the plan for missed quality targets, as documented by the ledger.

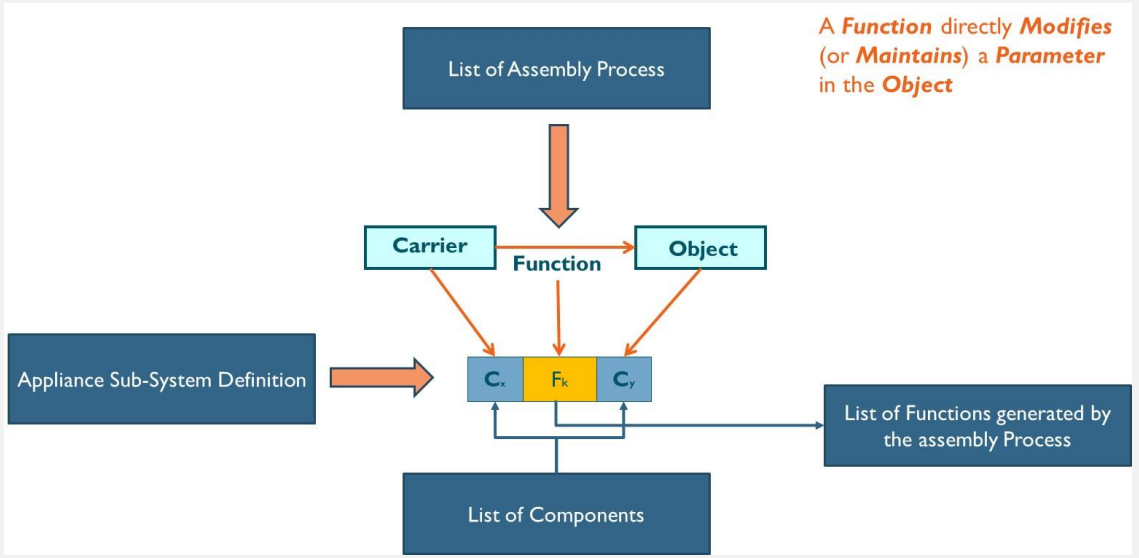
(5.) Optionally, **A** may pay C for the actual usage of its equipment, as documented by the ledger.

Type B Call Challenge

Pierluigi Petrali, Claudio Turrin
Whirlpool

Type B: Challenge





BASIC features of graphical tool

- Edit the functional model of a system of components and store the result of the graph in a machine readable format. The graph consist in two type of elements: materials and external entities (represented by rectangles and hexagons) and functions, represented by named arrows.
- Edit the Process Map of a production system using IDEF-0 or other suitable standard representations
- Associate each Function mapped with a specific process step
- Define a set of Quality performances and associate them to a set of components, functions, process

Qu4lity Market Platform

John Soldatos - Intrasoft

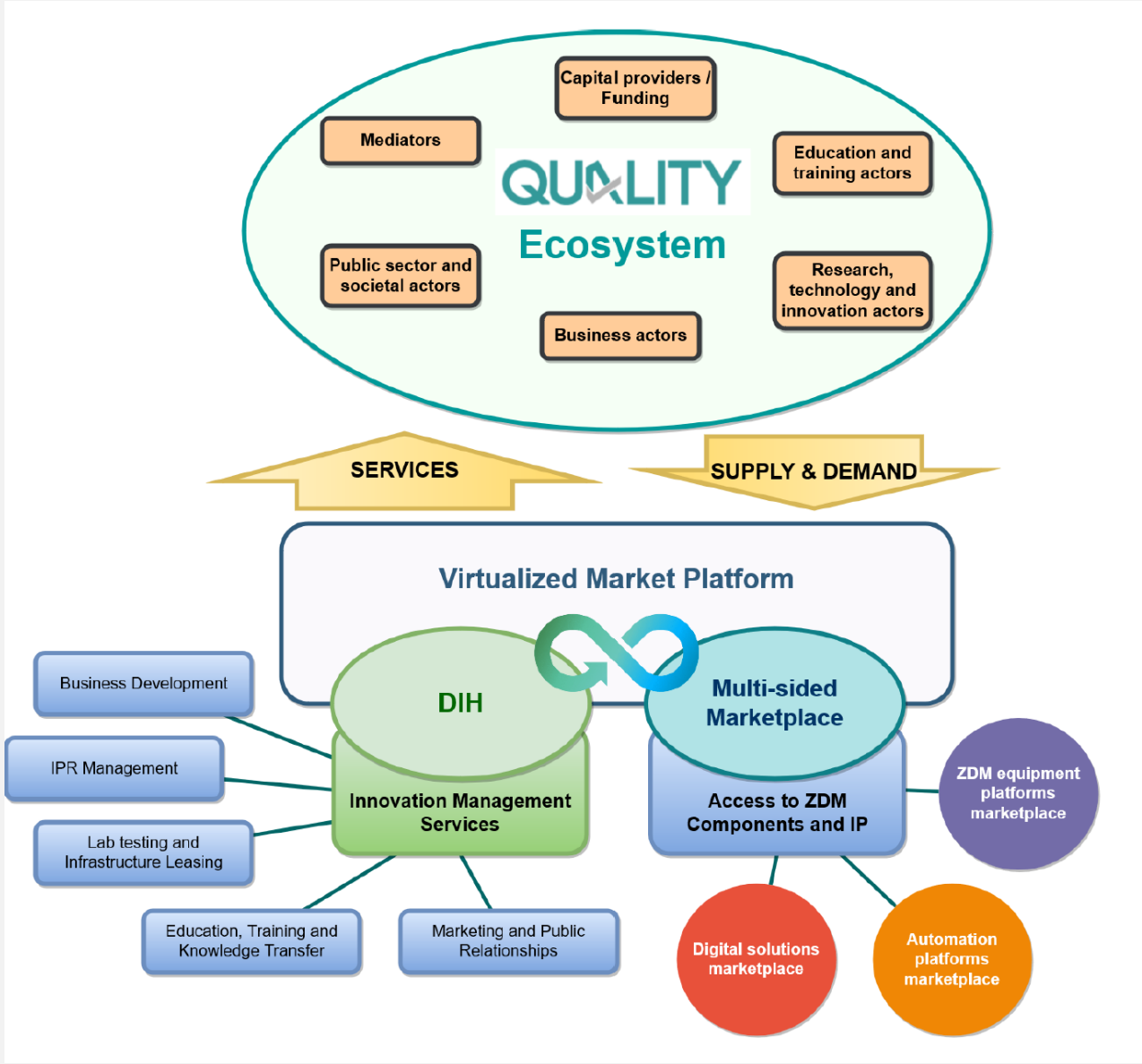
QU4LITY Market Platform Concept & Services

Market Platform & QU4LITY Results

- Single Point of Access to QU4LITY Results, notably ZDM related market-ready IP
- Examples:
  - Machine Learning Algorithms
  - BigData Analytics Middleware Platform
  - Enablers for Semantic Interoperability

Market Platform & Innovation Management Services

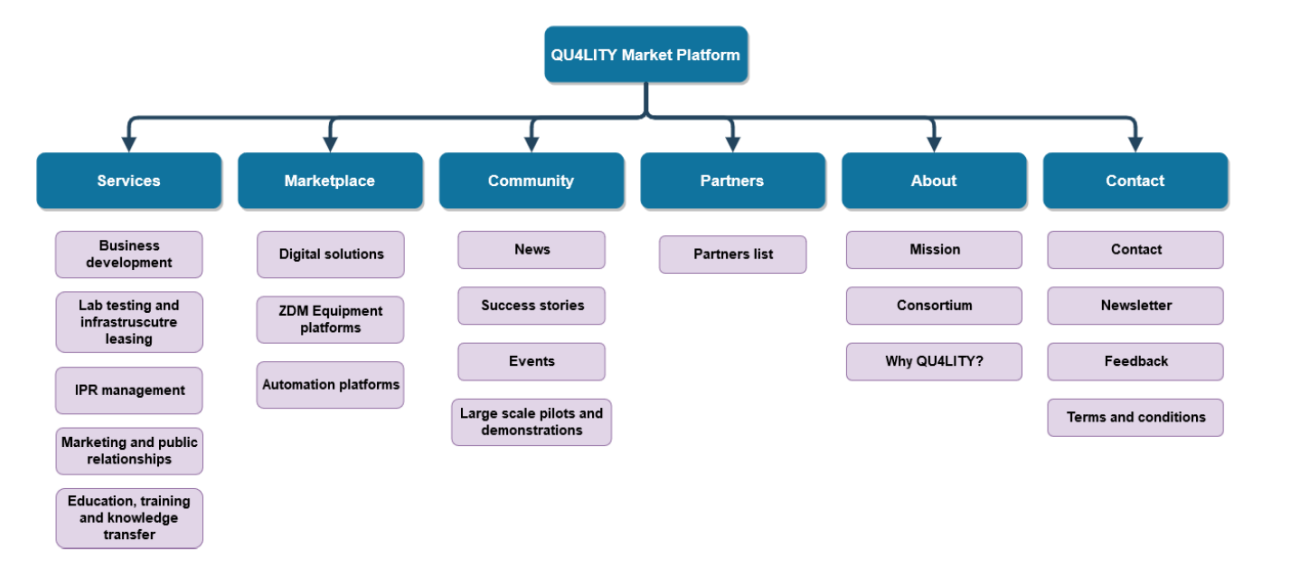
- Single Point of Access to QU4LITY Innovation Management Services
- Virtualized Digital Innovation Hub Concept
- Examples:
  - Access to Experimental Facilities (Testbed)
  - Training & Education Services
  - Support for Business Case Development

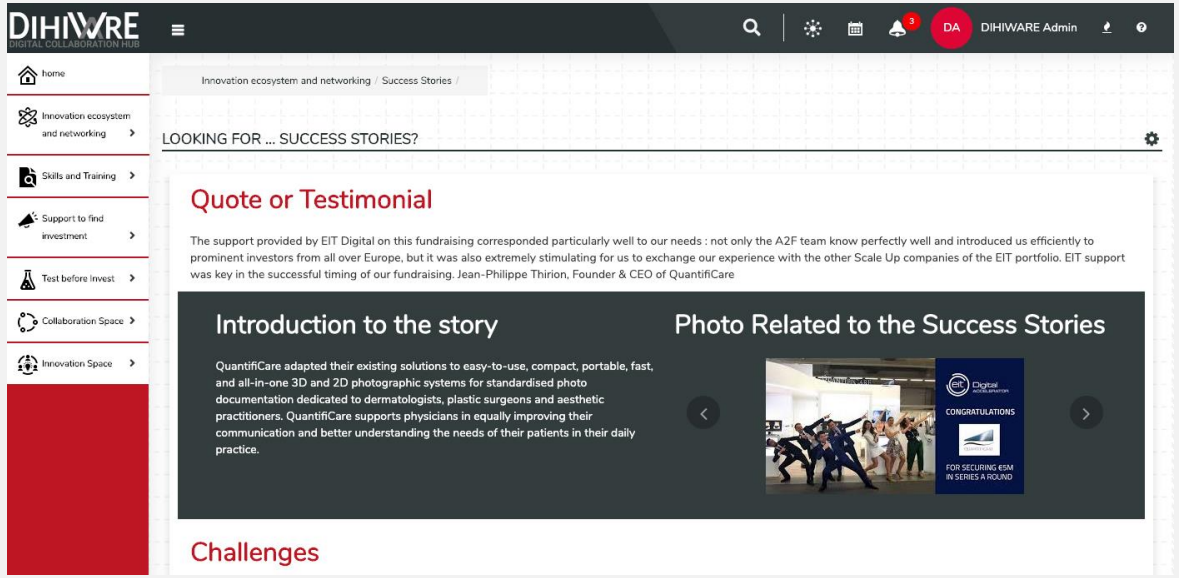


QU4LITY Market Platform: Implementation & Information Structure

Market Platform Implementation

- Implemented Over Existing Portal Platforms & IP Catalogues (i.e. IoT Catalogue, DIHIWARE)
- Information Architecture & Content Structure Available
- Alpha Version of Platform Available (Public Launch Expected in July 2020)





Open Call Proposer should:

- Describe the results that will be made available in the QU4LITY Market Platform
- Follow instructions and mandates listed in the Open Call Text
- Examples:
  - Digital Enablers: ML Algorithms, Data Platforms etc
  - Turn-Key ZDM Solutions
  - Open Datasets
  - Methodologies / Blueprints e.g., Quality Management / ZDM Methodologies

Open Call Winners should:

- Integrate the results in the QU4LITY Market Platform
- Prepare Relevant Content, including:
  - Market Level Description of the Results
  - Package for the Distribution of the Results (e.g., Docker Image)
  - Other Relevant Documentation (e.g., Samples, Presentations, Manuals)
- Register with the Market Platform and help QU4LITY grow its community

Open Call Winner Maintain the Ownership of their results

- QU4LITY partners won't claim IP of foreground developments carried out in the scope of Open Call Experiments
- They will however retain the background that might be used for developing the experiment
- Market Platform integration does not imply any obligation for sharing IP with QU4LITY partners
- Market Platform is (yet another) promotional channel for the dissemination and exploitation of the market-ready results of the Open Calls
- Open Calls Winners are expected to use it as much as possible
- Win-Win benefits with the QU4LITY Consortium
- **Conclusion**: Proposers should not hesitate to propose ideas that will enhance the value of the Market Platform and will help building the QU4LITY Community

QU4LITY

Thank you for your attention !!

Qu4lity

@EuQu4lity

www.QU4LITY-project.eu

Co-funded by the Horizon 2020 Programme of the European Union. Grant agreement ID: 825030

Partners:


INTELLIMECH
CONSORZIO PER LA MECCATRONICA

SIEMENS

Atos

AIRBUS

MONDRAGON

NXT
CONTROL

Institut für angewandte
Systemtechnik Bremen
GmbH

Continental

RIA STONE

UNIMETRIK
METROLOGY AND CALIBRATION

Technology
Transfer System

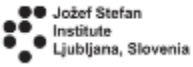
EPFL

SCS

FAGOR
FAGOR ARRASATE

TTTech
Ensuring Reliable Networks

technische universität
dortmund

thyssenkrupp

Jožef Stefan
Institute
Ljubljana, Slovenia

PRIMA
INDUSTRIE

eit Digital

ENGINEERING

P A C E
a TXT company

innovalia
ASSOCIATION

Telefónica

Synesis
sustainable automation

ghi

UNPARALLEL

DANOBAT

POLITECNICO
MILANO 1863

Whirlpool

VTT

VISUAL
COMPONENTS

ASTI

Fraunhofer

cea

INTERNATIONAL DATA
SPACES ASSOCIATION

PHILIPS

ATLANTIS

aic
AUTOMOTIVE
INTELLIGENCE
CENTER

KOLEKTOR

INTRASOFT
INTERNATIONAL

SINTEF

+GF+

Technische
Universität
Braunschweig

TNO innovation
for life

European
Research
Programme
Consulting

TTTech
industrial